

Next-Gen Nexus

Youth, Regulation, and Best Practices for Water, Energy, Food & Ecosystems

Executive Summary

This report explores the Water-Energy-Food-Ecosystem (WEFE) Nexus through a food-centered lens, offering an accessible introduction to how food systems interact with water, energy, and ecosystems, and outlining the main benefits, challenges, best practices, and policies shaping this interconnected approach.

The report highlights key recommendations from a youth perspective to further assist with the implementation of the WEFE nexus in an inclusive and sustainable way:

- Integrating WEFE Nexus methodologies in university curricula as a framework to assist for example SEA/EIA assessments;
- Offering scalable WEFE solution-based practices to young entrepreneurs in the form of capacity building workshops, technical assistance, sector-specific resource management, traditional and digital tools;
- Networking students and early-career professionals with WEFE Nexus experts for capacity building;
- Collaborating with youth-led NGOs and advocacy groups to implement joint initiatives, e.g. workshops, events and projects to grow the implementation scope of the WEFE Nexus.

WEFE Nexus

The Water-Energy-Food-Ecosystem (WEFE) nexus is a framework that recognizes the significant and inseparable connection between water, energy, food, and ecosystems. It is primarily employed to design tools entailing all these elements, and urges the user to think about the multi-purposed functionality of structures instead of one-faced solutions. The idea starts from the core – and often forgotten – assumption that the four dimensions belong to the same circularity.¹

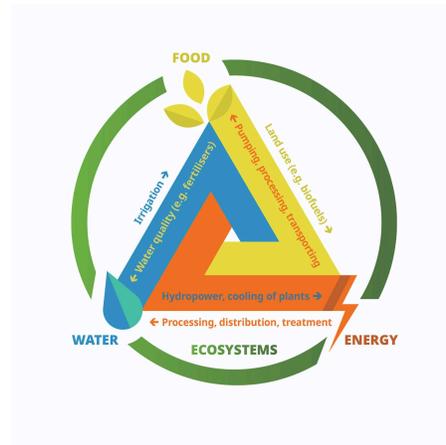


Fig. 1: WEFE Nexus, Water and Environment Support (WES-MED)

The WEFE nexus highlights that actions in one area – like using water for farming – can have big impacts on energy use, food production, and the health of natural ecosystems. For example:

- Water is needed for irrigation and electricity generation.
- Energy is required to pump, treat, and distribute water, as well as to process food.
- Healthy ecosystems help keep water clean and support biodiversity, which in turn benefits agriculture and energy production.

In such a way, the three dimensions (the ecosystem is implicit in this circle) are integrated to promote sustainable food/energy/water systems. This approach is especially important for the European Union and its policies at a moment where

¹ FAO. (2014). *The Water-Energy-Food Nexus: A new approach in support of food security and sustainable agriculture*. FAO. <https://openknowledge.fao.org/items/c171bc10-9788-4f3d-878a-a137be150c71>

climate change, urbanization, and resource pressures are making it harder to manage these resources sustainably. By understanding these links, the WEFE nexus approach can integrate management and governance to find solutions that benefit all sectors, avoid negative trade-offs, and protect the environment.²

Water Dimension

Water governance is a central lever in the WEFE Nexus because it underlies both production and resilience across sectors. It is not just a consumable input but also a regulator of flow regimes, hydrological cycles, and systemic risks. In agriculture, water supports irrigation, livestock, and post-harvest processing; in energy, it enables hydropower, cooling operations for thermal plants, and potentially biomass cultivation; for ecosystems, it maintains flowing rivers, wetlands, and aquatic habitats whose services include water purification, flood regulation, and habitat stability. Because water has limited substitutability, poor governance in this dimension can cascade into reduced food security, unstable energy supply, or ecological degradation. One can think of water governance as a “coordination pivot” in the nexus: allocation rules, quality norms, and regulatory frameworks influence which trade-offs are feasible among uses.³⁴

