UNECE

Deployment of Renewable Energy:

The Water-Energy-Food-Ecosystem Nexus Approach to Support the Sustainable Development Goals

Good practices and policies for intersectoral synergies to deploy renewable energy

UNITED NATIONS

Contents

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I. Introduction

Member countries in the United Nations Economic Commission for Europe (UNECE) have different levels of progress in developing their renewable energy potential. Their shares of renewable energy in total final energy consumption vary from more than 50% to less than 3%. Higher shares of renewable energy are driven by hydropower developments, with consequences for the management of water, food, energy sectors and other ecosystems. Several countries in the region, including some of the riparian countries covered by this policy brief, continue to face strategic energy challenges such as ensuring energy security, seasonal power outages and insufficient energy supply (See Figure 1 for details on the selected countries), which could potentially become drivers for renewable energy development[1]. Renewable energy could play a central role in these countries' climate change mitigation efforts as they move to implement their obligations under the Paris Climate Agreement.

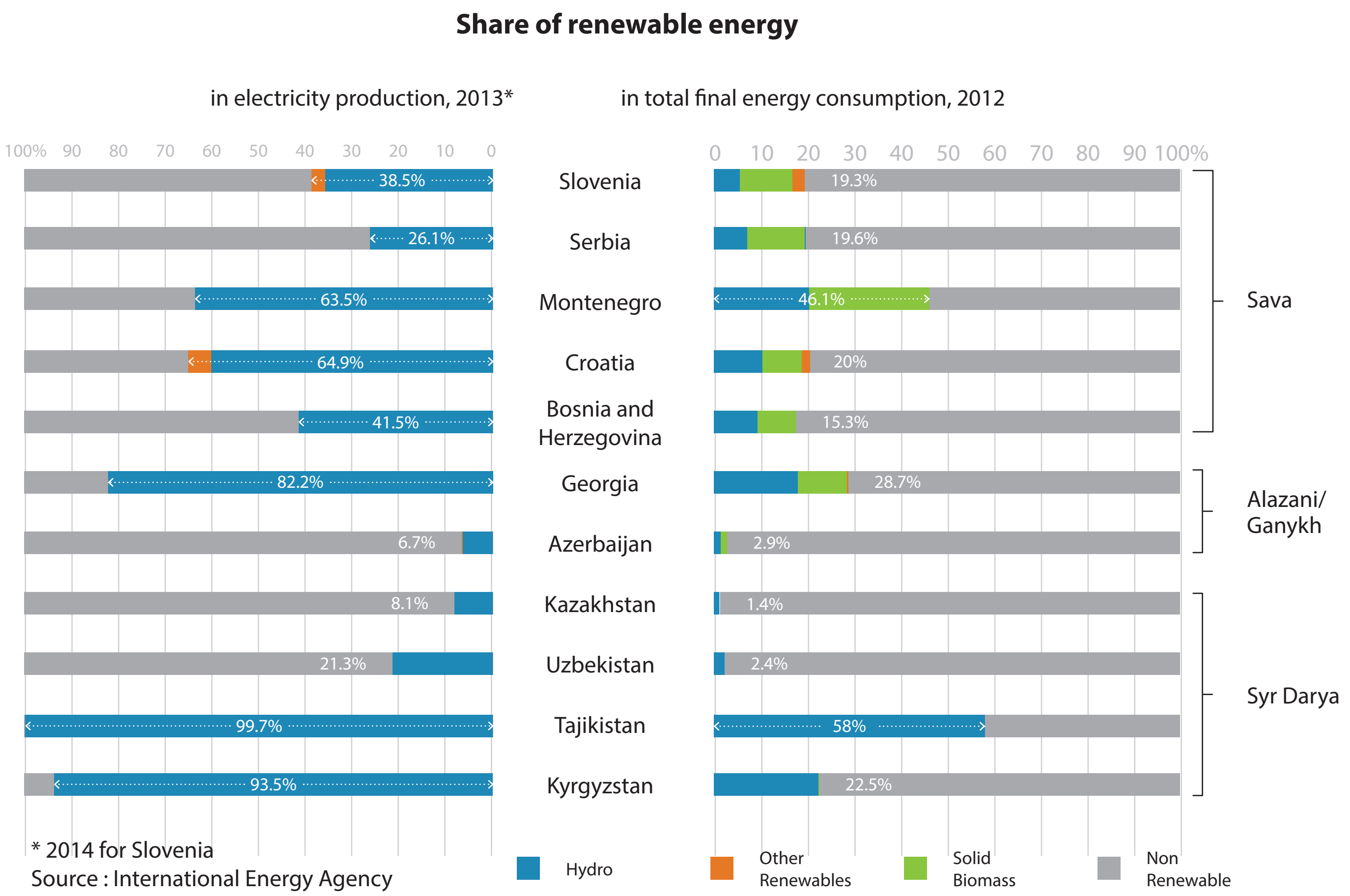

Figure 1: Renewable Energy in the Context of Energy Sector Challenges in Riparian Countries[2]

The UNECE, consisting of 56 member countries, 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 central to this approach. Therefore, the UNECE has been using the nexus approach to assist the Member States achieve a better understanding of the intersectoral synergies and leverage linkages between the energy, water and food sectors and the ecosystems.

