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Best practices on how to increase the uptake of renewable energy

Good practices and policies for intersectoral synergies to deploy renewable energy: the water-energy-food ecosystems nexus approach to support the Sustainable Development Goals

Note by the secretariat

Summary

With the aim of increasing the uptake of renewable energy in the United Nations Economic Commission for Europe region, and within the context of its work plan, the Group of Experts on Renewable Energy considers renewable energies to be in close correlation with cross-cutting areas, including the energy-water nexus. The Work Plan 2016–2017 of the Group of Experts focuses its activities on the following activity areas: 1. Tracking of the progress made in the uptake of renewable energy sources in the United Nations Economic Commission for Europe region; 2. Exchange of know-how and best practices in the United Nations Economic Commission for Europe region on how to help significantly increase the uptake of renewable energy; and 3. Integration of Renewable Energy into Future Sustainable Energy Systems in the region.

The present document highlights the potential of renewable energies to contribute to sustainable development in the energy sector and beyond, provided that intersectoral effects and possible synergies, as well as environmental impacts are taken into account. It does so by drawing upon the assessments of the water-food-energy-ecosystems nexus carried out in transboundary river basins under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, as part of the Programmes of Work 2013–2015 and 2016–2018. The document, revised in accordance with comments from the Group of Experts, will be revised at its annual session and distributed as a policy brief with recommendations for possible concrete actions.

I. Introduction

1. The United Nations Economic Commission for Europe (ECE), consisting of 56 member countries, gradually contributes to the development of the region's vast renewable energy resources in synergy with the more sustainable use of other resources such as water, land and food. A holistic perspective, which allows the preservation of the integrity of ecosystems, is integral to this approach. These efforts are in line with the 2030 Agenda for Sustainable Development, in particular with its Sustainable Development Goal 7 which advocates for access to affordable, reliable, sustainable, and modern energy for all. The The Sustainable Development Goal on energy is closely linked to those on food security and sustainable agriculture (N.2), water and sanitation (N.6), sustainable consumption and production patterns (N.12) and the protection and sustainable use of ecosystems (N.15). Achieving them will require coordination across sectors, coherent policies, and integrated planning. Transboundary cooperation will be necessary to achieve the sustainable management of water resources and, at the same time, increase the share of renewable energy sources and agricultural productivity, and therefore contribute to the achievement of SDGs.

2. The Group of Experts on Renewable Energy (the Group of Experts) is encouraging the exchange of know-how and best practices between member States, relevant international organizations and other stakeholders on how to significantly increase energy production from renewable sources as a means of sustainable development and climate change mitigation. This work is undertaken collaboratively with other organisations and stakeholders in a context of complementarity, as indicated in its Work Plan 2016–2017.

3. The scope of this paper is intended to encourage the consideration of good practices and policies for intersectoral synergies and for limiting negative impacts in deploying and developing renewable energy in the region. Countries in the region have different levels of progress in ensuring their energy security and development of their renewable energy potential. According to the United Nations Economic Commission for Europe Renewable Energy Status Report[1], prepared together with the Renewable Energy Policy Network for the 21st Century - REN21, several countries continue to face strategic energy challenges, such as the need to enhance energy security, continuing seasonal power outages and insufficient energy challenges that could potentially become drivers for renewable energy deployment. Renewable energy can also play a central role in the countries' climate change mitigation efforts. An example from the Sava River Basin, on which information is given below, shows that the development of renewable energy through a combination of hydropower, wind and solar technologies contributes to a reduction of greenhouse gas emissions. At the same time, climate change further adds to their challenges by introducing new uncertainties into accessing resources and also making existing systems more vulnerable. Policy makers, therefore, need to identify integrated solutions that can address trade-offs and maximise security across all sectors.

4. The Group of Experts, since 2014, has assisted national governments in enhancing their uptake of renewable energy. Nevertheless, a lack of intersectoral coordination is a major challenge both on the national and transboundary levels throughout the region, and presents an additional barrier to renewable energy development. This challenge is present in energy, land management and water resources planning. For example, when developing hydropower in transboundary settings, the trade-offs and externalities between water and energy management or the environment may cause friction between upstream and downstream countries and slow down or hamper project development.

[1] The full report is at http://www.unece.org/energywelcome/areas-of-work/renewable-energy/unece-renewable-energy-status-report.html

5. Renewable energy technologies could address some of the trade-offs between water, energy and food production/agriculture, bringing substantial benefits to all three sectors, as highlighted by a report[2] prepared by the International Renewable Energy Agency advocating for a nexus approach. They can moderate competition by providing energy services using less resource-intensive processes and technologies than conventional energy. The distributed nature of many renewable energy technologies also means that they can offer integrated solutions for expanding sustainable energy, while enhancing security of supply across the three sectors, hence contributing to addressing the region's strategic energy challenges. Distribution of small scale-solutions can also reduce their environmental impacts.

6. The meaning of "nexus", in the context of energy, water and food (agriculture) refers to the inseparable linkage of these sectors, so that actions in one sector commonly have impacts on the others, as well as on ecosystems. The "nexus approach" described in this brief aims to support more sustainable renewable energy deployment by building synergies, increasing efficiency, reducing trade-offs and improving governance among sectors, with an emphasis on transboundary cooperation in both energy sector development and water management.

