The Society/Technology/Environment Nexus: a Tool for Analyzing the Transformations of OHM Territories in the Context of Energy Transition ?

François-Michel le Tourneau[1], Sylvie Daviet[2], Vincent Robin[3]

[1] CNRS, Paris, France
[2] AMU, Marseille, France
[3] UL, Nancy, France

Summary

I. The rise of the FEW nexus concept in the literature

II. The STE nexus hypothesis for studying the reconfiguration of socio-ecosystems in the context of Energy Transition (ENERGON program)

III. Territorialized case studies (currently 3 out of 6 in ENERGON program)

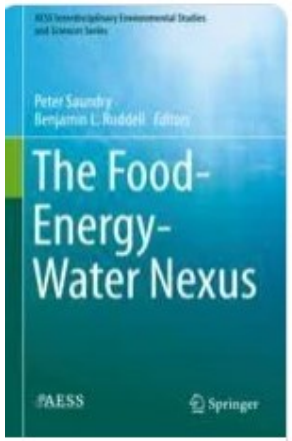
IV. First elements of conclusion and perspectives

I. The rise of the FEW nexus concept in the literature: an evolving concept

The Bonn Conference (2011) and the emergence of the FEW nexus concept

- The topic was "**The Link between Water, Energy and Food Security**: Solutions for the Green Economy".
- The conference was organized by the German federal government in collaboration with the World Economic Forum (WEF), the World Wide Fund for Nature (WWF), and the International Food Policy Research Institute (IFPRI) to prepare the 2012 United Nations Conference on Sustainable Development (UNCSD, or Rio+20) which would lead to the 2015 SDGs.
- From the outset, there is a concern for public policy; the observation of the degradation of ecosystems in a context of climate change; and **the desire for a "nexus approach"** that can support a transition to sustainability through technological innovation, recycling, waste valorization, better multi-level governance; the call for interdisciplinary research
- **FEW Nexus**: water to produce food, energy to bring water, food products are in turn a source of energy.
- These different interrelationships need to be addressed in **a systemic way** if we are to achieve a better understanding and management of food and energy security issues, both **at the international, national or regional level**

Success of the concept : hundreds of articles, dozens of books



The Food-Energy-Water Nexus - Saundry,…
89,66 €
Springer Nature
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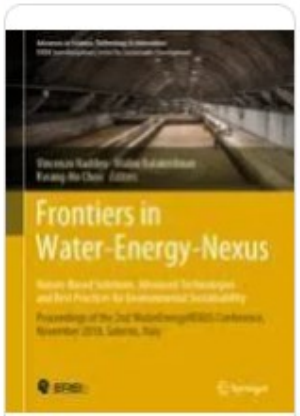

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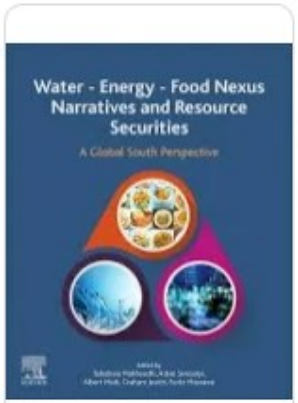

Water - Energy - Food Nexus Narratives and Resource…
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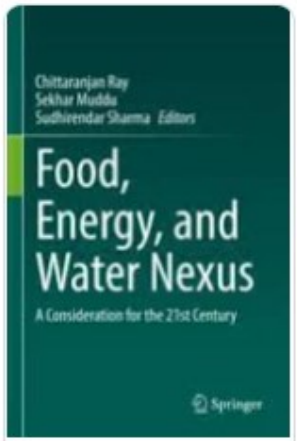

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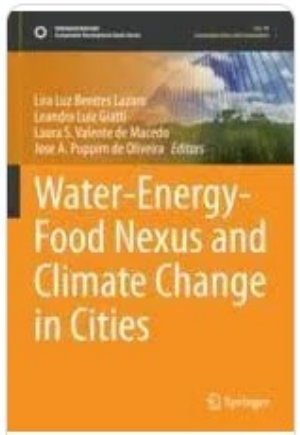

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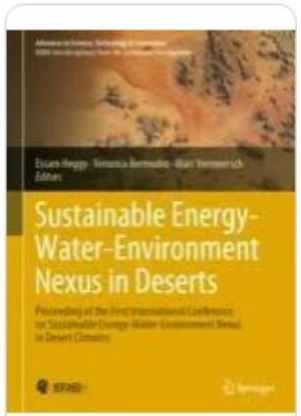