The UNECE Group of Experts on Renewable Energy (the Group of Experts) was created in 2014 with a mandate to carry out action-oriented, practical activities to greatly increase the uptake of renewable energy. The Group of Experts is encouraging the exchange of know-how and best practices among member states, relevant international organizations and other stakeholders. The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) fosters cooperation in the management of shared water resources. The Task Force on the Water-Food-Energy-Ecosystems Nexus provides a platform for exchange of experience on inter-sectoral (nexus) issues. The work includes considerations of water-energy-food-ecosystems nexus, in cooperation with the Task Force on the Water-Food-Energy-Ecosystems under the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, and is placed in the context of 2030 Agenda for Sustainable Development which strives to fulfil its 17 Sustainable Development Goals (SDGs).

The SDGs are closely interlinked and benefit from increased synergies in their deployment. For example, the Sustainable Development Goal (SDG) 7, which advocates for access to affordable, reliable, sustainable, and modern energy for all is interlinked both explicitly and implicitly with various other goals. Clearly, most energy generation forms depend on water to a variable degree and thus benefit from water management (part of SDG 6 on water sanitation). Energy access supports achievement of food security (SDG 2), but biofuel production may compete for the same limited land with food crops.

Access to energy is a precondition to economic growth driving improved health conditions and education. More sustainable energy is a basis for improved resilience. Figure 2 demonstrates the linkages between affordable and clean energy and other SDG's, namely those related to poverty elimination, decent work and economic growth, industry innovation and infrastructure, reduced inequalities and responsible consumption and production. Achieving the Sustainable Development Goals will require coordination across sectors, coherent policies, and integrated planning.3

The water-energy-food-ecosystems nexus approach comes in with the objective of promoting coordination and integrated planning and sustainable management of interlinked resources across sectors, which could speed up the achievement of the 2030 Agenda for Sustainable Development. The nexus could leverage deployment of renewable energy across the Goals. The meaning of "nexus", in the context of energy, water, and food 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 purpose of this policy brief is to encourage the consideration of good practices and policies for intersectoral synergies in the context of the nexus and for limiting negative impacts in deploying renewable energy in the UNECE region and improving it sustainably.

