

Decentralization at the water-energy-food nexus

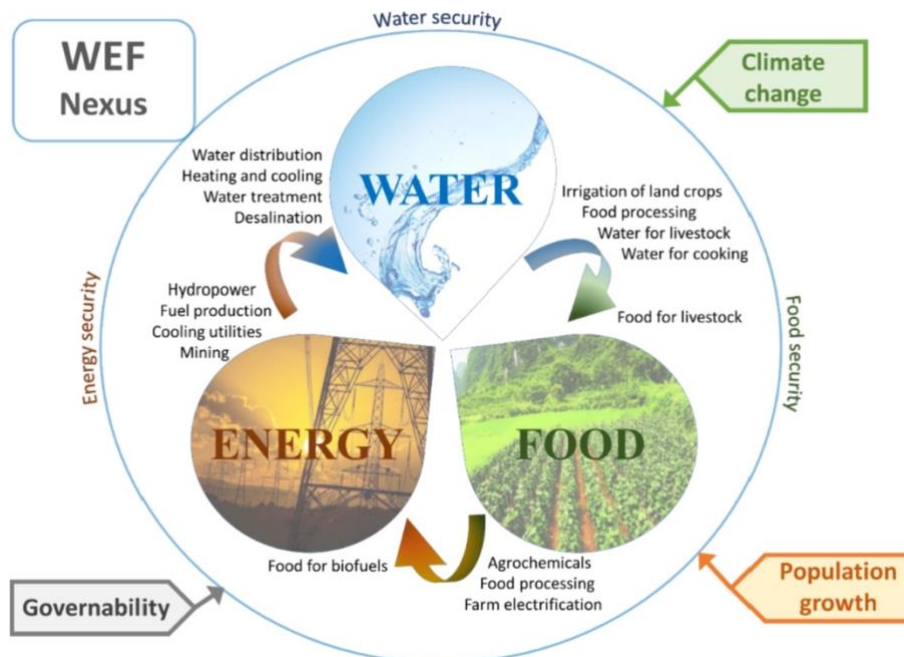
Paolo Zacchi-Cossetti, Global leader of Open Innovation and Supply Chain and **Will Sarni**, CEO of Water Foundry and founder and general partner at Water Foundry Ventures take a holistic approach to addressing water scarcity.

Scaling innovative technologies

Water is critical for economic development, business growth, social well-being and ecosystem health and climate change is a 'threat multiplier' making water the critical issue in food production and power generation (i.e., thermo-electric and hydro power production).

There is an opportunity to scale innovative technology and business solutions in water, agriculture and energy to build more sustainable and resilient societies and businesses. These innovative solutions are focused on decentralized systems as an alternative to more costly centralized water, energy and agricultural systems.

It is critical that we scale these water – energy – food 'nexus' solutions. The challenge of the nexus and impacts of climate change are illustrated below.



Nexus challenges: What has to change?

In several regions of the world, water is becoming scarce, and forecasts tell us that the situation will only get worse. Added to this already dramatic situation is increasing water pollution that means that the water we extract from the various sources of supply requires more treatment. This results in rising costs that become unaffordable both for governments and private entities and finally for individuals. All this requires a rapid and, above all, coordinated approach.

Indeed, there should be no stalling in deciding and pursuing concrete actions from both a regulatory and a technology innovation perspective: water, energy and food and the impacts of climate change do not wait and continues its relentless impacts.

Below are several innovative technologies and business models that can rapidly solve the water – energy – food nexus stress in a sustainable and resilient manner.

Agriculture

It is crucial, for example, to move to more sustainable farming concepts by completely rejecting intensive farming and going instead to propose zero-mile vertical farming where water use is optimised and space is drastically reduced compared to traditional farming. Take for example Italian startup, Planet Farms, which through its technology, compared to traditional agriculture, can: reduce water consumption by up to 95 per cent, reduce by up to 90 per cent the space needed to produce the same amount of produce, giving the opportunity to return soil to nature, thus ensuring reforestation and biodiversity.

It can also help to cut down on the production of CO₂ related to the transportation of vegetables through production located close to densely populated areas; this will be of increasing value considering the population growth and urbanization process that has been taking place for years now.