7. This policy brief summarises the recent and on-going work done by the Group of Experts in cooperation with the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) on the energy-water-food-ecosystems nexus and its implications for renewable energy deployment. The brief builds upon the nexus assessment, carried out in the framework of the Water Convention, to demonstrate the know-how, good practices and lessons learned in policies and measures for countries that want to fully utilise their renewable energy sources. Basin river case studies will be presented to demonstrate concrete examples. Policy conclusions and recommendations will be highlighted to inspire further work of the ECE Group of Experts.

II. Background and key activities

8. The Parties to the Water Convention decided on an assessment of the water-food-energy-ecosystems nexus to be carried out as a means of effectively addressing the aforementioned challenges. In the Water Convention's framework, a set of assessments were made in transboundary basins in South-Eastern Europe and Caucasus and Central Asia.

9. The cycle of nexus assessments had the overall aim of enhancing transboundary cooperation between countries through a participatory process. First, related sectors and relevant stakeholders identified intersectoral challenges and opportunities for benefits from stronger integration across sectors. Second, the assessments presented practical solutions to trade-offs between the sectors. So far, four nexus assessments have been undertaken in Alazani/Ganikh (Azerbaijan, Georgia), Sava (Bosnia and Herzegovina, Croatia, Montenegro, Serbia, and Slovenia), Syr Darya (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan[3]) and the Isonzo/Soča[4] (Italy, Slovenia) basins throughout 2013–2015. The

[2] IRENA (2015), 'Renewable Energy in the Water, Energy & Food Nexus'.

[3] It should be noted that Uzbekistan does not associate itself with the nexus assessment of the Syr Darya.

[4] The nexus assessment of the Isonzo/Soča in its first phase focused on the Italian part of the basin. A summary is available in document Assessment of the water-food-energy-ecosystems nexus in the Isonzo/Soča River Basin (ECE/MP.WAT/2015/10).

results of the first three nexus assessments were then published on November 2015 in a dedicated report[5].

10. As continuation of the above mentioned work under the Water Convention's present programme of work (2016–2018), notably, an assessment of inter-sectoral links, trade-offs and benefits between water, food and energy sectors as well as ecosystems in the Drina River Basin (Drina project) shared by Bosnia and Herzegovina, Montenegro and Serbia, was launched in a workshop on 21–22 April 2016.

11. This brief paves the way to further collaboration on renewable energy in the context of the energy-water food nexus under the Group of Experts, highlighting in particular the intersectoral and environmental considerations relevant to the development of renewable energies. Taking these trade-offs into account, it prepares the planned International Conference on Renewable Energy and International Forum on Energy for Sustainable Development accompanying the Group of Experts session planned in Baku, Azerbaijan on 20–21 October 2016.

III. Tools supporting identification of inter-sectoral synergies

Nexus assessment methodology

12. The nexus assessments undertaken under the Water Convention were intended to provide an overview of the interdependencies across water, ecosystems, energy, food and other areas, such as climate change. Using a specifically developed methodology, the assessments addressed uses, needs, economic and social benefits, potential synergies, tensions and trade-offs at both the national and transboundary levels. From the identification of interlinkages the process led determining possible policy, technical and cooperation responses between energy, water and food sectors as well as environmental protection. Renewable energy was integrated into the analysis, an especially important factor given hydropower potential in the concerned river basins.

13. The nexus approach took into account special characteristics associated with transboundary basins and looked at the specific role the basin area played within the countries sharing them. The process strongly emphasized inter-sectoral dialogue in a transboundary context, which is informed by a joint assessment with participation from the concerned countries.

14. Focusing a large part of the dialogue and assessment on uncovering the potential for improvement, and the possible benefits from cooperative and coordinated solutions allowed for a more constructive, solution-oriented participation and outcomes that may attract or mobilize wider support.

15. Assessments are made jointly with officials and experts from the countries sharing the basins. This process helps develop dialogue from one sector to another, across borders and between the local and national levels.

16. Analytical frameworks are used to assess the impacts of policies upon different sectors. They inform policy-making by quantifying the trade-offs between resources and providing a sound framework through which potential, and sometimes unexpected, nexus-

[5] UNECE (2015), 'Reconciling resource uses in transboundary basins: Assessment of the water-food-energy-ecosystems nexus'. The methodology and the general conclusions and recommendations contained in the publication were endorsed by the seventh session of the Meeting of the Parties to the Water Convention (Budapest 17-19 November 2015).

related risks are identified. Moreover, they also help identify context-specific integrated solutions that allow the three economic sectors of the nexus to develop without compromising long-term sustainability[6].

17. The analytical framework[7] developed for the nexus assessment under the Water Convention is based upon a six-step process entailing: (1) Identification of basin conditions and the socioeconomic context, (2) Identification of key sectors and stakeholders to be included in the assessment, (3) Analysis of key sectors, (4) Identification of intersectoral issues, (5) Nexus dialogue and (6) Identification of synergies (across the sectors and countries). Steps 1 through 3 initiate the stakeholder participation process by raising awareness and developing a preliminary understanding of the main issues and challenges within the basins. These steps also facilitate potential ideas and opportunities for cross-sectoral cooperation. Steps 4 through 6 focus on conducting a participatory workshop and analysing its outcomes.