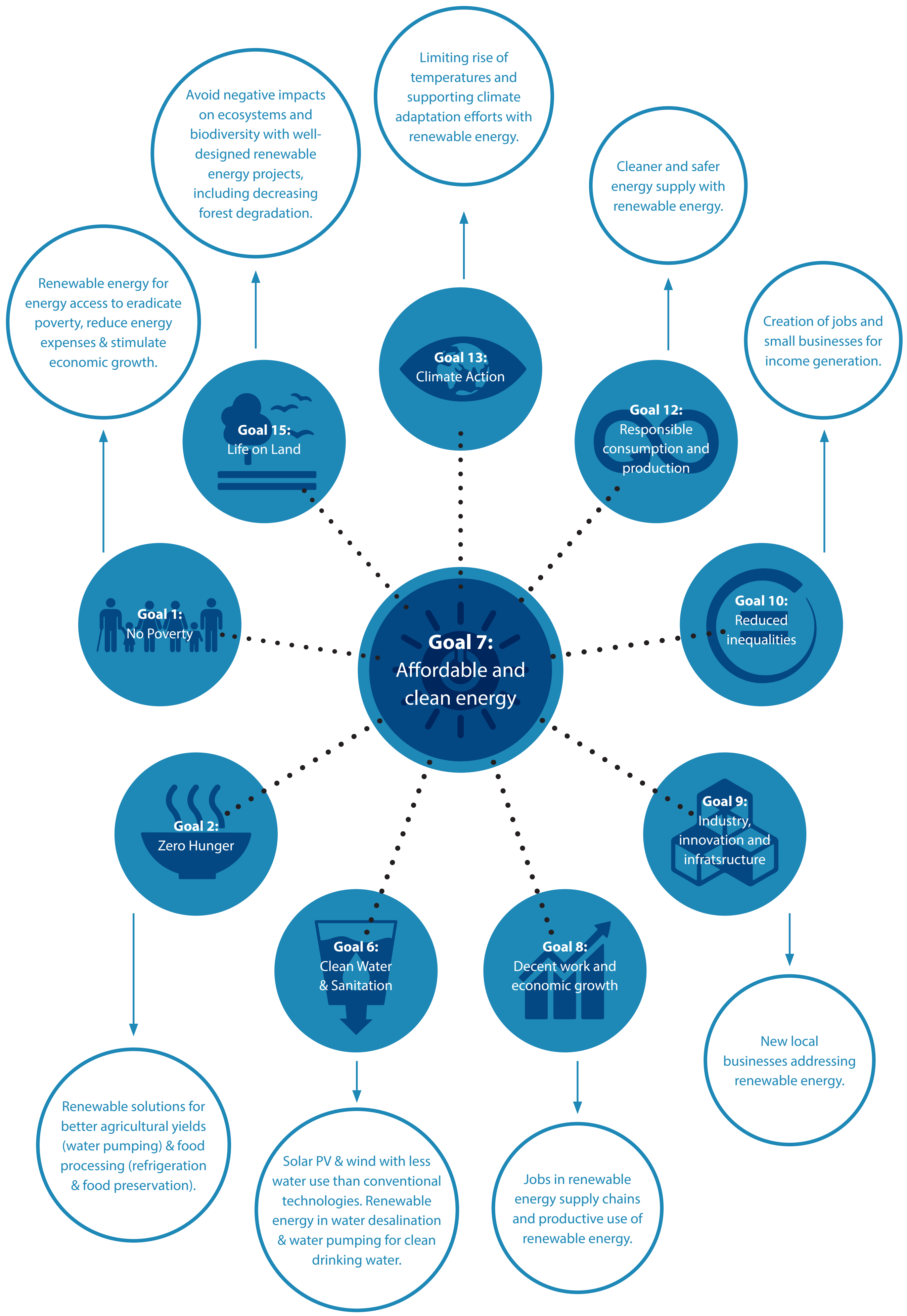

Figure 2: Nexus approach to Sustainable Development Goals: Affordable and clean energy[3]

II. Renewable energy and water-energy-food-ecosystems nexus

Renewable energy could play a strong role in helping to achieve better management of resources within the water-energy-food-ecosystems nexus. The potential role of renewable energy in addressing the nexus could be specifically explored and the links to Agenda 2030 and climate change considerations could be further highlighted.

Renewable energy technologies could address several of the trade-offs between water, energy, food and ecosystems bringing substantial benefits to all sectors. The benefits of renewable energy include energy and emissions savings, reduced dependency on fossil fuels and increased energy security. The distributed nature of many renewable energy technologies could improve energy and water access especially in remote areas, which generates positive impacts on food security. The opportunities for renewable energy in the water-energy-food nexus were highlighted in a report[4] prepared by the International Renewable Energy Agency (IRENA). The energy-water-food nexus was part of the World Energy Outlook by the International Energy Agency and gives insights into the role for renewable energy.[5]

Renewable energy, depending on the selected technology could reduce water requirements in energy production.[6] For example, electricity generation using solar photovoltaic (PV) and the wind requires a limited amount of water, e.g. for cleaning solar PV panels for improved efficiency CSP and geothermal use heat in electricity production and have water requirements. Energy systems that include renewables have proved to be less water intensive compared to conventional energy in all countries analysed in the IRENA report. Many renewable energy resources, such as solar, wind and tidal, are freely available and require minimal water inputs to be developed and deployed, which benefits overall water efficiency.

Renewable energy technologies could boost water security by improving accessibility, affordability, and safety. Renewable energy could fulfil energy requirements along the water supply chain. For example, solar-based pumping solutions could offer a cost-effective alternative to on-grid electricity supply or diesel generators. Large water utilities are deploying decentralised renewable energy options to offset both, electricity costs and their carbon footprint. Renewable energy offers solutions in wastewater treatment and wastewater treatment processes themselves can generate energy. Wastewater's energy potential could be utilised and the system's energy loop could be closed with local energy sources (E.g. biogas from waste).

Renewable energy could stimulate the food sector with new economic opportunities and bridge the modern energy deficit along the supply chain to reduce losses and enhance productivity. Renewable energy could provide energy on-site or could be integrated through large-scale installations into the existing conventional energy supply chain. Waste energy could be utilized, but other renewable sources could also be adopted, for example, solar and geothermal heat can be used as dehydration energy sources in food processing.

The production of bioenergy still raises concerns related to water consumption and land use. Bioenergy could play a positive role in addressing water-energy-food-ecosystems nexus linkages under specific parameters. For example, installation of anaerobic digesters in farms could provide a locally available source of electricity or heat using a range of crop residues, animal and food waste. Forestry's by-products could also serve this purpose. Energy sector planning needs to use specific safeguard measures and regulations to exploit the bioenergy potential in a sustainable manner.