And ensure fresh vegetables every day, harvested according to demand and at the correct ripeness, avoiding the enormous waste associated with a global supply chain that wastes 1.3 billion tons of food each year, equal to the dispersion of 250 km³ of water (often potable before use with consequent energy waste and further CO₂ release into the atmosphere.)

This is the 'decentralization of agriculture', which fits perfectly with a broader theme of decentralization that must, for obvious reasons, also include energy and water.

Such decentralization is also necessary because the concept of returning land and areas now cultivated to nature is fundamental. Why is this issue so important? Because through the return of land to nature and its gradual reforestation there is an effect that is very important: the soil protected by plants remains wetter, retains more water and in the long run causes the groundwater to be positively affected as well.

The soil will also be more receptive in absorbing and storing rainwater due to the progressive increase in organic matter related to the absence of pesticide use and the increase in

biodiversity. Indeed, there is evidence that the water absorption capacity of the soil is related to the amount of organic matter present.

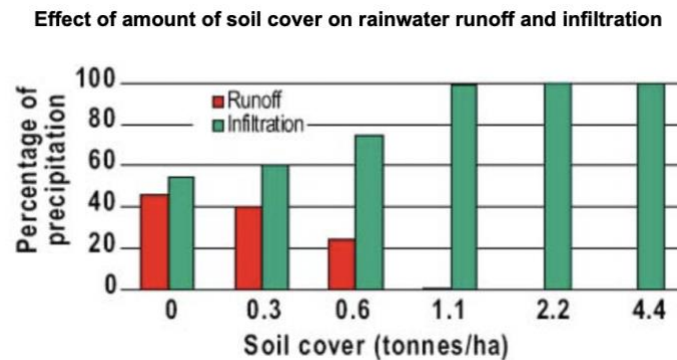


FIG 1 - Effect of soil organic matter in water retention (Ruedell, 1994)

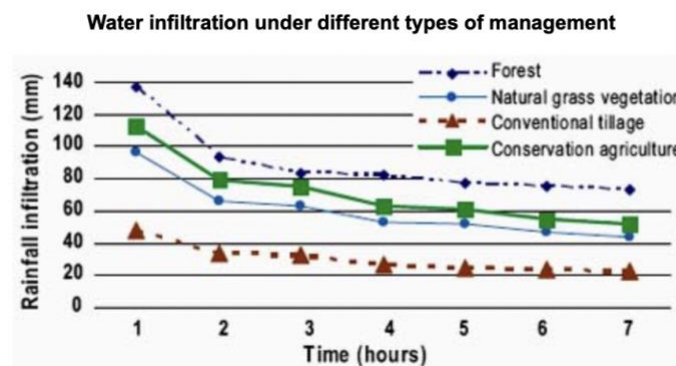


FIG 2 - : Water infiltration for different typologies of soil (Machado, 1976)

Food

In the food industry, a lot of issues experienced today are linked to very difficult to treat streams, requiring very complex and expensive systems. Recently we have seen new technologies that promise to disrupt this sector, like Aquacycl BETT, based on microbial fuel cells, able to treat very high-strength water generating electricity. This is good news, especially from a sustainability perspective.

Yet, we have the possibility to generate an even larger impact rethinking the way waste streams are managed during food production and using part of them to generate additional value. This would permit one side to keep the disruptive effect of solutions like Aquacycl, at the end of the process, adding during the process value-generating steps taking well identified streams to produce high value products.

An example is Mycorena, a Swedish startup that has developed a process to produce mycoprotein through fermentation using fungi. It takes side streams from industrial production

and in custom-designed bioreactors, it provides the fungi with optimized growth conditions in a controlled environment. The fungal biomass is then harvested and can be used back in the food industry as a high protein supplement.

Thanks to technologies like this we can design more effective and sustainable wastewater treatment solutions for the food industry, able to generate instead of destroy value. The production of superfood because the process has obvious positive impacts on the food chain and the amount of water needed to produce this food.



FIG 3 - Tetra Pak will develop a fungal fermentation production facility together with Mycorena to create alternative protein-based food applications based on microbiology (Agro-Chemistry.com).