18. Several analytical tools were applied and are presented for possible further studies of issues focusing on the water-food-energy-ecosystem nexus in order to inform policy development and decision-making. These tools include dialogues between sectoral actors at different levels and scales, mapping, multi-resource scenarios, extended systems analysis using fit-for-purpose tool-kits[8] and governance analysis. In the ECE basin assessments, the governance analysis focused on organizations, law and policy.

19. The implementation of a nexus approach to manage the basins' resources requires better information to improve inter-sectoral coordination at the national and transboundary level. Information-related solutions can include, for example, improving monitoring, data management, and forecasting as well as extension programmes. Balanced decision-making can be supported by jointly developed guidelines and strategic planning approaches that seek to define how, in practice, diverging interests can be weighed based upon agreed relevant criteria.

Strategic Environmental Assessment and Environmental Impact Assessment in a transboundary context

20. Regulatory instruments are useful tools for further advancing nexus analysis. Transboundary Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) are those commonly and respectively used to take into account environmental (including health) considerations in planning projects and programmes in various sectors, and advancing the use of intersectoral coordination that is necessary for the nexus approach. In the pan-European region, EIA and SEA procedures are regulated by the ECE treaties[9], as well as the European Union (EU) and national legislation. At the global

[6] IRENA (2015), 'Renewable Energy in the Water, Energy & Food Nexus'.

[7] De Strasser and others (2015). A Methodology to Assess the Water Energy Food Ecosystems Nexus in Transboundary River Basins, Water 2016, 8(2), 59

[8] For a brief overview of approaches and tools, the following source can be referred to: United Nations Economic Commission for Europe (2015), 'Reconciling resource uses in transboundary basins: Assessment of the water-food-energy-ecosystems nexus'. For example, the Reference Energy System is commonly used in integrated energy planning. This system has been extended to include the Climate change, Land, Energy and Water-use (CLEW), and building on such a framework, multi-resource scenarios and extended systems analysis can be developed. Mark Howells and others (2013). Integrated analysis of climate change, land-use, energy and water strategies. Nature Climate Change, vol. 3, pp. 621–626. IAEA, Annex VI: Seeking sustainable climate, land, energy and water (CLEW) strategies. In Nuclear Technology Review (Vienna, International Atomic Energy Agency, 2009).

[9] Namely, the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and its Protocol on Strategic Environmental Assessment.

level, international financing institutions support the application of SEA, including the World Bank and the Asian Development Bank and other expert and advisory bodies, such as the Netherlands Commission for Environmental Assessment.

21. The SEA is a tool for integrating environment and health considerations into sectoral plans and programmes, helping to coordinate national development objectives and offering alternatives, which can avoid costly mistakes and damages to the environment and health. The SEA works to resolve conflicting demands on water usage, and can be used for policy-level assessments of cumulative multi-sectoral impacts. A key feature of the SEA procedure is that it facilitates communication and consultations among stakeholders (central and subnational governmental agencies, the business sector or the public) in streamlining their policies – not only at the national level, but also at the international level in cases where transboundary impacts are expected – and by promoting transboundary cooperation.

22. While laws on EIA and SEA have been introduced at the framework level in a number of countries in the ECE region, their implementation in some countries is not complete and the practice is not well developed. The SEA for a river basin management plan would help to comprehensively assess the optimal use of available resources for boosting the economy within carrying capacity of ecosystems, while properly integrating water and parallel policy sectors, including energy, regional development and transport. Focusing on energy in particular, a SEA can reveal the significant cumulative environmental effects of planned hydropower plants early on in the process, while the environmental effects of the individual hydropower plants, as identified and addressed through the environmental impact assessment (EIA) procedure that occurs later at the project level, may not be significant. A SEA can also bring its strategic and integrated approach to identifying geographical areas in which large scale wind and solar photovoltaic projects could be located, while reflecting on environmental, social and economic considerations.

Sustainable Hydropower guidelines

23. Another example of a tool with application in a transboundary context of the energy-water-food nexus with implications for renewable energy is sustainable hydropower guidelines. They are based on the principle of sustainability, which discusses how resources should be managed in a holistic way, coordinating and integrating environmental, economic and social aspects. The guidelines outline an approach for increasing hydropower potential, while at the same time meeting the obligations of water management and environmental legislation.

24. Guiding Principles on Sustainable Hydropower Development in the Danube Basin[10] were elaborated on by representatives from Danube countries and their relevant sectors, thus representing their shared understanding. The "Guiding Principles" are primarily addressed to public bodies and competent authorities responsible for the planning and authorization of hydropower. This specifically includes bodies on the national, regional and local level in charge of energy, environment and water management. Furthermore, they also provide relevant information for potential investors in the hydropower sector, as well as NGOs and the interested public.

[10] International Commission for the Protection of the Danube River. Sustainable Hydropower Development in the Danube Basin: Guiding Principles (Vienna, ICPDR, 2013). Available from: http://www.icpdr.org/main/activities-projects/hydropower

IV. Basin case studies

25. The water-food-energy-ecosystems nexus assessment has been carried out in four transboundary river basins under the framework of the 2013–2015 programme of work by the Water Convention, namely the Alazani/Ganykh, the Sava, the Syr Darya and the Isonzo/Soča River Basin.

26. The basin assessments had the general objective of fostering transboundary cooperation across three areas. Firstly, the assessment focused on identifying inter-sectoral synergies that could be further explored and utilized. Secondly, the assessment was used to determine policy measures and actions that could reconcile tensions or conflicts, related to the multiple uses of and need for common resources. Thirdly, the nexus assessment also emphasized assisting countries in optimizing their resource use, increasing efficiency and ensuring greater policy coherence and co-management; and building the capacity to assess and address inter-sectoral impacts.