Other renewable energy technologies could complement hydropower generation. This may relieve the pressure on water resources use and trade-offs between power generation and irrigation or other water uses. The nexus approach helps to identify the stress points where hydropower development is creating concerns.

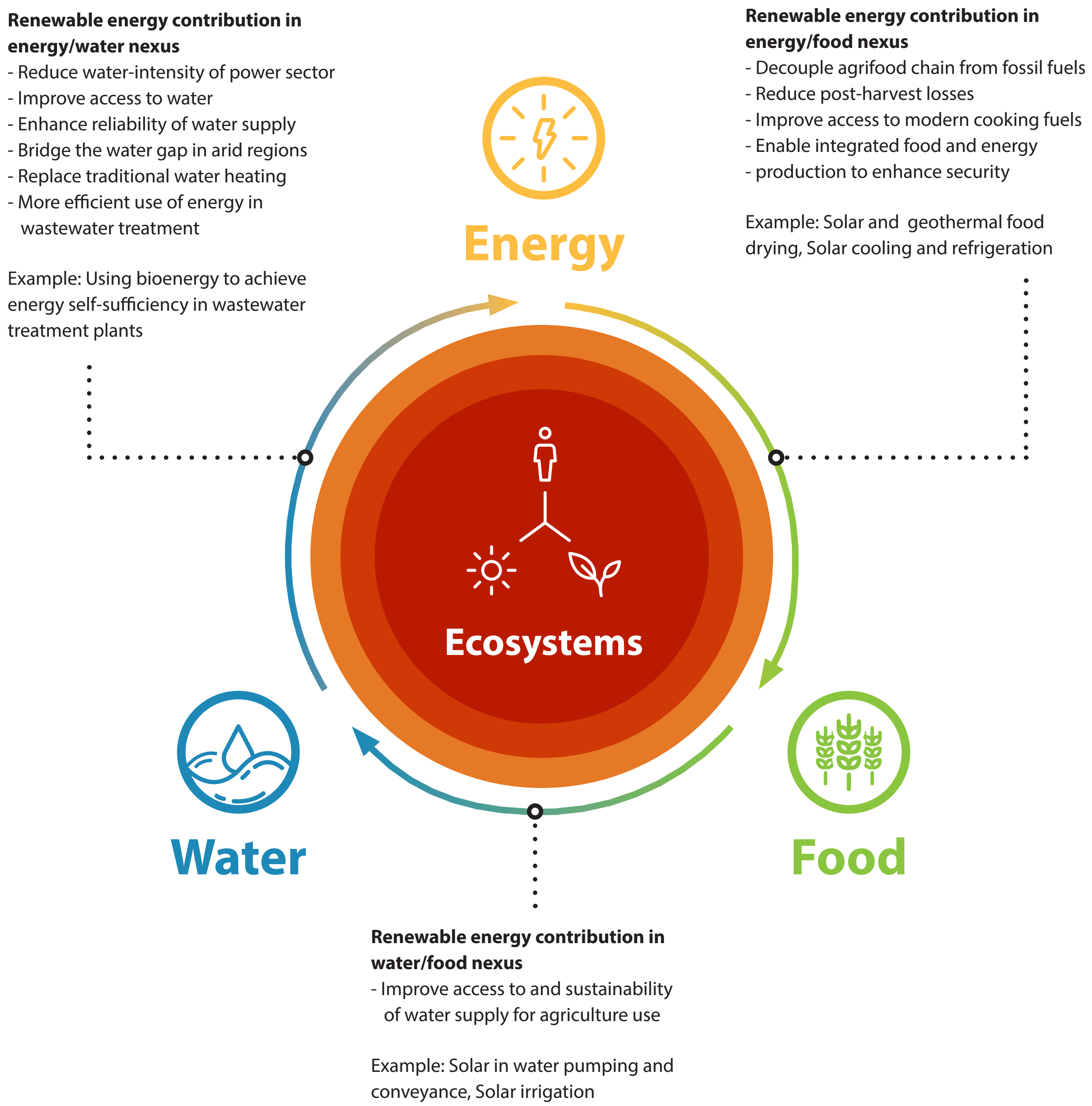

Figure 3: Renewable energy opportunities in the energy-water-food-ecosystems nexus

The nexus approach presents an opportunity to strengthen the actions aimed at achieving the Sustainable Development Goals. First, nexus approach could contribute specifically by setting complementary goals and targets, which are jointly achievable. Nexus allows to identify interactions between goals and across sectors. It points at how individual targets might serve multiple goals. Second, nexus approach promotes collaboration and partnerships, which are essential to achieving the 2030 Agenda. Third, nexus could be used as a framework for solutions to emerge based on examination of plans of other entities or countries. In this context, nexus approach could contribute to mobilising renewable energy deployment beyond the SDG 7, ensuring access to affordable, reliable, sustainable and modern energy for all. For example, using nexus approach could identify opportunities for renewable energy powering interventions contributing to SDG 2, ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture, and SDG 6, ensuring availability and sustainable management of water and sanitation for all. Other SDGs could be brought in as well (12, 13 and 15).