Over the last three decades, the water sector has been implementing the Integrated Water Resource Management (IWRM) principles,⁵ established in the 1992 Dublin Statement,⁶ to coordinate and optimize water use between users and stakeholders. The freshwater sources are particularly important to the IWRM approach, as they are defined as scarce public goods due to their role in agriculture, industry and domestic use. The nexus follows many basic principles

² Farmandeh, E., Choobchian, S., Karami, S., (2024). *Conducting water-energy-food nexus studies: what, why, and how*. Scientific Reports, 14, pp. 1-25. <https://doi.org/10.1038/s41598-024-79214-4>

³ Behnassi, M., et al., (2024). *Governance, policies and research options for the WEFE nexus*. In *Interlinking climate change with the Water–Energy–Food–Ecosystems (WEFE) nexus in the Mediterranean Basin* (pp. 209–239). MedECC Secretariat.

https://hal-ciheam.iamm.fr/hal-04809128v1/file/MedECC%202024_SR%20Climate%20WEFE%20Nexus_Chapter%205%20HD.pdf

⁴ Carmona-Moreno, et a., (2021). *Implementing the Water–Energy–Food–Ecosystems Nexus and Achieving the Sustainable Development Goals*. IWA Publishing.

<https://uploads.water-energy-food.org/resources/wio9781789062595.pdf>

⁵ WEF Nexus, (2014). *Nexus Concept // The Nexus Approach vs IWRM - Gaining Conceptual Clarity*.

<https://www.water-energy-food.org/news/nexus-concept-the-nexus-approach-vs-iwrm-gaining-conceptual-clarity>

⁶ Global Water Partnerships. (n.d.), *Dublin–Rio Principles*.

<https://www.gwp.org/contentassets/05190d0c938f47d1b254d6606ec6bb04/dublin-rio-principles.pdf>

from IWRM, though it enriches them to optimise natural resource efficiency, and food and energy security.⁷

Energy Dimension

Fossil fuel use and energy use in general, have always been at the center of climate change discussions. The continuous and increasing use of fossil fuels is a clear example of the energy–ecosystem link within the WEF Nexus, showing how energy use has contributed to changes in the Earth’s climate system.

Now that renewable energy sources are increasingly seen as an alternative to fossil fuels, it is important to highlight that without strong policies, proper monitoring, and research, they can also bring negative effects, such as biodiversity loss or deforestation. Indeed, energy is closely connected to both water and food. For instance, hydropower and thermal power plants need large amounts of water to produce electricity. At the same time, energy is essential for irrigation, desalination, wastewater treatment, and the cold chains that keep food fresh during transport. Similarly, vegetable oils, which are also consumed as food, can be used as raw materials for biodiesel production.⁸

Within the WEF Nexus, integrating renewable energy into farming and water systems creates various benefits. Examples of beneficial applications include solar-powered irrigation, agro-photovoltaics (combining solar panels with farmland), and biogas made from agricultural waste. These measures help cut greenhouse gas emissions, make farms more economically stable, and reduce dependence on fossil fuels.⁹

Food Dimension

As the WEF Nexus entails a seemingly unending number of interconnections, it is impossible to describe the true scale of the links. However, food is perhaps the most tangible entry point of the Nexus, because each item on our plate makes visible the hidden inputs of water, energy, and ecosystems. It is a daily reminder of the nexus condensed into something concrete and familiar. While we all drink

⁷ WEF Nexus, (2014). *Nexus Concept // The Nexus Approach vs IWRM - Gaining Conceptual Clarity*. <https://www.water-energy-food.org/news/nexus-concept-the-nexus-approach-vs-iwrm-gaining-conceptual-clarity>

⁸ Shove, E., Walker, G., (2014). *What Is Energy For? Social Practice and Energy Demand*. Theory, Culture & Society 31(5), pp. 41-58. <https://doi.org/10.1177/0263276414536746>