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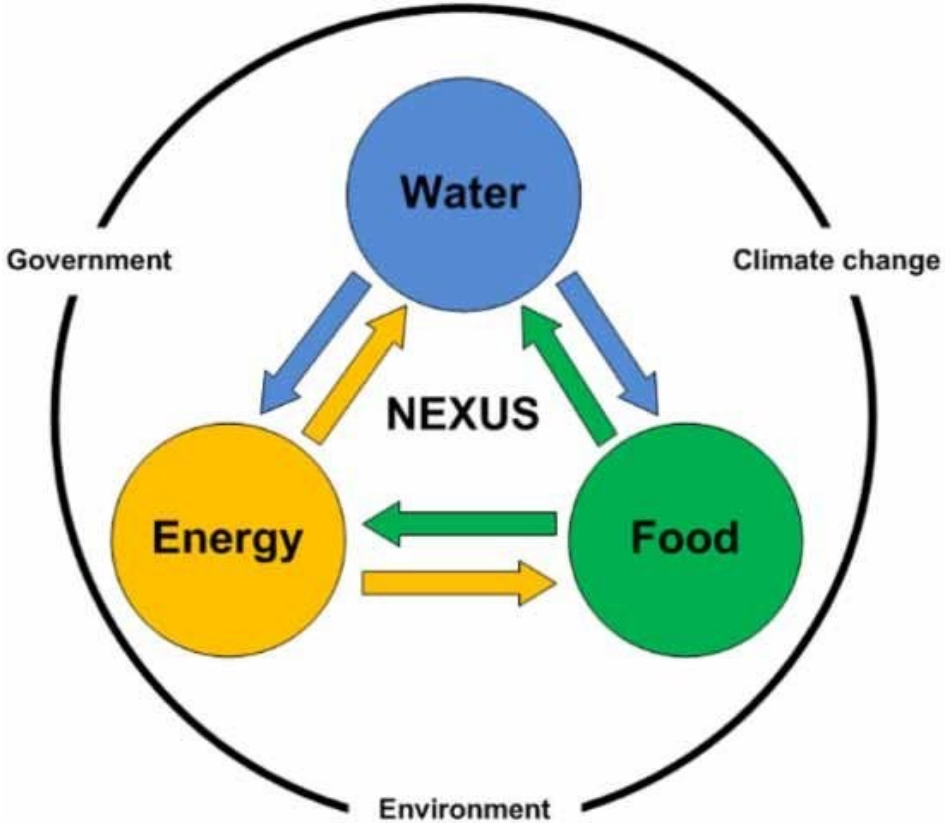
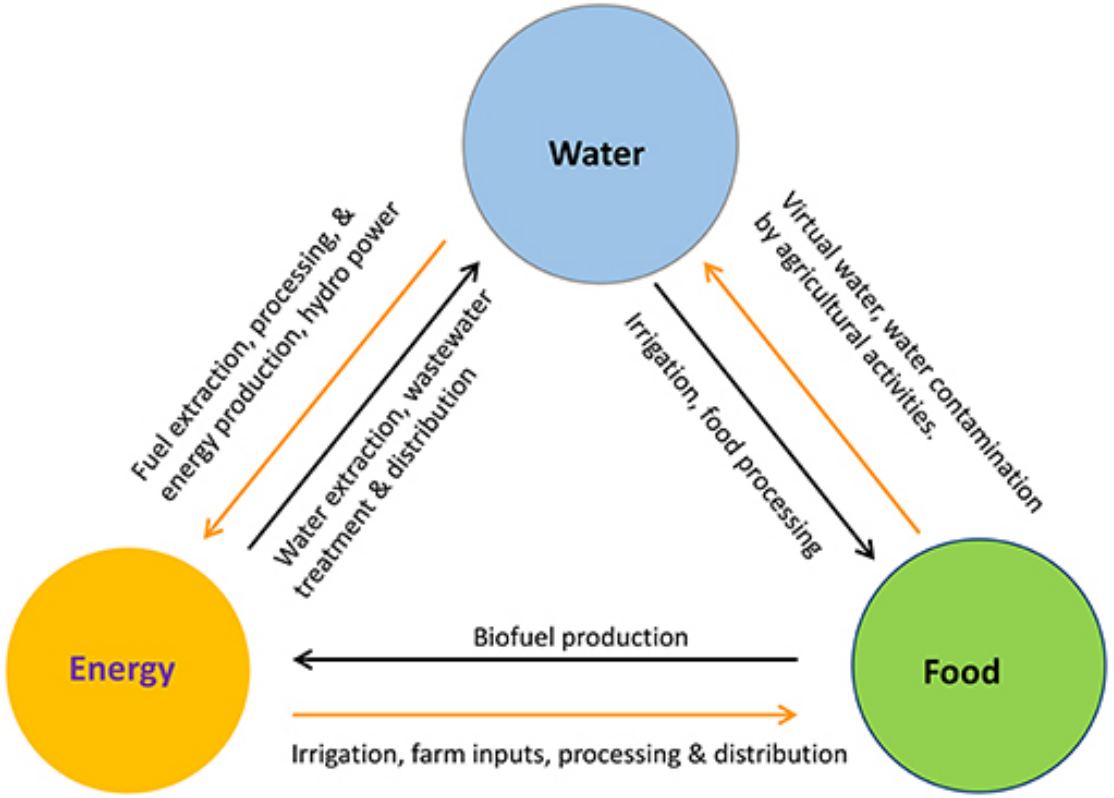
Diagramming and modeling