The process initiated through the 2030 Agenda for Sustainable Development could in return contribute to achieving the principles of the nexus approach. Good governance and environmental protection, which are at the centre of the nexus approach run through the 2030 Agenda for Sustainable Development. Policy planning in relation to 2030 Agenda is now underway and could stimulate the riparian countries to adjust their national policies and institutions, which in return could facilitate the nexus approach. For example, Montenegro adopted a National Strategy for Sustainable Development, which drives achievement of the goals. Serbia, on the other hand, has created an Inter-Ministerial Working Group, which monitors implementation of SDGs.

Climate change has significant effects on energy, water and food sectors and ecosystem processes related to species and environment quality that are leading to a global loss of biodiversity. Climate change is behind water availability variations which affect the hydropower generation capacities. Several of the riparian countries are already experiencing impacts of climate change. For example, Drina basin is prone to episodes of flooding and droughts which cause significant damage to the economy. The concerns around climate change impacts emerged during the nexus assessments and could be used to leverage nexus approach as an additional tool for identifying ways to tackle climate change, combining mitigation and adaptation. Processes like developing national and transboundary strategies to adaptation to climate change could serve as an intersectoral coordination effort that nexus approach calls for. Development of renewable energy resources in a transboundary manner could be of unifying elements of such collaborations.

Lack of intersectoral coordination is a major challenge in leveraging all the existing opportunities for renewable energy deployment in the riparian countries. The gap exists both on the national and transboundary levels throughout the UNECE region 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.

The UNECE Group of Experts has been actively supporting the identification of opportunities, benefits, and the tools for the application of the nexus to facilitate transboundary collaborations and increase understanding of water, energy, food sectors and ecosystems, including the potential for improving renewable energy deployment. The collaboration with the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) forms an initial core for this work. Series of nexus assessments has been carried out in transboundary basins in South-Eastern Europe and Caucasus and Central Asia in the framework of the Water Convention to demonstrate the need, value of working across sectors and some concrete opportunities in policies and measures for countries that want to utilise their renewable energy sources and yield benefits for the energy, water and food sectors.

The nexus assessments used 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 completed in the Alazani/Ganikh (Azerbaijan, Georgia), Sava (Bosnia and Herzegovina, Croatia, Montenegro, Serbia, and Slovenia), Syr Darya (Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan[7]), and Drina Basins (Bosnia and Herzegovina, Montenegro and Serbia). The results of the first three nexus assessments, together with the methodology, were then published on November 2015 in a dedicated report[9] and Drina Basin assessment was being finalised at the time of writing this brief. An important conclusion from this work lies in policy recommendations that could facilitate renewable energy deployment, which is more sustainable and accounts for the nexus trade-offs between the energy, water and food sectors and the ecosystems.

III. Tools supporting identification of intersectoral synergies

The potential for improving renewable energy deployment through consideration of the water-energy-food-ecosystems-ecosystems nexus is clear. Yet, the challenge is in making sure that the nexus approach is fully integrated into the decision making and deployment of renewable energy potential and consequently projects. Several tools are in place and could be used by decision makers to identify renewable energy opportunities.

Nexus assessment methodology

The nexus assessments methodology was developed under the Water Convention. The assessment provides an overview of the interdependencies across water, energy, food, and the related ecosystems. Using a specifically developed methodology, the assessment addressed uses, needs, economic and social benefits, potential synergies, impacts and trade-offs at both the national and transboundary levels. The process starts with the identification of interlinkages. Then the possible policy, technical and cooperation responses between energy, water and food sectors, as well as environmental protection are determined. Renewable energy is integrated into the analysis through the lenses of the specific basin with hydropower in the main focus, given energy-water linkages and the prominence of hydropower in the basins assessed. Within this process, the UNECE Group of Experts on Renewable Energy contributes to the application of the nexus assessments methodology in relation to the increase of renewable energy uptake.[10]

The process strongly emphasizes intersectoral dialogue in a transboundary context, which is informed by a joint assessment, with participation from the concerned countries. The dialogue focuses on uncovering the potential for improvement and possible benefits from cooperative and coordinated solutions. Assessments are made jointly with officials and experts from the countries sharing the basins.

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-related risks are identified. The analytical approach also helps to identify context-specific integrated solutions that allow the three economic sectors of the nexus to develop without compromising long-term sustainability, including the integrity of ecosystems and the services they provide[11].

The analytical framework[12] 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 synergetic actions (across the sectors and countries) and related benefits.