Renewable energy in riparian countries

27. The riparian countries have active hydropower development in all of the basins, but also the potential to exploit other renewable sources such as solar, wind and geothermal. Applicable technologies entail renewable energy for power generation, heating and cooling, and the transport sector, as highlighted by the Status Report.

28. For example, in the Syr Darya Basin, large-scale dams and reservoirs are both operating and still in the planning stage for energy development. Significant potential for developing other renewables (e.g. wind and solar) however, are currently unexploited. The Drina basin has the significant potential for renewable energy technologies beyond hydropower, evident in the smaller developments beginning to pick up.

29. In the Sava Basin, small and medium-scale hydropower plants are primarily developed. However, the basin’s large hydropower capacity, coupled with its flexibility, can facilitate greater penetration of solar and wind power plants in its riparian countries by providing “balancing services” (i.e. storing energy from intermittent renewable sources and then providing energy supply when demand peaks).

30. In the Alazani/Ganykh Basin, the full potential of hydropower requires further assessment, though the geological conditions pose challenges to construction. Both Azerbaijan and Georgia support small hydropower production through a variety of different schemes (such as power purchase guarantees and feed-in tariffs). In addition, there are also plans to exploit solar, wind and biomass power. Additionally, there is also potential for the use of geothermal sources.

31. While access to affordable, reliable and sustainable energy was highlighted as a challenge by the Status Report, renewable energy was identified as a solution to improving the quality of energy access in selected countries. This includes heating for residential use through solar thermal systems (E.g. Albania), the conversion of small systems to modern biomass (e.g. Montenegro) and potentially the use of geothermal heat pumps in households.

32. The following case studies highlight the conclusions from the nexus assessments undertaken

Alazani/Ganykh River Basin

33. Basin overview: The Alazani/Ganykh Basin is a sub-basin of the Kura Basin. The Alazani/Ganykh River, shared by Georgia and Azerbaijan, extends over an area of 11,717 km^2, with 59% of the basin being in the territory of Georgia and 41% in Azerbaijan.

34. Governance of water resources: In the past, several initiatives were taken to establish basin-wide cooperation in the Kura River. So far, no formalized cooperation has been established. However, a draft bilateral agreement between Azerbaijan and Georgia on the shared water resources of the Kura River Basin is currently being negotiated.

35. Energy development**:** Even if the basin population has secure access to electricity, alternative sources (hydropower in particular) are being explored mainly as small-scale projects. Nationally, there is also interest in exporting energy, e.g. through the "Energy Bridge Azerbaijan- Georgia-Turkey" project. Historically, Azerbaijan is a major producer of oil and gas.

36. Renewable energy development: There is a great potential and interest in renewable energy deployment. For example, Georgia supports renewable plants with less than 13 MW of generation capacity (including small hydropower) through long-term purchasing agreements, feed-in tariffs and license-free electricity generation.

37. Nexus linkages / opportunities: The main nexus linkages identified in the basin are water-energy (hydropower) and land-energy-water (biomass use, erosion/ sedimentation, hydrological flow).

(a) Example of energy-land-water nexus: Deforestation due to fuelwood collection is evident in the upper Alazani of Georgia. Fuelwood is harvested for heating and cooking purposes and mainly used in conventional stoves that produce high concentrations of particulate matter and smoke, a major cause of respiratory diseases. Fuelwood use contributes to deforestation, a reduction in the ecosystem service of water retention, which is important in the event of flash-floods. Consequently, erosion increases and sedimentation negatively impacts ecosystems, as well as infrastructure. Moreover, quality of energy supply is very poor, with the use of firewood for heating and cooking purposes resulting in negative health impacts. Moreover, lack of access to non-solid fuels was highlighted as one of the key energy access challenges in the region by the Status Report;

(b) Nexus opportunities lie in facilitating access to modern energy sources and energy trade, minimizing impacts from new hydropower development, and improving catchment management to control erosion. Additional opportunities exist in ensuring incorporation of intersectoral perspectives into national strategic documents, such as the energy sector strategy of Georgia and the National Water Strategy of Azerbaijan. Improved location, design and construction of small-scale hydropower building on international guidelines would be beneficial. Erosion control will bring benefits to different sectors, including energy;

(c) Solutions: Improved transboundary cooperation is needed for the integrated management of basin resources. It will allow Georgia and Azerbaijan to collaborate on resource optimization (e.g. Georgian forests and Azerbaijani gas) and risk management (coordinated hydropower development and flood risk management). Concluding the bilateral agreement and establishing a multi-sectoral body for its implementation would be a step forward.

Sava River Basin

38. Basin overview: The Sava Basin covers large parts of Bosnia and Herzegovina, Croatia, Montenegro, Serbia, Slovenia, and a very small part of Albania. The basin is home to a significant share of hydropower, water and land areas and economic activity– for example, 53% per cent of the electricity generation capacity within the riparian countries is located within the basin.

39. Governance of water resources**:** Water governance at the basin-level is well developed where the Framework Agreement on the Sava River Basin (FASRB) is used to provide the legal and institutional framework for cooperation, while the International Sava River Basin Commission (ISRBC) operates as the implementing body of the FASRB. Relevant EU policies are expected to push for closer coordination of Sava countries in the energy sector, and the Energy Community is supporting the adoption of the EU's legislation, "acquis communautaire", in energy and related areas of Western Balkan countries.