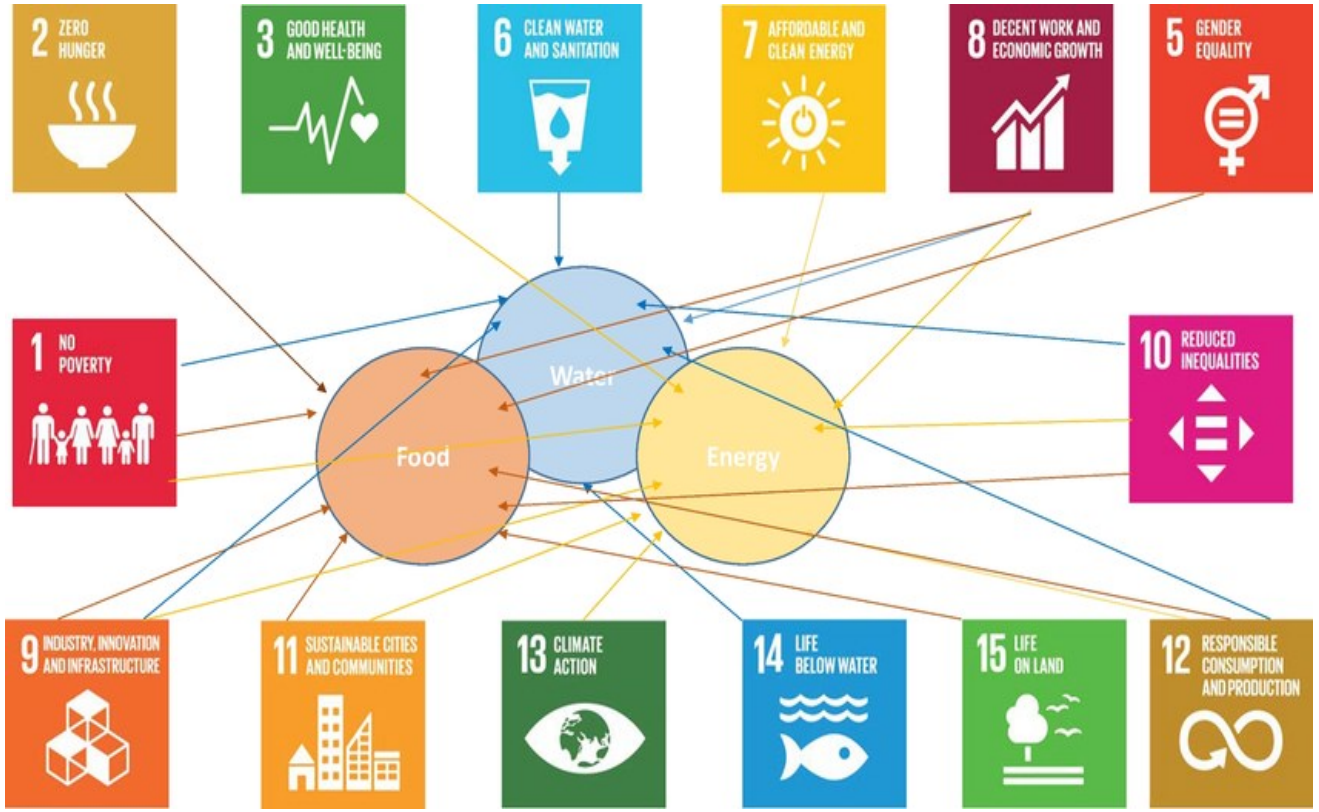




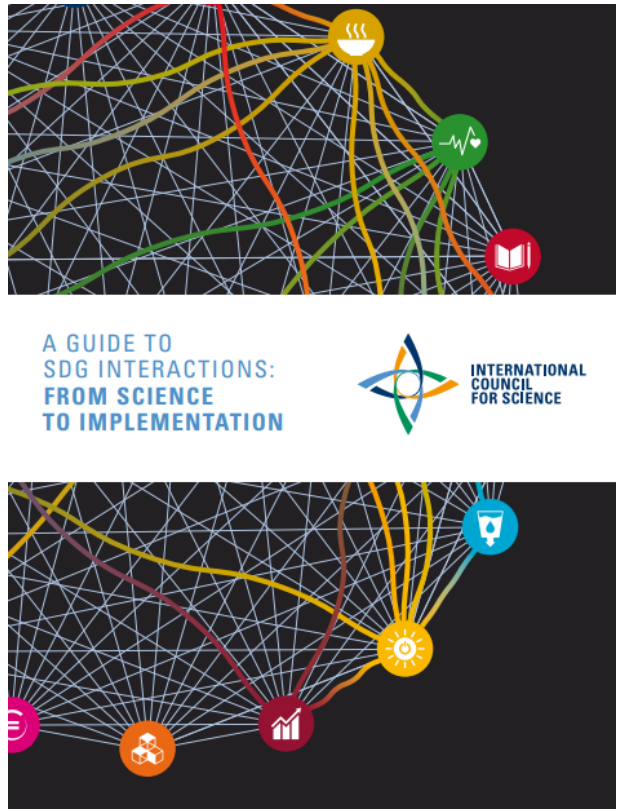
Water, energy, and food nexus: review of global implementation and simulation model development Albert Wicaksono, Gimoon Jeong and Doosun Kang* Dept of Civil Engineering, Kyung Hee University, 1732 Deogyeong-daero, Giheung-gu, Yongin-si, Gyeonggi-do 17104, Republic of Korea *Corresponding author. E-mail: doosunkang@khu.ac.kr ; Water Policy 19 (2017) 440–462

Front. Environ. Sci., 07 May 2019 Sec. Freshwater Science
Volume 7 - 2019 | https://doi.org/10.3389/fenvs.2019.00056

Nexus FEW and international SDG approach



Schlör and Schubert Energy, Sustainability and Society (2022) 12:43
https://doi.org/10.1186/s13705-022-00369



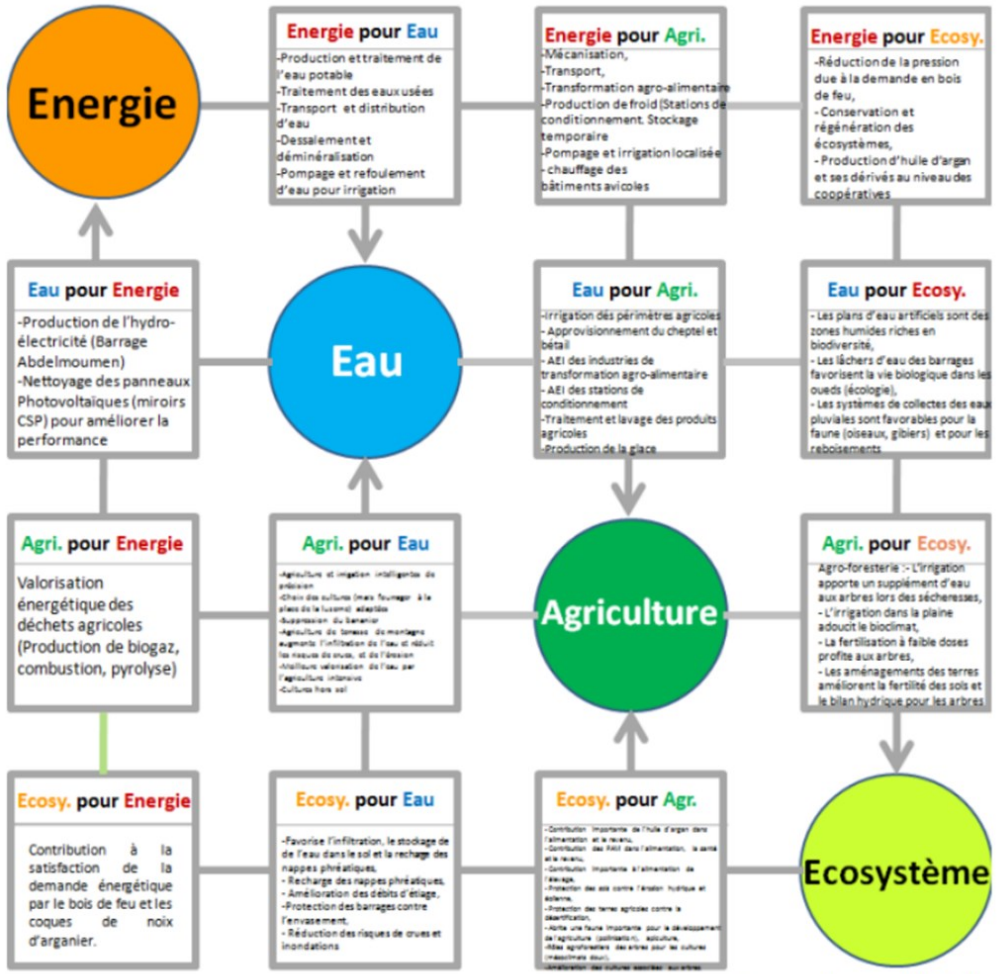
https://council.science/publications/a-guide-to-sdg-interactions-from-science-to-implementation/

Territorialized studies have introduced the notion of ecosystem as a 4th pole

This is particularly the case in the work of IRES (Royal Institute for Strategic Studies) which has carried out several studies on the nexus in Morocco.

➡ **an evolving model**

Graphique 49: Matrice globale des Interdépendances entre les 4 secteurs Eau, énergie, agriculture et écosystème dans la région de Souss Massa