Several analytical tools[13] could be applied, fit-for-purpose, 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, require better information to improve intersectoral coordination at national and transboundary level. Information-related solutions could include, for example, the improvement of monitoring, data management, forecasting process, and their extension programmes. Balanced decision making could be supported by jointly developed guidelines and strategic planning approaches that seek to define how, in practice, diverging interests could be weighed based upon agreed relevant criteria.

Strategic environmental assessment and environmental impact assessment in a transboundary context

Regulatory instruments are useful tools for further advancing the nexus analysis of the trade-offs and better alternatives but, moreover, for promoting intersectoral coordination. Transboundary Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) are commonly used to take into account environmental (including health) considerations in preparation of policies, plans, programmes, and specific development projects in various sectors. They contribute to 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 UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and its Protocol on Strategic Environmental Assessment, as well as the European Union (EU) and national legislation. At the global 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.

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 could help to avoid costly mistakes and damages to the environment and health. The SEA works to resolve conflicting demands on water usage, and could 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 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. SEA can streamline application of environmental impact assessments at project level. For example, focusing on energy, SEA could reveal significant cumulative environmental effects of planned hydropower plants early in the planning process. Such cumulative effects could be significant even if individual hydropower plants do not have a significant impact, as identified and addressed through the environmental impact assessment (EIA) procedure. SEA could 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

Sustainable hydropower guidelines constitute another example of a tool with application in a transboundary context of the water-food-energy-ecosystems nexus. The guidelines outline an approach for increasing hydropower potential, while at the same time meeting the obligations of water management and environmental legislation. 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. An often quoted example at the transboundary level so far is the Guiding Principles on Sustainable Hydropower Development in the Danube Basin[14], which were elaborated by the representatives from the Danube countries and their relevant sectors, thus representing their shared understanding. The Principles are primarily addressed to public bodies and competent authorities responsible for the planning and authorization of hydropower at the national, regional and local level. The Principles provide relevant information for potential investors in the hydropower sector, NGOs and the interested public.

National environmental standards

National environmental standards provide the opportunity for central governments to promote the adoption of consistent standards at the regional and municipal levels. National environmental standards are regulations which prescribe technical standards, methods or requirements for land use, management of lake and river basins, water use and discharge, and more. They could also prescribe technical standards, methods or requirements for monitoring. A resource management act is one of the forms to bring consistency across sectors at national level to infrastructure planning requirements to avoid overexploiting resources and compromising the integrity of ecosystems. With regard to renewable energy development, these standards could promote the use of environmentally-friendly energy resources with a benefit of cutting CO_2 emissions.

Policy guidelines for promotion of renewable energy

The nexus approach requires that a complex set of considerations is taken into account in developing renewable energy (See Figure 4). Comprehensive policy guidelines could facilitate this by helping policy makers to consider interlinkages among different areas of policy at the formulation stage, while offering prompt response to nexus considerations. For example, specific policy guidelines could support the formulation of short-, medium- and long-term policies and strategies targeting the promotion of renewable energy. Integration of policy guidelines implies that policymaking in any one area considers the effects of (and on) policies and outcomes in other sectors and areas. This helps to ensure that policy is mutually coherent across the full range of dimensions, and that the effects of policy in one area do not contradict or undermine desired outcomes in others. While setting a trajectory for meeting renewable energy targets, the policy guidelines should include recommendations based on best practices tested, open the space for public consultations with relevant stakeholders and ensure greater policy coherence and co-management across sectors. For example, the Energy Community Secretariat[15] published on Policy guidelines on reform of the support schemes for promotion of energy from renewable sources in December 2015. The guidelines include recommendations based on good practices tested in the implementation of the support schemes for renewable energy by EU member states. Obviously, what makes good policy or technical approaches, depends in many ways on the context.

Towards an energy-specific nexus assessment tool

The International Renewable Energy Agency proposes a conceptual framework for a tool which could conduct basic assessments of nexus impacts on energy policy, including renewables[16]. The proposed concept uses energy balances under baseline and alternative (desired) scenarios as an input. The proposed approach estimates the water, land, emissions and cost implications of the incremental energy balance. These provide insights about the basic resources, cost and emissions implications of the analysed energy policy. The proposed concept provides information about the impacts of a specific policy choice but does not give indications how the policy should be developed. For example, policy incentivizing utility-scale solar PV installations will have specific land use impacts (land surface used), which need to be examined by decision makers. Still, providing parameters of nexus implications offers an opportunity to review the planned renewable energy policy changes under the nexus lens. The last step in the assessment is the evaluation by decision makers whether the nexus impacts are acceptable and adjusting proposed policy changes accordingly. The IRENA assessment tool is in a concept stage and needs to be translated into a practical instrument which could be leveraged for more sustainable deployment of renewable energy.