40. Energy developments: Use of water, land and energy resources in the Sava Basin will increase over the next 15 years. Additionally, the increase in economic activity in the West Balkans will be the main driver of this expansion in resource use throughout the basin. Despite the energy efficiency targets and policies of the riparian countries, energy generation is expected to increase, partly through renewable sources. This energy expansion will have implications for energy security and trade.

41. Renewable energy development: Other than hydropower, renewable energy sources are currently underdeveloped. Despite this, all countries are committed to expanding their share of renewables.

42. Nexus linkages / opportunities: The main nexus linkages identified in the Sava Basin are water-energy (hydropower), land-energy-water (biomass use, erosion/ sedimentation, hydrological flow).

(a) Example of water-energy nexus: Most of the region's electricity production takes place in the Sava Basin, home to 76% of the region's thermal power plants. The basin has the largest proportion of hydropower generation in the region – in numbers, 15% in Slovenia, and 5% in Croatia, 24% in Bosnia and Herzegovina, 31% in Serbia and 45% in Montenegro, of national hydropower generation. Yet, the energy sector in the Sava Basin has proven vulnerable to the status of water resources, recently evident in dry spells and flooding instances;

(b) Nexus opportunities: The nexus assessment in the Sava basin suggests the sustainable development hydropower and the integration of other, more intermittent renewable energies, such as wind and solar power emphasizes the role of RES in de-carbonizing energy generation and enabling the multiple-use potential of hydropower infrastructure (e.g. flood response). ISRBC could be better used as a platform to discuss all the relevant basin resources and for a consultation process to review the impact of national and sectoral development strategies;

(c) Solutions: Beneficial actions include coordinating hydropower investments with other infrastructure investments, such as those for other renewable energy sources (which helps to integrate them); putting the Guiding Principles on sustainable hydropower (ICPDR, 2013) into practice; ensuring coordination with needs for cooling thermal power plants and for navigation etc. and with flood control and low flow preparedness. The development of renewable energy resources is important in reducing emissions from energy generation. Harmonizing regulation and permitting can further underpin synergies across the sectors.

Syr Darya River Basin

43. Basin overview: The Syr Darya is the longest river in Central Asia (3,019 km from the headwaters of the Naryn) and the second largest in terms of water quantity (annual average runoff of 36.57 km^3). The basin is shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan.

44. Governance of water resources: In the Soviet era, the priority for water use was agricultural production, while hydropower generation was of less importance. Following the independence of former republics, a number of institutions for basin cooperation were established, including the Inter State Commission for Water Coordination (ICWC) and the International Fund for Saving the Aral Sea (IFAS).

45. Energy development: Some of the world’s largest oil, coal and natural gas reserves are found in Kazakhstan and Uzbekistan. The basin is home to both existing and planned pipelines that deliver fossil fuels from Turkmenistan, Uzbekistan and Kazakhstan to the Russian Federation and China. Meanwhile, hydropower generation is the primary source of electricity in Kyrgyzstan and Tajikistan, and is very important for their economies.

46. Renewable energy development: From an energy production perspective, the Syr Darya Basin is vital for Kyrgyzstan, which is also planning to expand its hydropower capacity. There is both the potential for and interest in developing small hydropower, upstream in particular. Significant potential for developing other renewables (e.g. wind and solar) is currently unexploited.

47. Nexus linkages / opportunities: The main nexus linkages identified in the Syr Darya basin are water-land-ecosystems (irrigation, salinization), water-energy (hydropower) and land-ecosystems.

(a) Example of energy - water nexus: Kyrgyzstan and Uzbekistan are dependent on the basin water for energy production. Kyrgyzstan is heavily reliant upon hydropower, while the majority of Uzbekistan’s thermal power plants use the Syr Darya Basin water for cooling. As an example of the water-energy nexus, the planned Kambarata-1 dam in Kyrgyzstan would have a much smaller water capacity than the Toktogul (4,650 million m3), but higher generation capacity (around 1,860 MW). The construction of this dam may further diminish access to irrigation water downstream, but it may also allow the Toktogul dam to return to an irrigation regime that is in the interest of the downstream countries. Without the restoration of the regional electricity grid and further development of connections, major capacity expansions might have limited utility. Any such expansions would be best in facilitating multiple uses of the overall flow regulation system;

(b) Nexus opportunities: The nexus assessment in the Syr Darya Basin suggests the restoration of the regional electricity grid and vitalizing the regional energy market, developing the current minimal trade in agricultural products, improving efficiency in energy generation, transmission and use as well as efficiency in water use, specifically for irrigation;

(c) Solutions: Transboundary cooperation between riparian countries is essential given that the Syr Darya Basin demonstrates a considerable number of trade-offs across sectors, resulting in an inefficient use of resources, environmental degradation and tension between riparian countries. Reforms to water and energy pricing could support a more rational use of water and energy resources. For example, Kazakhstan has introduced volumetric water tariffs, with differentiated tariffs across oblasts according to water scarcity levels. Improving energy security upstream would significantly benefit from the diversification of sources, and the alternatives might include some fossil fuels, energy trading, integrating more of other renewable energy sources, for example.