⁹ Joint Research Centre (JRC). (2019). *WEFE Nexus Energy work package datasets*. JRC Data Catalogue. <https://data.jrc.ec.europa.eu/collection/id-00134>

water and constantly use energy, food is multi-dimensional in different aspects compared to water and energy. Agricultural production draws on water for irrigation, ecosystems for soil fertility and pollination, and energy for machinery, fertilizer, refrigeration, and transport. At the same time, food systems drive pressures across all three dimensions: intensive farming degrades ecosystems, over-extraction for irrigation undermines water security, and long food chains raise energy demand. That makes food uniquely tangible: it is a physical, visible product that carries the footprint of all the other nexus dimensions inside it.¹⁰

But trade-offs are equally stark. Expanding bioenergy crops may bolster renewable energy targets but can compete with food crops for land and water. Similarly, large irrigation schemes can temporarily increase yields but undermine long-term water availability and ecosystem resilience. The food dimension therefore illustrates why cross-sectoral governance is essential: productivity gains in agriculture must be weighed against water withdrawals, carbon emissions, and biodiversity impacts.¹¹

In short, food is not only one strand of the nexus but a central hinge. Decisions in food systems ripple outward to water, energy, and ecosystems, making agricultural and dietary policy a decisive arena for building resilience and delivering sustainable outcomes across the nexus.

Ecosystem Dimension

Ecosystem services are the essential benefits that the environment provides, including clean water, fertile soil, pollination, climate regulation, and recreation. In the WEF nexus, these services are not just an extra dimension – they are the foundation that supports water, energy, and food security. Healthy ecosystems regulate water flows, purify water, maintain soil fertility for agriculture, and support biodiversity that underpins both food production and energy systems. The nexus approach recognizes that if ecosystem services are degraded – by pollution, overuse, or poor management – then water, energy, and food systems all suffer. For example, wetlands filter pollutants and buffer floods, benefiting both

¹⁰ Mooren, C. E., Munaretto, S., La Jeunesse, I., Sievers, E., Hegger, D. L. T., Driessen, P. P. J., Hüesker, F., Cirelli, C., Canovas, I., Mounir, K., & Godinez Madrigal, J. (2025). *Water–energy–food–ecosystem nexus: How to frame and how to govern. Sustainability Science*. Advance online publication. <https://doi.org/10.1007/s11625-025-01691-x>

¹¹ Food and Agriculture Organization of the United Nations. (n.d.). *Chapter 2.5*. FAO Open Knowledge Repository. Retrieved October 17, 2025, from <https://openknowledge.fao.org/server/api/core/bitstreams/bc8810ae-2a13-4cfe-b019-339158c7e608/content/src/html/chapter-2-5.html>

water quality and agriculture, while forests store water and regulate climate, supporting energy and food systems. By integrating ecosystem services into WEFE planning, implementers can identify synergies and avoid trade-offs that harm nature and society. Ultimately, the WEFE nexus helps ensure that the natural systems providing these vital services are protected and valued in decision-making, leading to more resilient and sustainable outcomes for all sectors.

Advantages & Disadvantages

The WEFE Nexus approach has some clear benefits. It helps improve efficiency by recognizing how resources are connected, reduces possible conflicts, and creates synergies. In this way, it promotes a broader vision of sustainability where ecosystems, farming, and energy production can be managed together. It also encourages cross-disciplinary collaboration in decision-making, which can make policies more coherent.¹² Nexus research also shows that it should go beyond just physical resource connections and include governance, justice, and ecosystem services as well.¹³

On the downside, putting WEFE Nexus into practice comes with challenges. Bringing together expertise from different sectors requires time, resources and coordination. There's also no single clear method for implementing the nexus, which makes applications very context-dependent.¹⁴ Many of the models and tools developed – like WEFE Nexus simulation tools – are either not accessible to practitioners or require advanced technical skills, limiting their use.¹⁵ Most importantly, the Nexus approach often focuses heavily on technological solutions, which could result in fair resource sharing, social inequalities, and local priorities.¹⁶ This could make it harder to fully align the concept with the goals of sustainable development.