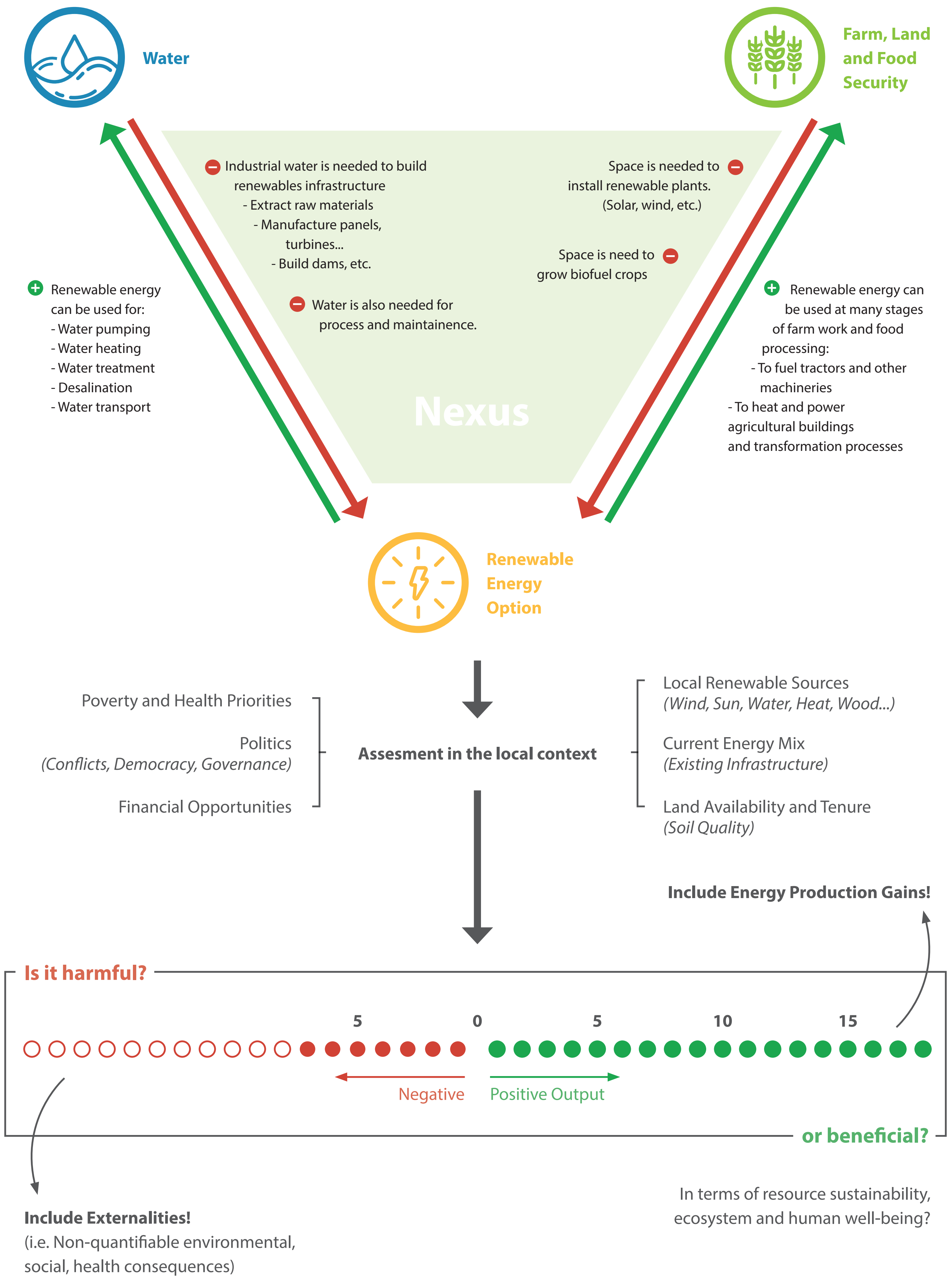

Figure 4: Water, land, renewable energy trade-offs in developing renewable energy sources

IV. Good practices: Innovating along the water-energy-food-ecosystems nexus

The water-energy-food-ecosystems nexus provides tangible value when it moves from the conceptual stage toward practical implementation. The nexus is already being used by both public and private sectors alike to create innovative solutions, which enable economic development and business growth in the riparian countries. The scarcity of water is the choke point for both agriculture and energy and it is the most common focus of addressing the nexus stress. Better and more sustainable use of renewable energy is an integral part of the innovation. Figure 4 indicates some relevant considerations for assessing benefits and potential trade-offs for renewable energy to be beneficial in a local context from a nexus perspective. The following examples have been selected to demonstrate different concepts of applying the nexus in the context of renewable energy deployment. The first example shows the role to be played by a utility as an operator of a hydropower plant in improving water allocation practices in the proximity of its assets. The second example demonstrates the decentralised use of renewable energy on farms. The last example pertains to leveraging bioenergy in the context of wastewater treatment facilities, which enables operators to close their energy loop in Germany. It is worth noting that