Isonzo/Soča River Basin

48. Basin overview: The Isonzo/Soča is a 140 km long alpine river, (40 km in Italy downstream and 100 km in Slovenia upstream). One-third of its basin is located in Italy (1,150 km^2) and two-thirds in Slovenia (2,250 km^2)

49. Water governance: Isonzo/Soča does not have a formal transboundary basin authority, but there is a good level of technical cooperation between Italy and Slovenia in coordinating their respective plans, prepared in line with policies and the requirements of the European Commission.

50. Energy developments: Slovenia's main energy production comes largely from hydropower, with high installed capacities. For example, the largest level of hydropower generation is 322 MW. In Italy, the use of hydropower is less prioritized and consequently less developed. The dams of Sagrado, Straccis and Piedimonte (total capacity of 5.8 MW) are owned by industrial companies and are not connected to the grid.

51. Renewable energy development: Renewable energies have been promoted in Italy since the liberalization of its energy market, with large investments resulting in high employment rates. In Slovenia, renewable energies have also been promoted for a long time, with well-established feed-in tariffs schemes, but a clearer account of the environmental impact of new energy plans remains to be made.

52. Nexus linkages and opportunities: The main nexus linkages identified in the Isonzo/ Soča basin are water-energy-ecosystems (river-flow continuity) and water-energy (hydropower).

(a) Example of water-energy-ecosystems nexus: Due to absence of counter-regulation infrastructure in Italy, hydro-peaking causes daily cycles of water stress and high flow in the river course. During low flow, some tracts of the river are prone to dry up temporarily. This has affects not only on biodiversity – e.g. the endangered marble trout, but also on the agricultural sector and irrigation in downstream parts;

(b) Water-food-energy in agriculture systems: Electricity generation in the agricultural sector is connected to the national grid. Although, small and decentralized productions do exist, RES deployment into existing agricultural buildings and infrastructure stems mainly from small hydropower, which is widely used in combination with diversion channels of irrigation schemes;

(c) Nexus opportunities: The nexus assessment in the Isonzo/ Soča basin identifies that RES have links to existing infrastructure in the agricultural sector (small hydropower, solar biomass) and has further potential in irrigation technology and energy efficiency. RES deployment will reduce dependency on water and benefit tourism;

(d) Solutions: Exploring the potential for basin-level green economic growth - taking advantage of complementarities between the two sides of the basin (e.g. natural and cultural tourism), was identified as a solution to improve the intersectoral cooperation. Restoring river continuity and increasing drought resilience, while simultaneously reducing stress on riverine ecosystems, was identified as another solution.

Drina River Basin

53. Basin overview: The Drina River Basin has a total surface area of 19,570 km^2 and covers territory in Bosnia and Herzegovina, Montenegro, Serbia and a very small share of Albania. The River forms an international boundary along some of its reaches between Serbia and Bosnia and Herzegovina.

54. Water governance: There are robust water governance mechanisms at the regional level of the Sava River Basin, of which the Drina is a sub-basin. The Framework Agreement on the Sava River Basin ("FASRB") establishes a legal framework for basin cooperation, although Montenegro's participation is limited to technical cooperation as an observer. There are also robust water governance mechanisms in place at the regional level of the Danube River Basin, which affect its sub-basin the Sava and in turn the Sava's sub-basin Drina.

55. Energy development: All riparian countries plan to develop new hydropower in the basin - in line with their commitments to increase their share of renewables to mitigate climate change (i.e. National Renewable Energy Action Plans and Intended Nationally Determined Contributions), as well as to improve security and/or produce for export (e.g. to Italy). Building new infrastructure will make coordination on dams operation more urgent.

56. Renewable energy development: The Drina Basin holds important hydropower potential, which is still largely unexploited. The available resources also allow for the use of other renewable energy technology.

57. Nexus linkages and opportunities: Several inter-sectoral linkages and influences on inter-sectoral themes were identified in the basin under the nexus assessment of the ECE. The linkages include rural development, dams and water flow and water quality (including solid waste).

(a) Example of water-energy nexus: The operation of thermal power plants causes thermal pollution in the river, consequently damaging ecosystems; ash deposits are also a problem, and tailings dams/ash ponds can affect the water bodies and the surroundings. Flow regulation comprising operation of hydropower plants and large reservoirs could better serve also, for example, flood response; on the other hand, water availability and the different uses of water can likewise affect hydropower generation;

(b) Solutions: 1) adapting the operation of reservoirs to meet different purposes of water use in existing and future hydro generation projects; 2) implementation of environmental flows regulation, as it does not exist in all riparian countries; and, 3) adequate maintenance and handling of waste from thermal power plants.

V. General conclusions and policy recommendations

58. Collaborative practices and coherent policies can support deployment of renewable energies and improve overall resources management in the river basins. Consideration of inter-sectoral impacts is a critical step in achieving synergies across the water-energy-food-ecosystems nexus, which support the Sustainable Development Goals. ECE and other United Nations Regional Economic Commissions have in their joint statement by the Executive Secretaries in 2014 called for a possible collective effort to achieve energy sustainability and have proposed a set of recommendations to help the member States to that end (Annex I).

59. A number of policy recommendations and lessons learned emerge from the work of the ECE on how the nexus assessment carried out in the framework of Water Convention can be leveraged for better resource management, with a particular focus on renewable energy deployment across the basins.