¹² Erikson, N., Avellan, T., Teutschbein C., Blicharska, M., (2025). *Towards a common understanding of water-energy-food nexus research: A view of the European nexus community and beyond*. Science of the Total Environment, 967, pp. 2-13. <https://doi.org/10.1016/j.scitotenv.2025.178775>

¹³ Lejemtel, L., Vallet, A., Chiron, F., Levrel, H., Lavorel, S., (2025). *Exploring environmental justice and nexus approaches in Paris urban nature policies*. Journal of Environmental Management, pp. 2-17. <https://doi.org/10.1016/j.jenvman.2025.126547>

¹⁴ Erikson, N., Avellan, T., Teutschbein C., Blicharska, M., (2025). *Towards a common understanding of water-energy-food nexus research: A view of the European nexus community and beyond*. Science of the Total Environment, 967, pp. 2-13. <https://doi.org/10.1016/j.scitotenv.2025.178775>

¹⁵ Taguta C, Senzanje A, Kiala Z, Malota M and Mabhaudhi T (2022) *Water-Energy-Food Nexus Tools in Theory and Practice: A Systematic Review*. Front. Water 4:837316. doi: 10.3389/frwa.2022.837316

¹⁶ Ibid.

There are clear chances to move the Nexus forward in food-focused governance and measurement. Creating cross-sector groups that bring in agriculture, water, and energy actors, running joint programmes, and using shared indicators (like liters of water or energy used per kilo of food produced) can help align actions. Expanding drought and climate-risk observatories with crop and soil data would give farmers and decision-makers stronger tools. Boosting wastewater reuse for irrigation and recycling organic waste into soil amendments can directly cut input costs for farmers and support food security.

On the financing and participation side, aligning CAP and Green Deal funds with food system projects that deliver water, energy, and biodiversity co-benefits is a major opening. Blended finance can support multipurpose infrastructure (e.g., renewable-powered water reuse for farming), while social safeguards ensure farmers, especially smallholders, benefit fairly. Living labs and serious games can bring farmers, communities, and policy-makers together to co-design practical Nexus solutions for food and farming.¹⁷

WEFE Nexus very often overlaps with ESG (Environmental, Social and Governance) practices, company sustainability strategies, and complex infrastructural projects. ESG is a framework used to measure the sustainability performance of companies and institutions. While the WEFE Nexus emphasizes the need to consider water, energy, food, and ecosystems together, ESG practices provide measurable criteria for achieving sustainability goals. The importance of this label is to stress explicitly how Water, Food, Energy and Ecosystem are deeply interconnected, because even though the link among them seems pretty obvious, the sustainability practices often tend to hide behind processes and strategies not clear, while the purpose of WEFE is to put the Nexus on the spot.

WEFE Nexus in Practice

To effectively implement the WEFE nexus in practice, it is necessary to have access to accurate and reliable data and information to guide economic cost-benefit analyses and assess ecosystem impacts. Such data provide the foundation for linking sectoral outcomes, the value of water used or contaminated, the types of crops produced, the energy generated, and the ecosystem goods and services either supported or degraded. However, economic evaluations must

¹⁷ Res4Africa Foundation. (March, 2023). *Financing the Water, Energy and Food Nexus: A comprehensive review of financial mechanisms for the WEF Nexus*.
https://uploads.water-energy-food.org/resources/Res4Africa-WEF_Financial-Mechanisms-WEBVER.pdf

also take into account other key considerations – such as safeguarding rural livelihoods, advancing national development goals, and conserving biodiversity. Only by balancing these elements can informed trade-offs be made, monitored, and refined over time.