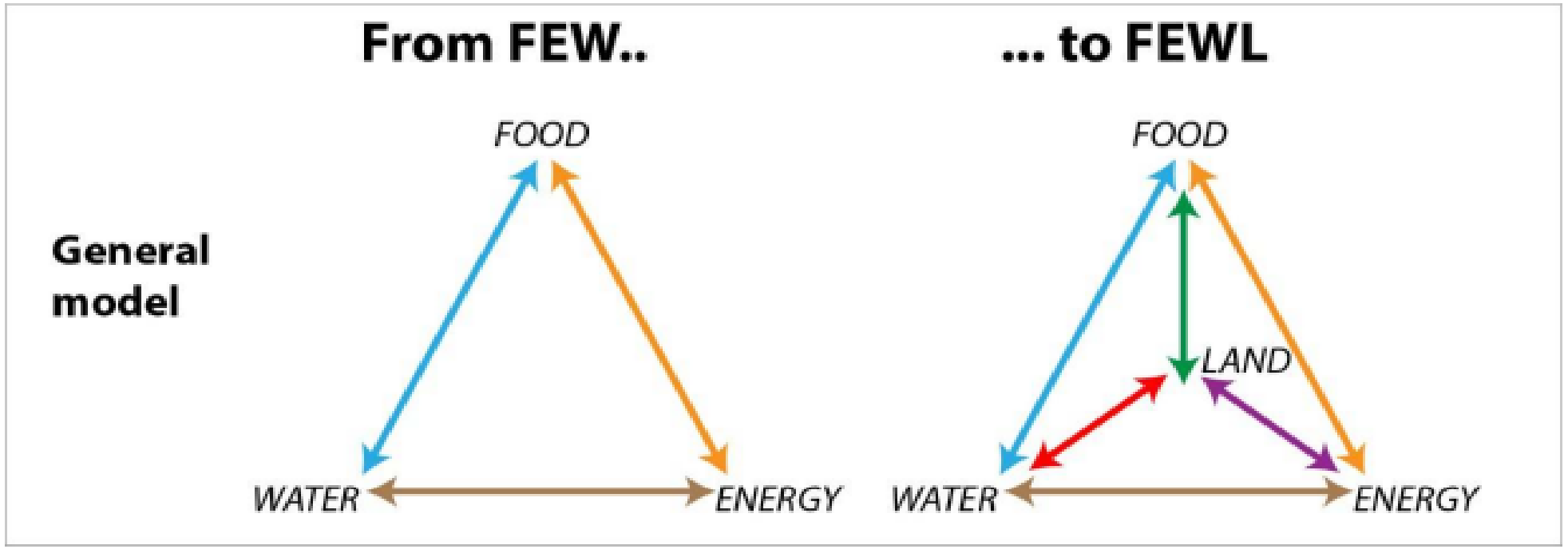


Source : Auteurs de l'étude.

https://ires.ma/fr/publications/rapports-thematiques/approche-nexus-pour-la-gestion-de-leau-dans-le-bassin-souss-massa, 2021

D. Blanchon and F-M. Le Tourneau introduced the notion of "land”

Figure 1a et 1b : De FEW à FEWL, le passage à quatre dimensions du Nexus



David Blanchon and François-Michel Le Tourneau, “Quand la terre dévoile l’eau : l’ajout d’une quatrième dimension au concept de Nexus Eau/Énergie/Alimentation et sa pertinence pour les recherches sur l’eau”, Géocarrefour [Online], 96/2 | 2022, Online since 22 July 2022,. URL: http://journals.openedition.org/geocarrefour/20162 ; DOI: https://doi.org/10.4000/ geocarrefour.20162

II. The STE nexus hypothesis for studying the reconfiguration of socio-ecosystems in the context of Energy Transition

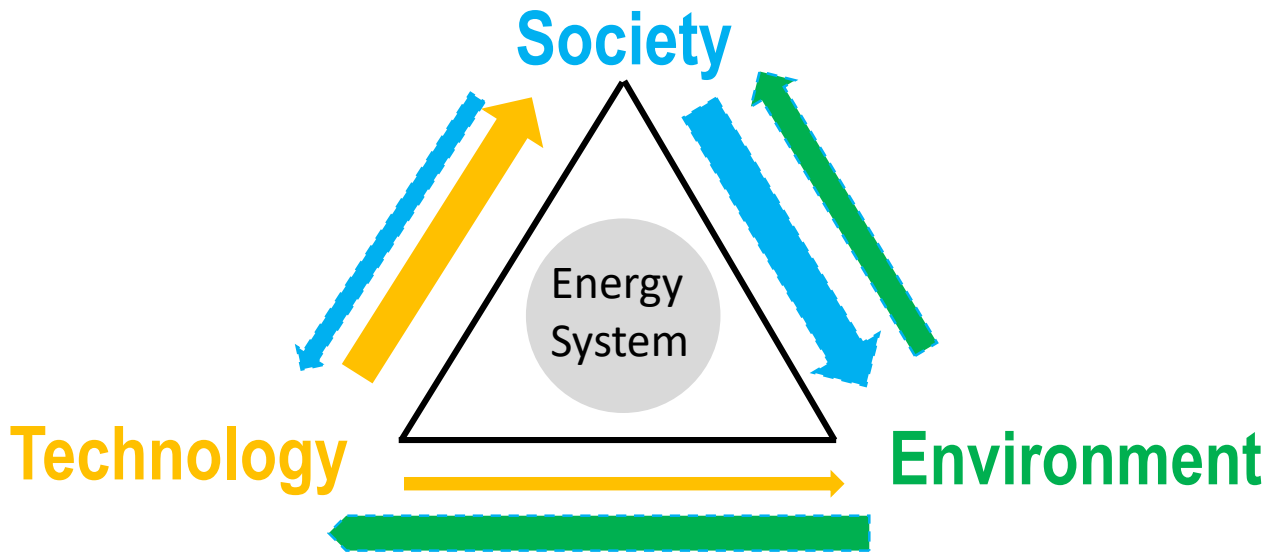
ENERGON program includes 6 case studies

Step 1: identification of the 3 dimensions in each OHM of the program

	Technological issues	Social issues	Environmental issues
OHM-Pays de Bitche (Lorraine)	Changes in the wood sector **emergence of a wood-energy market**	The problem of renewing individual and collective boilers	Problem of the impact on the ecological state of the forests and on the renewal capacity of the biomass stocks
OHM-Vallée du Rhône	**Development of hydroelectricity** (new dam project, small hydroelectric power plants …)	Public debate on this new equipments	Environmental impacts of this new equipment
OHM-BMP (PACA)	Question of the performance of **coal-fired power plants converted to biomass**	Controversies concerning biomass plant and Hynovera project (biofuels)	Problem of impact of biomass plant on exploitation of regional and extra-regional forest resources
OHM-Nunavik (Québec)	Management of climatic conditions in an off-grid area. Role of **circumpolar greenhouses**	Link between energy autonomy (greenhouses) and food	Diesel generators are replaced by clean technologies. However, we question the place of grey energy
OHM Pima County (Arizona)	**Development of solar energy** (storage for the night but also cooling of photovoltaic panels)	Cost of technology change, place of the consumer-producer	Links with the land issue, life cycle of solar panels, imported CO2...
OHM-Fessenhein (Alsace)	**End of a nuclear power plant** influence of existing system on possible transition trajectories	Path dependencies; role of networks of associative, political and economic actors in transition trajectories	Soil condition (pollutant/contamination) around the pre-existing industrial plant; Heat rejection in the environment ;