(a) Multi-sectorality in setting up or revising cooperation modalities is an opportunity for creating value in water management, infrastructure development and electricity trade. These findings suggest that where cooperation is limited, riparian countries are more exposed to external shocks. The economic cost of non-coordination can also be significant. For example, when multiple uses of infrastructure cannot be agreed upon, costly investments might be made in response in order to duplicate or extend infrastructure. Additionally, obstacles to trade can lead to production that is not well supported by the resource base. National level actions, such as improving efficiency in water and energy use – which are in countries' own economic interest – can reduce the pressure on shared resources and progressively build trust to gain high-level political backing. Complementarities in different sectors (e.g. in the energy mix) can create a broader package of benefits that are attainable through cooperation;

(b) Highly participatory basin-wide collaboration is a key element of the nexus assessment. Such collaboration provides an invaluable opportunity to gather up-to-date information and insights about the issues, to exchange views across sectors, which seldom happens under current management practices, and to generate ideas about solutions. At the same time, remote consultations with stakeholders are key to complementing face-to-face consultation at the intersectoral assessment workshop, allowing the involvement of a greater number of actors;

(c) Reliable data and information beyond sectoral boundaries needs to be gathered for a meaningful analysis. Frequently, up-to-date data at the basin level or at the level of local administrative units is unavailable, and the national level situation is not always a good proxy for the respective country's share of the basin. Having adequate, harmonized and up-to-date data becomes even more important if the countries decide to follow up on some of the conclusions and study the implications and benefits of some response actions in more detail;

(d) Addressing the energy-water-food-ecosystems nexus requires adequate infrastructure development and the related financing. Introducing instruments to apply the "polluter pays principle" for resource management and "beneficiary pays principle" for infrastructure financing, including private companies, public companies and agencies, and households could contribute to establishing a business case. Well-targeted economic instruments could motivate a rational use of water and energy, while at the same time contributing financially towards repairs and extending infrastructure. This need is particularly pressing in agriculture;

(e) The nexus assessment contributes to capacity building at the local level and in increasing awareness about synergic (intersectoral) opportunities. Advancing knowledge, tool-kits, capacity-building and inter-sectoral transboundary dialogue, this nexus approach aims to help identify areas where coordinated planning, dialogue and governance holds new and effective paths to secure sustainable development. It seeks to offer insights into where integrated management might provide additional benefits, while laying the foundation for future joint actions. The information generated can help in the coordination of policies and actions across sectors, institutions and countries;

(f) Linking issues between or within the sectors can lead to mutually supportive policies and processes. Beyond individual instruments, the nexus assessments call for coherent mixes of policy instruments and investments, and in many cases, they also step up enforcement of environmental regulations. Various inter-sectoral coordinated processes can help align policies. Examples can be seen within national sustainable development strategies, adaptation plans on climate change, across Strategic Environmental Assessments and Environmental Impact Assessments, and in regional development strategies and integration processes (e.g. EU approximation, where applicable). Further examples are economic instruments, i.e. water and energy pricing, but also different environmental fees, which can provide behaviour-altering incentives and also raise funds for infrastructure maintenance and development, as well as environmental protection.

60. Adaptation of the nexus assessment to the needs of increasing renewable energy deployment in the river basins could be considered for further action by the Group of

Experts. By understanding the interlinkages, win-win opportunities with other sectors can be found. All the basins covered so far by the assessments reported suboptimal development of renewable energy, despite high resources potential. Based on a dedicated IRENA report[11], increasing the share of renewable energy can lead to reducing water requirements in power generation, boosting water security by improving accessibility, affordability and safety and contributing to food security objectives. Overall, a dedicated nexus approach to renewable energy development could provide an additional contribution by the Group of Experts to the Sustainable Development Goals.

61. Renewable energy policies need to be redesigned. Although policies should be designed in light of the economic circumstances, development challenges, and renewable energy potential of their respective countries, key concrete recommendations for making renewable energy development more sustainable can be summarized for consideration and possible agreement by the Group of Experts (see Table 1).

62. The key targets of the Sustainable Energy for All (SE4All) initiative – energy efficiency, renewable energy and access to modern energy services – are interrelated and fully aligned with the Sustainable Development Goals. Integration of a nexus approach to these issues can be expected to lead to a more sustainable, as well as increased, uptake by countries. Possible concrete ECE interventions in support of SE4All objectives could include the following:

(a) Assist member States (upon request) in developing national sustainable energy action plans that are aligned with their future energy needs;

(b) Collaborate with member States to improve their national energy statistics programmes, including collecting, analysing and publishing data related to the Global Tracking Framework;

(c) Provide capacity building to member States in action areas related to Renewable Energy;

(d) Encourage international dialogue for renewable energy technological and knowledge exchange on lessons learned and best practices;

(e) Develop internationally recognized minimum energy performance standards and strengthen the link with all renewable energy technologies.

[11] IRENA (2015), 'Renewable Energy in the Water, Energy & Food Nexus'.