Some nexus practices that have been/will be implemented include:

- Agro-photovoltaic systems, which combine crop production with solar panels, reducing evaporation while producing renewable energy and boosting land productivity. In these systems, both energy and crops are produced on the same land, which increases land efficiency. They also provide extra electricity for rural areas that are not connected to the main grid. On top of that, the panels create shade, which helps save water and makes farming more efficient.¹⁸ One example of this practice in Europe is the agrophotovoltaic farm built in Heggelbach, Germany, with the support of the Fraunhofer ISE institute.
- WEFE4MED is a project implemented by PRIMA and composed of the European Commission's Joint Research Centre and Directorate-General on Research and Innovation, and UfM. The project is responsible for building the community network, actively engaging with individuals, organizations, and demonstration projects, and catalyzing dialogue in Mediterranean countries, capacity enhancement, and collaborative initiatives within its community towards a WEFE-based approach. Some initiatives being implemented or implemented through the project include:
 - In Spain, the three municipalities of the Metropolitan Area of Barcelona will install three biosolar green roofs (PV modules and vegetation space) in two kindergarten buildings and one library. The installation aims to generate clean energy, reduce energy demand of the buildings due to the insulation provided by vegetation, as well as improve air quality and promote biodiversity.¹⁹
 - Salus Space (FrontAg Nexus project) in Bologna, Italy, interweaves the redevelopment of multifunctional urban space into social integration and local food production. The space includes blended housing for elderly, migrants, refugees and young families, alongside

¹⁸ Weselek, A., Ehmann, A., Zikeli, S., Lewandowski, I., Schindele S., & Högy, P., (2019). *Agrophotovoltaic systems: applications, challenges, and opportunities. A review.* Science and Impact (39)35, pp. 1-20.
<https://doi.org/10.1007/s13593-019-0581-3>

¹⁹ WEFE4MED, 2024, *Biosolar Green Roofs*, <https://wefe4med.eu/demo/biosolar-green-roofs>

a Syrian restaurant, library, vegetable garden and workshop areas for art. Indoors, the space has a hydroponic system growing mushrooms, lettuce, kale, microgreen and more inside modular shipping containers. The project included a capacity building workshop for 40 students on grafting horticultural crops in a hydroponic system.²⁰

Policies implemented at the EU level

Various policies at the EU level walk the sustainability path and have connecting elements with the WEF E Nexus. Originating from the 2011 Bonn “Water–Energy–Food Security Nexus Conference”, the Nexus approach has since influenced EU-level sustainability policies. Many directives, regulations, and strategies now incorporate standalone and cross-sectoral elements that align with Nexus principles.

- The Water Framework Directive, which mandates the management of water resources at the basin scale, sets objectives for ecological and chemical status, and requires that member states prevent deterioration of water bodies and restore them toward “good status”.²¹ Under the WFD umbrella, the notion of ecological flows (or flow regimes that maintain ecosystem functioning) is increasingly discussed in guidance and implementation debates, though the WFD itself does not prescribe a single method. Ecological flows are often considered essential to meet ecological objectives and associated controls on abstraction.²² They have improved water quality and pushed integrated planning, which helps food production. Yet, they remain highly compliance-driven, often disconnected from energy and agricultural policy cycles. For example, wastewater reuse for farming is encouraged, but uptake is low due to fragmented standards and investment gaps.²³
- The European Green Deal and the Fit for 55 initiative. These strategies set ambitious climate targets, which indirectly benefit food systems through

²⁰ WEF E4MED (2023). *Salus Space – Front Ag Nexus*, <https://wefe4med.eu/demo/salus-space-frontag-nexus>

²¹ European Commission, (n.d.), *Water Framework Directive*.

https://environment.ec.europa.eu/topics/water/water-framework-directive_en

²² Ecologic Institute. (October 2023). *Implementation of the ecological flows in the EU*.