What is the effect on the wastewater network? Industries adopting these kinds of solutions can discharge directly in the network, saving a lot of money and repaying once more the investment; the wastewater stream is low-strength and easy to treat, solving in this way the issues linked to overload of existing water treatment plants.

We would call this: 'value-driving wastewater decentralization for the food industry'.

Energy

Talking about renewables, we are normally thinking about solar or wind, that are trending technologies and where most of the development has happened in the last decade. Clearly these two typologies are very important and have a key role in the energy transition and decarbonization.

Furthermore, the recent developments of photovoltaic tiles and vertical residential turbines is key to moving from large production fields, sometimes realized in green areas and responsible for aridification of these areas, to decentralized production of energy. It is much more sustainable from an ecological standpoint and permits giving back to nature precious portions of land.



FIG 4 - Solar tiles installed in Germany and a “Wind Tree” by New Wind in France

But we must remember that the highest contributor to renewable energy is still hydropower, with 15.3 per cent of global electricity production.

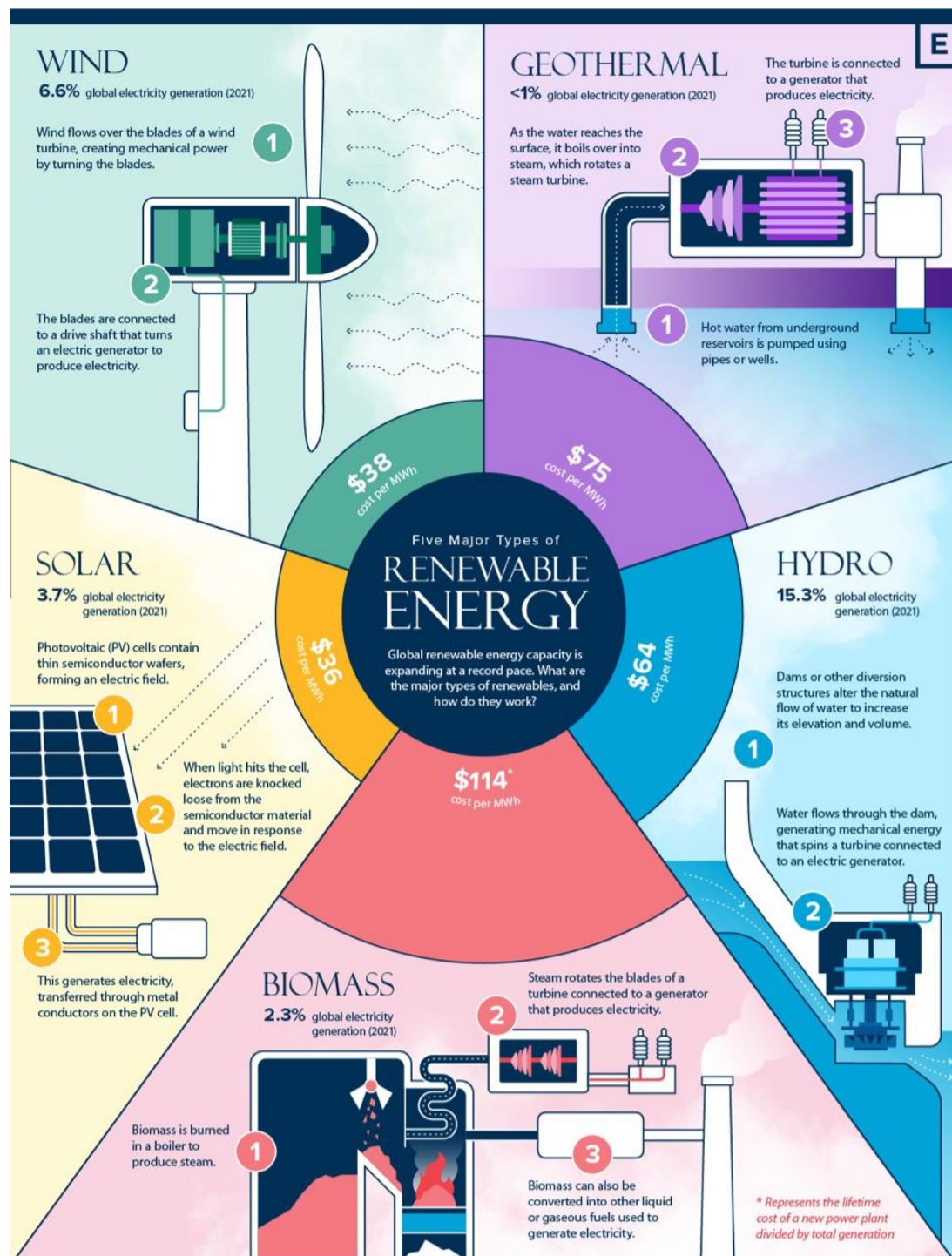


FIG 5 - Five major types of renewable energy (Source: Visual Capitalist)

Hydro has always had two big side effects: alteration of the ecosystem, especially in case of large infrastructures and massive infrastructure costs reflecting in high production costs during lifetime (amortization and maintenance costs).