Step 2: definition of the poles of the nexus

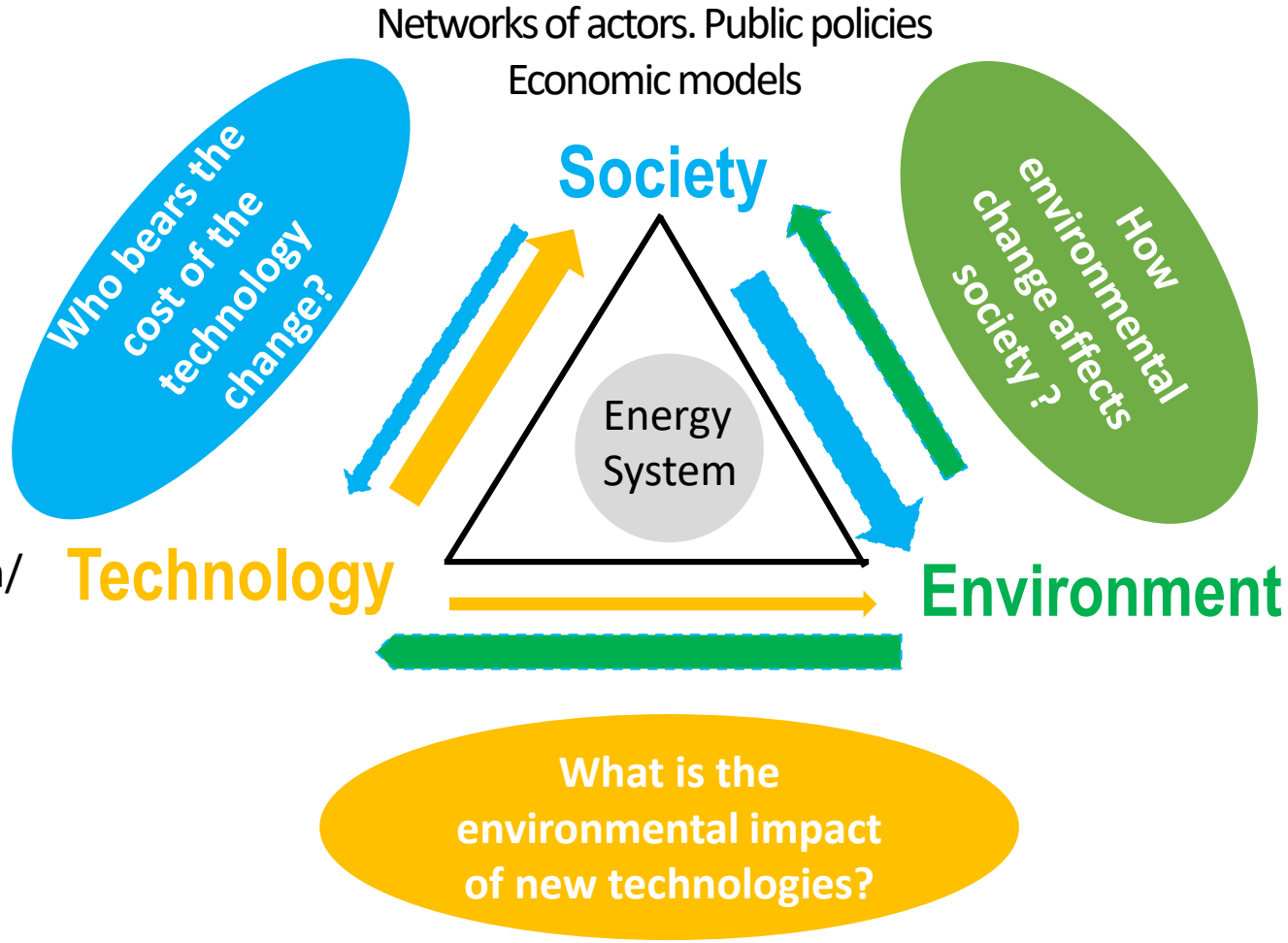
Networks of actors. Public policies
Economic models



Changes in energy systems ; production/ transportation/use

Redistribution of spaces ; landscape changes ; pressure on resources

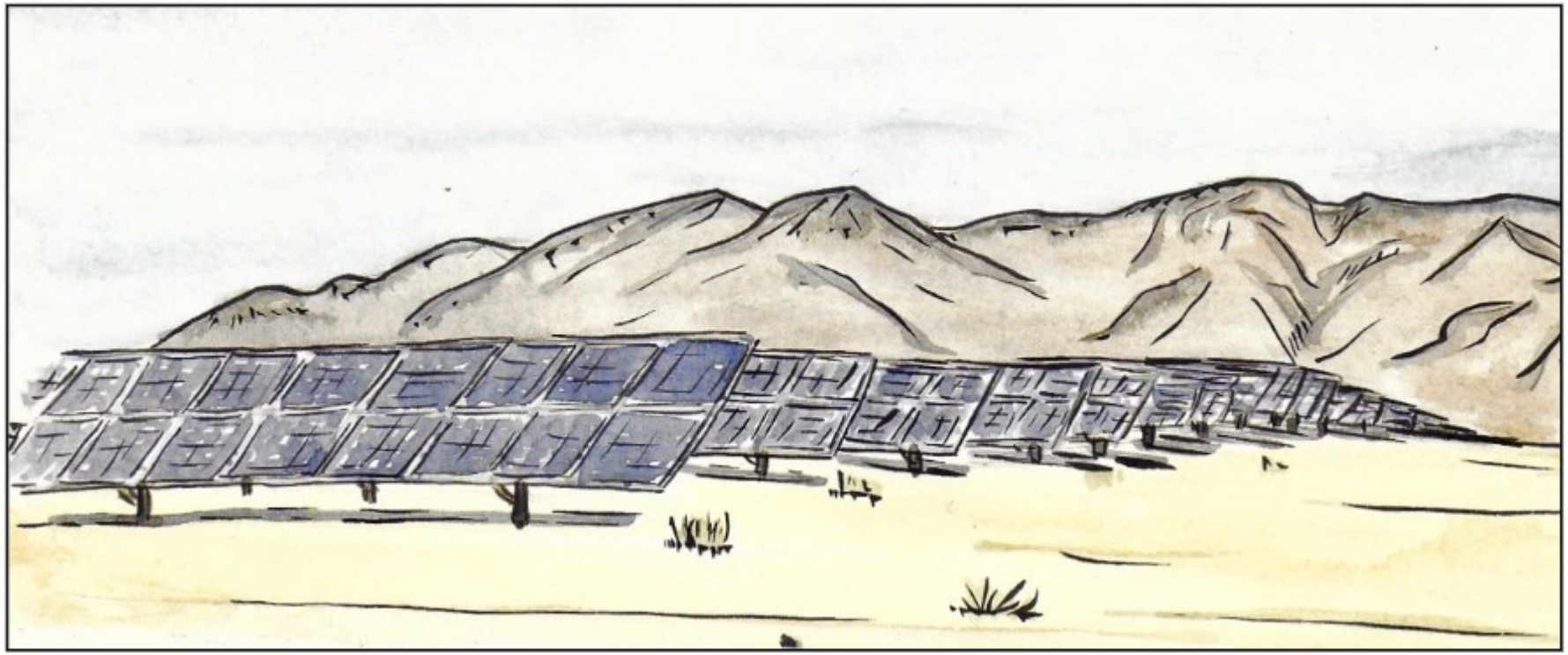
Step 3: questions about interactions; Step 4 about flow quantification