<https://www.ecologic.eu/sites/default/files/publication/2024/70603-implementation-of-ecological-flows-in-the-eu.pdf>

²³ Joint Research Centre (JRC). (2018). *Position paper on Water, Energy, Food and Ecosystems (WEFE) Nexus and Sustainable Development Goals (SDGs)* (EUR 29509 EN). Publications Office of the European Union. <https://publications.jrc.ec.europa.eu/repository/handle/JRC114177>

cleaner energy and more resilient ecosystems. However, trade-offs are not always managed well. Bioenergy incentives have in some cases competed with food production for land and water, showing that without Nexus thinking, climate goals can create new pressures.

- The Common Agricultural Policy & the Farm to Fork Strategy. These are the most direct levers for food, water and energy integration. Precision farming and soil measures supported by CAP reduce inputs and resource use, but the policy has been criticised for slow uptake and for not adequately rewarding farmers who adopt circular practices like wastewater reuse.²⁴ Additionally, Farm to Fork's ambitions often clash with market realities, limiting transformative change.
- Similarly, the EU Biodiversity Strategy²⁵ and the Habitats²⁶ and Birds Directives²⁷ are integral to the WEF Nexus, as they link ecosystem restoration to agricultural resilience. Their Protection and restoration benefit food systems by safeguarding pollination, soil, and water regulation. Yet implementation is patchy, and agriculture is often treated as separate from conservation rather than as a partner. This reduces the potential co-benefits for food security.
- The Nature Restoration Regulation: Mandates member states to adopt national restoration plans to revive degraded ecosystems, including wetlands, rivers, riparian zones, and habitats, and aims to enhance biodiversity, resilience, and ecosystem services (IG B-Berlin, 2024; wiring reports). The regulation frames restoration as contributing to the health of water systems, but while it emphasizes restoring ecosystems that support services (e.g. "securing what nature does for free, like cleaning water and protecting from floods") (European Commission, n.d.), it does not always explicitly enumerate every hydrological function (e.g. recharge enhancement) in its text.
- Sendai Framework & EU Civil Protection Mechanism: The Sendai Framework

²⁴ European Commission. (2021). *Commission Staff Working Document: Evaluation of the impact of the CAP on biodiversity, soil and water (natural resources) (SWD/2021/0424 final)*.

<https://eur-lex.europa.eu/legal-content/NL/TXT/?uri=SWD:2021:424:FIN>

²⁵ European Commission (2020). *EU Biodiversity Strategy for 2030: Bringing nature back into our lives*. COM(2020) 380 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0380>

²⁶ Council Directive 92/43/EEC. (21 May 1992) *On the conservation of natural habitats and of wild fauna and flora (Habitats Directive)*. <https://eur-lex.europa.eu/eli/dir/1992/43/oj/eng>

²⁷ Directive 2009/147/EC of the European Parliament and of the Council (30 November 2009). *On the conservation of wild birds (Birds Directive)*. <https://eur-lex.europa.eu/eli/dir/2009/147/oj/eng>

and the EU Civil Protection Mechanism have made Europe better prepared for disasters and improved early warning systems. However, they are not well connected to food and farming policies that aim to build resilience. In Latin America, drought observatories help farmers plan and adapt to changing conditions, but in Europe similar tools are rarely used for agriculture. This means Europe is missing a chance to make its food systems stronger against climate impacts.²⁸

Water, energy, climate	Food & Soil	Ecosystems	Cross-sectoral
Water Framework Directive	Common Agriculture Policy	Biodiversity Strategy	Circular Economy Action Plan
Renewable Energy Directive	Farm to Fork Strategy	Birds/Habitats Directive	European Green Deal
Climate Law	Soil Strategy for 2030	Nature Restoration Regulation	Sendai Framework

Table 1. Some regulations with WEF elements. Own design

Conclusive remarks: Future prospects for youth and recommendations

The WEF nexus aims to tackle the well-known pressures of ever-increasing societal demands for water, energy, and food coupled with declining environmental health, in a situation that is made worse by right-at-the-front-door climate change. The WEF nexus approach can help address poor decision-making regarding cost-benefit trade-offs by improving policy, legislation, planning, education and action coherence across water, energy, and food production.