This has negatively impacted hydro, especially when solar and wind have reached proper efficiencies resulting much more attractive for investors and utilities.

But there is a new generation of hydro that can revamp the sector and, in parallel, can bring very positive effects on the ecosystem.

Natel Energy, a company out of Alameda, CA, has developed a completely new range of fish-friendly turbines for low-head applications that have some key advantages that could make a difference:

For example, fish safe turbines grant negligible injury or mortality to all resident and migratory fish species at all life stages, as compared to natural hazards encountered during a fishes' life cycle, while passing through the runner. This feature permits to avoid expensive to build and to run (continuous cleaning) fish screening systems. This translates into a 40 per cent reduction in installation costs, mainly thanks to the smaller infrastructure needed and simpler screen-cleaning systems. All of this is positively impacting lifecycle costs driving cost per MWh much closer to solar and wind.

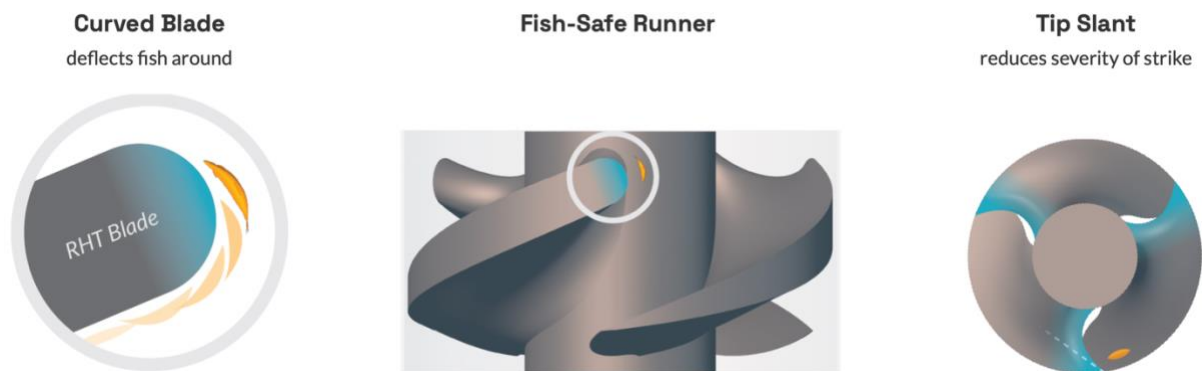


FIG 6 - Fish-Safe runner (Source: Natel Energy)

Unlike conventional hydro, distributed hydro can have very important benefits on the ecosystem. Restoration Hydro projects generate multiple environmental co-benefits that may include habitat creation, improved water quality and sustained increases in groundwater and aquifer recharge rates. When deployed strategically at multiple sites across a basin, Restoration Hydro projects enhance river, wetland, and watershed connectivity, which can help partially mitigate the impacts of droughts and floods.