Changes in energy systems ; production/ transportation/use

Redistribution of spaces ; landscape changes ; pressure on resources

III. A- The case of Pima County

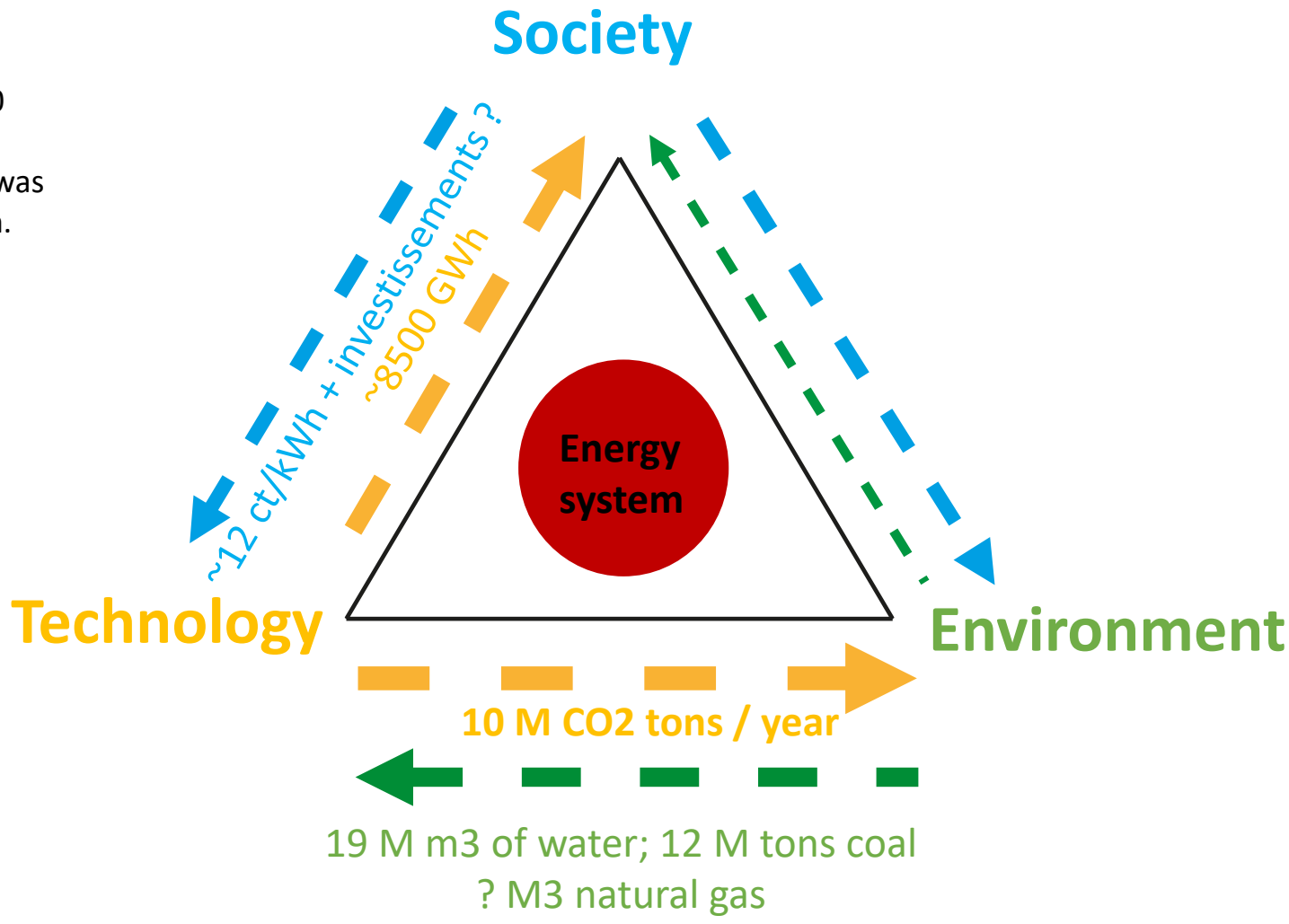


The city of Tucson is more than five times larger than Paris with a density about 25 times less. Tucson as a metropolis has a population of about 1 million, spread out over the semi-arid Sonoran desert.

Before transition

Technology / society
TEP's provided ~8,500 GWh in 2020
price of Kwh 12ct in 2020;
it is very difficult to estimate what was the cost to build the current system.

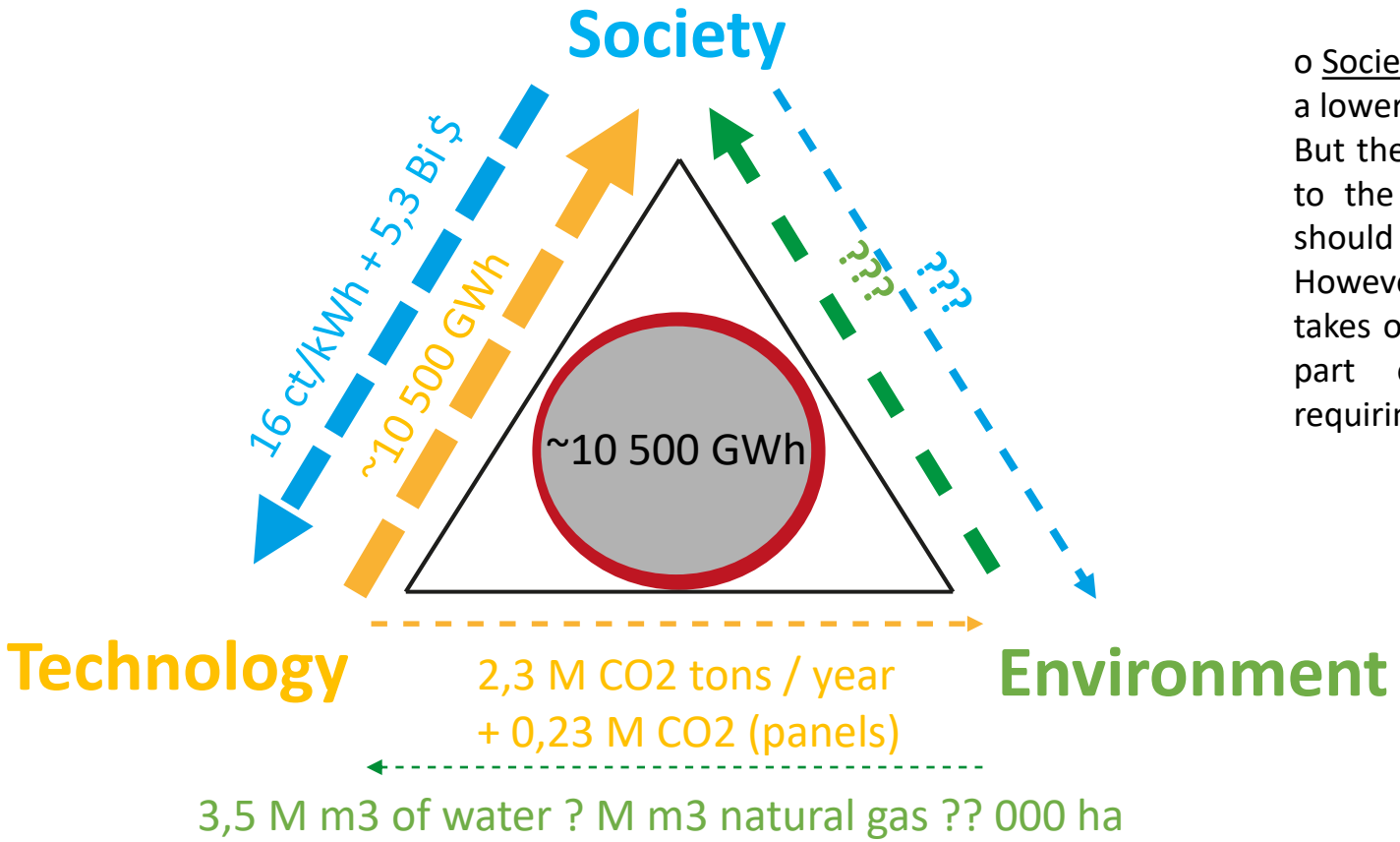
Technology / environment :
CO2 emitted by coal and gas power plants -> 10 million tons per year.
In 2020 about 12 million tons of coal, 19 million m3 of water... Calculation to be done for natural gas