²⁸ European Commission. (2023). *Sendai Framework for Disaster Risk Reduction – Midterm Review 2023 - Working towards the achievement of the Sendai priorities and targets*. https://ec.europa.eu/echo/files/policies/prevention_preparedness/sendai_framework_for_disaster_risk_reduction_midterm_review_2023.pdf

There exists a vast amount of research and academic work on the WEFE nexus, with universities, research institutes, and international organizations developing tools and policies to promote integrated management. However, public awareness of this topic remains low, and education is seen as a missing link for making the WEFE nexus a reality in everyday life.²⁹

Youth can be a key stakeholder to accelerate the implementation of a multi-faceted approach like the WEFE Nexus. As future leaders and active citizens, by understanding the WEFE nexus, youth can facilitate smarter, more sustainable policies and practices. Educating youth, increasing their awareness and including them in participatory policy processes, can help bridge the gap between academic knowledge and real-world action, making the EU more resilient and sustainable for everyone.

As shown below, various youth groups and representatives can be involved in the WEFE Nexus framework, as its dimensions are natural entry points for youth engagement.

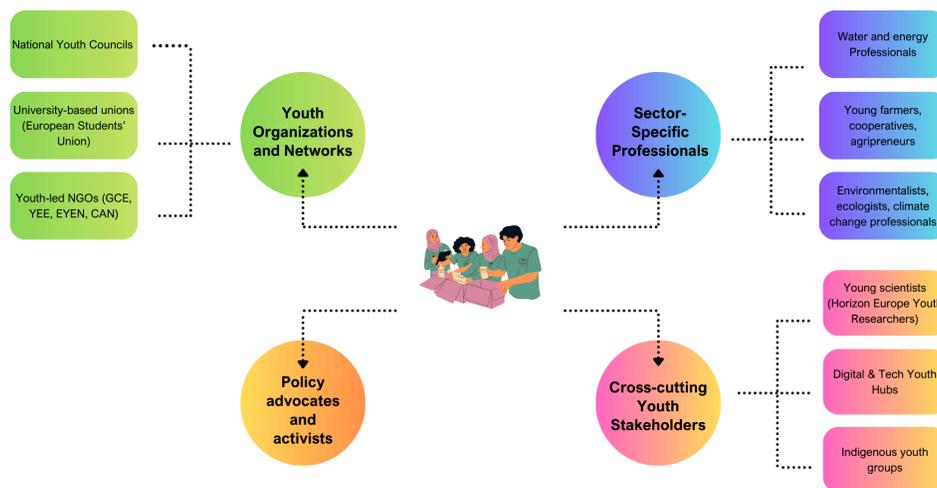


Fig 2. Youth Stakeholders that can be engaged in the WEFE Nexus. Own design

Key recommendations from a youth perspective, to further assist the implementation of the WEFE Nexus in an inclusive and sustainable way, include:

- Integrating WEFE Nexus methodologies in university curricula as a framework to assist for example SEA/EIA assessments;

²⁹ UN Office for Sustainable Development, (n.d.), *Youth Inclusion in the WEFE Nexus*, https://unosd.un.org/sites/unosd.un.org/files/wefe_workshop_day_2_session_7_ms_wendy_geza_.pdf

- Offering scalable WEFE solution-based practices to young entrepreneurs in the form of capacity building workshops, technical assistance, sector-specific resource management, traditional and digital tools;
- Networking students and early-career professionals with WEFE Nexus experts for capacity building;
- Collaborating with youth-led NGOs and advocacy groups to implement joint initiatives, e.g. workshops, events and projects to grow the implementation scope of the WEFE Nexus.

For youth, protecting water, energy, food, and ecosystems together, helps to secure more green jobs and comfortable livelihoods, to better public services, to protect and restore ecosystems for future generations, and form stronger collaborations. This means building economies and societies that can withstand climate shocks, reducing the risks and costs of livelihoods, increasing innovation as well as cooperation and solidarity.