The Serre-Ponçon dam and reservoir is located in the Durance and Verdon River system in southeast France. The system is composed of 21 hydropower plants generating 6,500 GWh per year of renewable electricity. The system supplies drinking water and water for industrial purposes to an entire region. It also supplies water for irrigation to over 150,000 hectares of farmland. The reservoir has guaranteed storage of 450 million cubic meters of water in the summer, allowing a total annual withdrawal of about 1,800 million cubic meters.

At the beginning of 2000s, EDF realized that it needs to address the issue of water consumption directly with the irrigators to avoid over consumption and hence limits on power generation during peak demand. Therefore, EDF developed and signed a Water Saving Convention, an agreement with two main irrigators in proximity of the dam. The agreement sets out irrigators' commitment to reduce their water consumption and EDF's commitment to remunerating them for their savings. The agreement allows the irrigators to revise their commitment on an annual basis. EDF's approach for valuing water is unique. EDF decided to link water price to the value of energy it could produce per cubic

Example 2 - How renewable energy addresses nexus linkages at farm level[20]

On-farm renewable energy technology applications diversify farm income sources or reduce energy costs. Therefore they are used as a common strategy to increase resilience. The energy produced from renewable energy sources can be consumed on the farm or sold to the main grid, provided the regulatory regime allows for it. Farms in England provide an interesting example. 23% of English farms generated renewable energy in 2015[21]. The average income from energy generation was 9% of the farms' total income[22] though an income of up to 52% has been reported[23]. Changes in feed-in tariffs create uncertainties, which are hampering further installation of power generation capacities on farms in England. However, advances in energy storage could change prospects for on-farm renewable energy use.

A similar situation has developed in Italy. Due to a successful feed-in tariff scheme, 13% of the total installed solar PV capacity was installed in the agricultural sector[24] raising concerns of speculation and competition with farms' core agricultural activity[25]. This risk is expected to decrease with the feed-in-tariff scheme terminated and current regulation favouring self-consumption and small installations[26 27]. Meanwhile, the attention to of energy production and consumption in agriculture stays high, with the Ministry of Energy and Forestry joining forces with the Italian National Agency for New Technologies, Energy, and Sustainable Economic Development for developing innovative solutions for energy efficiency and production from renewables[28]. This experience depicts the value of revising and adjusting the policies as the situation evolves.

Whilst renewable energy clearly contributes to renewable energy production targets at national level, they could affect several parts of the nexus positively or negatively. Renewable energy affects water quality in a positive manner, for example by using farmyard manure for anaerobic digestion. Negative impacts during construction and when more crops are grown for digestion include erosion. Impacts for food and ecosystems also need to be considered. On the food side, this may include land lost for food production and potential changes in microclimate. The risk to habitat, for example, the fish migration due to micro-hydro construction and bird collisions with wind turbines are the most common concerns.

The nexus approach should be leveraged to achieve more sustainable development of renewable energy sources. Evaluating in advance how changes in energy supply might affect the water, food sectors or ecosystems as a whole may avoid unintended consequences and capitalise on win-wins between the sectors.

Example 3 – How energy potential of waste-water addresses urban nexus[29]

The Jenfelder Au eco-district addresses water-energy linkages leveraging bioenergy opportunities in the content of urban nexus linkages. The district is part of the Hamburg Water Cycle, which is a closed-loop system which optimizes the use of resources by integrating two systems, the energy production system and the waste water treatment system. The district collects wastewater from toilets and diverts it into a biogas plant. The biogas is used to produce heat and electricity for the neighbourhood of 770 accommodation units and 2,000 residents. Grey water from residential units is recycled separately to be used for irrigation and flushing. Rainwater is also integrated into the system for irrigation purposes.

The project has been championed by the Hamburg municipality water company, Hamburg Wasser. The company first demonstrated the system's feasibility in the environmental theme park, Gut Karlshöhe where it was operationalized for educational purposes. The system was then adopted by the Wandsbek District Authority followed by the Jenfelder Au neighbourhood.

The system has several benefits addressing water-energy nexus linkages. Biogas usage from wastewater reduces external energy requirements in wastewater treatment. The system is CO_2 emissions free. The separation of grey and black water and promotion of onsite green areas reduces the stress placed on stormwater infrastructure. This reduces the risk of flooding while increasing the neighbourhood's resilience to climate change. The benefits of the system could also be extended to agriculture. The biogas plant's fermentation residues could be re-used in farming.