Society / environment:
How to measure the social cost of energy system ? By life expectancy ? Diseases ?
The Tucson territory is not directly impacted by the fossil power plants located outside the perimeter.
Is there a decrease in these "environmental services" due to the energy sector? Which metric?

After transition (objective)

Technology / society:
TEP's power system is expected to provide ~10,500 GWh of power in 2035; (drastic increase due to electric cars or not? Will urban growth continue at the same pace?).
the price of Kwh in 2035 is rising TEP asks for a 12% readjustment in 2023, i.e. 16 ct/kwh;
Cost of distributed systems ?
Cost of the last two power plants
-> 5.25 billion US$ to be invested in 15 years



o Society -> environment: we suppose a lower cost because less CO2
But there is a risk of degradation due to the fact that solar power plants should consume space.
However, if distributed generation takes off, it can produce a substantial part of the electricity without requiring more artificialization

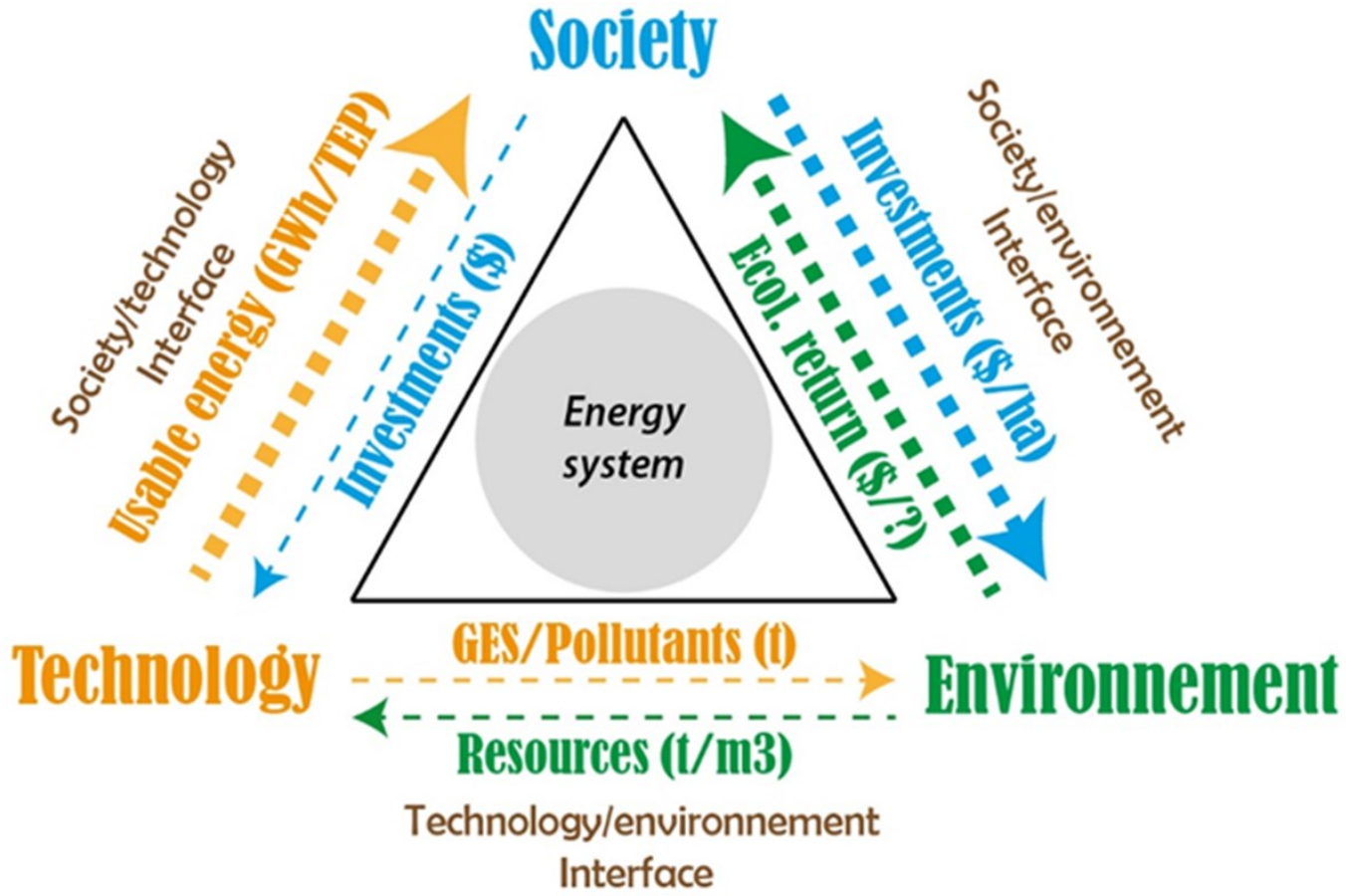
o Technology -> environment: reduction of CO2 emissions to 2.3 million tons per year for conventional power plants. The carbon footprint of solar panels is estimated at 230 000 tons of CO2 for this part / year ?
o Environment -> technology: coal = 0; natural gas ?; water = 3.5 million m3; question of components of solar panels or wind turbines + batteries (rare earths, metals, lithium...). + space consumption for the power plants,