Annexes

Annex I

The Nexus Approach to Do Renewable Energy Right: Recommendations for Action

Possible Recommendations/ Priorities[12]	*Relevant Nexus Interlinkages, Potential Development Opportunities And Trade-Offs*	*Available Tools*
1. Ensure full and fair access to the existing grid for electricity produced from renewable energy.	Possible reduction of environmental impact through a better coordinated and integrated use of renewable energy. More diversified energy mix contributing to climate change mitigation.	National and regional grid codes adapted to the requirements of renewable energy.
2. Consider the energy system of the future in planning grid infrastructure development or replacement.	Coordination with other sectors and energy areas can allow better synergies (e.g. coordination of hydropower and more intermittent renewable energies, improving energy security by diversification) and reducing risks (e.g. related to water scarcity). Without development of connections, capacity expansions might have limited utility. A broader consultation reduces differences (and delays) at later project development stages.	Nexus assessment, specifically multi-resource scenarios used to feed into infrastructure and power system planning.
3. Decrease systems costs with market reforms, normative instruments (such as standards), and business models	Evaluated multiple use options to broaden the funding base and consensus about projects; develop joint projects (also transboundary); trading balancing services. Standards can also serve to promote resource efficiency and more environmentally friendly solutions/practices.	Nexus assessment, specifically nexus mapping and multi-resource scenarios used to feed into national and regional grid codes revisions and regulatory energy reforms.
4. Develop targeted instruments to reduce renewable energy financing costs.	Complementing such instruments with energy efficiency would slow the burden of investment in new capacity. A nexus approach will allow sharing investment costs in different areas as well as a reduction of investment risks.	For countries with less mature renewable energy markets, de-risking renewable energy investment framework.[13]

[12] Joint Statement of the Executive Secretaries of the United Nations Regional Commissions for the 5th International Forum on Energy for Sustainable Development (4-7 November 2014), section on Renewable Energy, available at http://www.unece.org/index.php?id=37243.
[13] Waissbein, O., Glemarec, Y., Bayraktar, H., & Schmidt, T.S., (2013). Derisking Renewable Energy Investment. A Framework to Support Policymakers in Selecting Public Instruments to Promote Renewable Energy Investment in Developing Countries. New York, NY: United Nations Development Programme.

Possible Recommendations/ Priorities	*Relevant Nexus Interlinkages, Potential Development Opportunities And Trade-Offs*	*Available Tools*
5. Remove barriers faced by new generation, non-conventional renewable-energy technology and promote their penetration into national energy systems to gain experience with their deployment.	Addressing barrier issues for new technologies facilitates the reduction of green-house gas emissions	Renewable energy promotion schemes and measures addressing non-economic and economic barriers to their deployment.
6. Promote decentralized direct uses of renewable energy as a way of providing on-site energy services, including through micro-, mini- and off-grid renewable energy options for remote areas.	Energy access is key to reduce energy poverty both in urban and remote areas. Reduced or more distributed environmental impact may result. Potential synergies with rural development schemes. Agricultural activities can provide opportunities in terms of siting or input.	Renewable energy promotion schemes and measures enabling development of decentralised renewable energy projects.
7. Promote international, regional and national collaboration on long-term research and development of energy efficient technology and knowledge exchange on lessons learned about large scale deployment of renewable energy capacity.	Synergies among international, regional and national institutions is needed for an holistic and integrated development of renewable energy. International guidelines synthesize good practice in reconciling different uses in transboundary settings. Institutions for cooperation provide platforms for negotiating and evaluating effects of new development plans. Adequate assessments of environmental and social impacts and common agreement about priority projects reduces risks for investment.	Systematic use of energy-water-food nexus assessments and leverage of the Group of Experts to allows for exchange of know-how between mature and developing renewable energy markets among the United Nations Economic Commission for Europe member countries.

Annex II

Renewable Energy in the Context of Energy Sector Challenges in Riparian Countries[14]

	Country (all data is country level)	*Energy intensity level of primary energy (MJ/$2011 PPP GDP) 2012*	*Share of renewable energy in total final energy consumption (% of total final energy consumption) 2012*	*Energy imports, net (% of energy use) 2013*	*Energy subsidies (% of GDP) Source: IMF 2015*	*Electricity production from hydroelectric sources (% of total) 2013*	*Electricity production from renewable sources, excluding hydroelectric (% of total) 2013*
Alazani/ Ganykh	Azerbaijan	4	2.85	-328	6.30	6.4	0.3
	Georgia	3.90	19.97	53.02	5.20	60.04	4.90
Sava	Bosnia and Herzegovina	7.93	15.27	28.46	37.00	41.46	N/A
	Croatia	5.15	28.69	63.36	3.70	82.22	N/A
	Montenegro	5.20	46.20	25.57	16.70	63.47	N/A
	Serbia	7.14	19.61	23.69	34.70	26.01	0.05
Syr Darya	Kazakhstan	8.68	1.36	-107.34	11.00	8.11	0.01
	Kyrgyzstan	10.75	22.48	55.46	26.40	93.48	N/A
	Tajikistan	5.11	57.97	29.79	7.10	99.74	N/A
	Uzbekistan	14.43	2.37	-26.08	26.30	21.33	N/A
Isonzo/Soča	Italy	3.31	12.09	76.34	0.60	18.33	20.58
	Slovenia	5.20	19.32	47.93	2.40	29.21	3.05
Drina	Bosnia and Herzegovina	7.93	15.27	28.46	37.00	41.46	N/A
	Montenegro	5.20	46.20	25.57	16.70	63.47	N/A
	Serbia	7.14	19.61	23.69	34.70	26.01	0.05
	Albania	3.00	38.22	12.28	1.90	100.00	N/A

[14] World Development Indicators, unless indicated otherwise