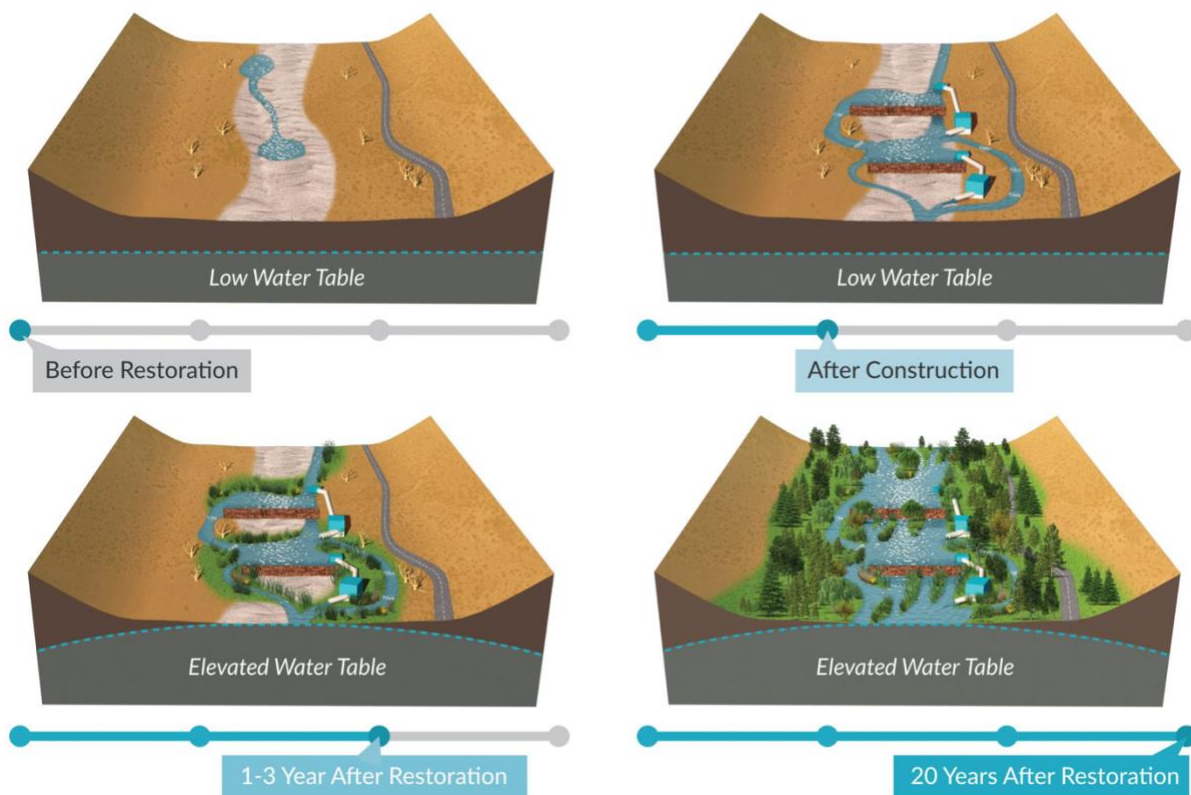


FIG 7 - Restoration Hydro (Distributed Low-Head Hydro) effect on river ecosystem and water table (Source: Natel Energy)

Besides the unique advantages that Low-Head distributed hydro can bring and that are highlighted above, there is another important effect that is the fact that hydro is running 24/7, unlike wind and solar.

Distributed hydro is another important form of decentralization, that we'll call 'decentralized hydro'.

So, another example of technology sitting at the Nexus, in this case Water-Energy Nexus.

Positive impacts on the ecosystem

What we have seen are all examples of decentralization sitting at the nexus between energy, food and water and where water is the common element. All of them have positive impacts on the single elements and the ecosystem providing short and long-term sustainability. It's our advice that, by only looking at technologies at the nexus between water, energy and food we'll be able to make an impact and accelerate the mitigation and maybe come up with a solution of the problems affecting us today and linked to climate change. Only coordinated actions can drive to success, thinking by sector cannot drive to any positive outcome in the long term but just bring illusory short-term wins.

Above all, it's our belief that the key is to give back to nature as much land as possible, re-establishing the natural ecosystem that has supported life for centuries; the ecosystem that the humans have started to impact with industrial revolution without caring of the effects of their actions, effects that we experience now through climate change.

There are plenty of technologies out there that can help in doing this. What is needed is the willingness to implement innovative regulations and public policies that benefit all of society and challenge the status quo to build a more sustainable and resilient society.