III. B- The case of the OHM Bassin Minier de Provence

End of the coal-fired power plant in favor of a biomass plant and other renewable energies
in an area of 17 municipalities with 110,000 inhabitants

o **Society -> technology**: the investment to convert the unit 4 to biomass was about 230 M€ + public funds (ADEME) to evaluate. At the same time, investment of households and local authority in new renewable equipment to be quantified

Technology -> society: The conversion of the power plant leads to a decrease in capacity from 600 MW (coal) to 150 MW (biomass). At the same time, development of renewable energy (geothermal, PV, biogas, heat pumps) by households and local authorities. But the energy deficit of the territory tends to increase



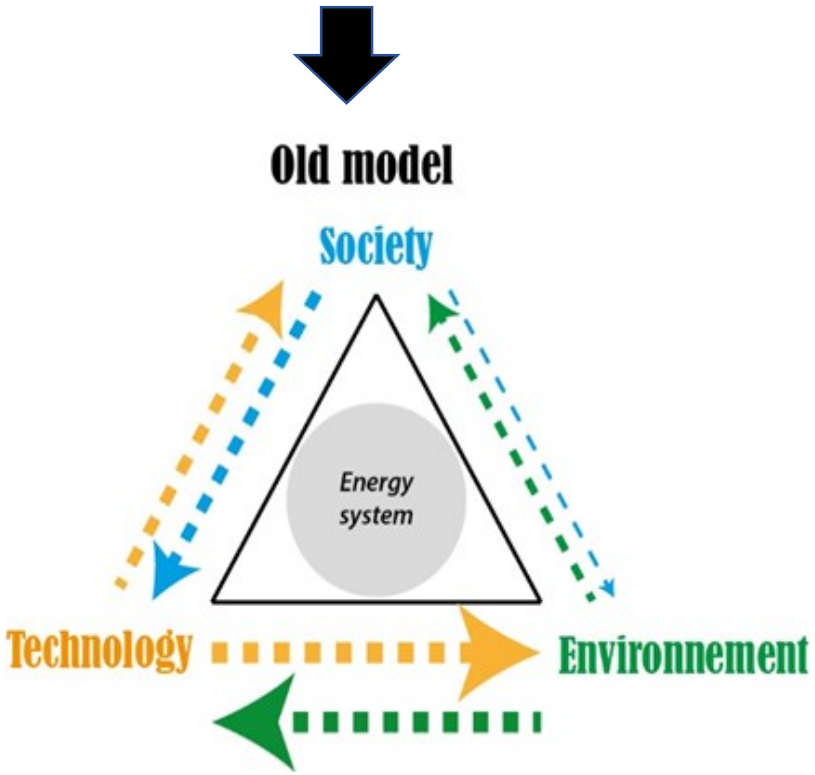
o Technology -> environment: GHG emissions must decrease from 1000 g CO2/kwh for coal to 32 g CO2/kwh for biomass; + wood transportation emissions to consider.

o **Environment -> technology**: consumption wood : 850 000 t/year or 2300 t/day (% of Brazilian and regional wood). the life cycle of the resource to be specified

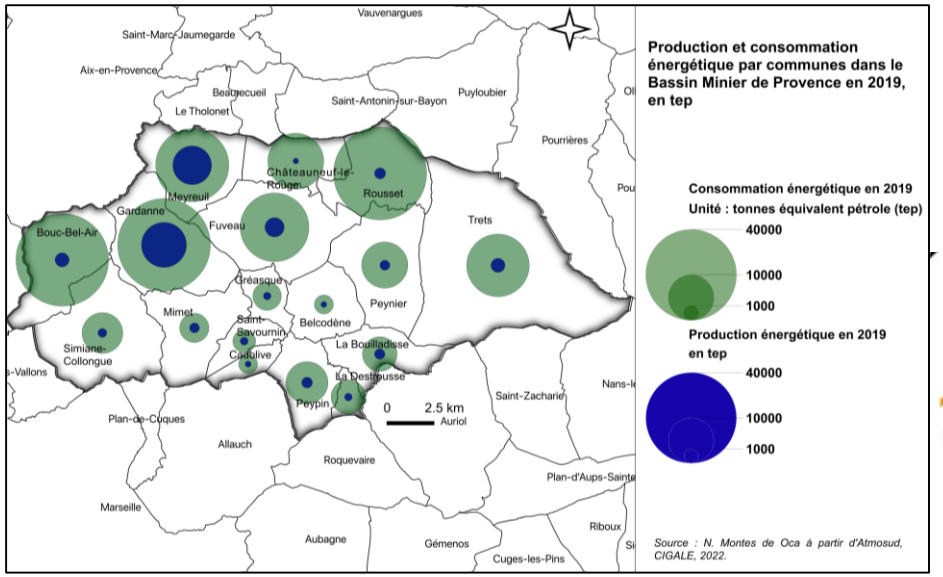
o **Society-> environment** Investments in the environment: several regional nature parks in the nearby area + private forest. But the development of biomass poses a risk to the forest resource (= negative investment).

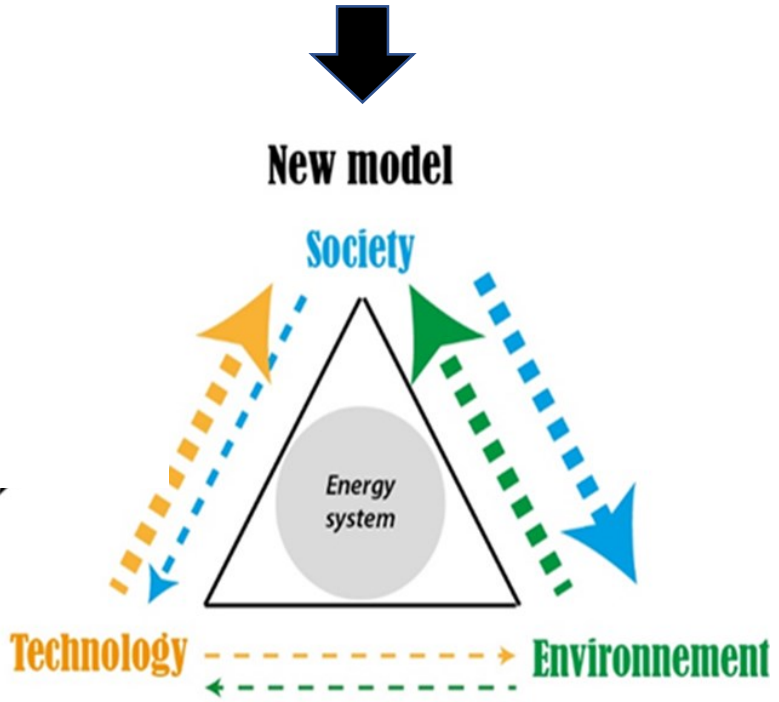
o Environment -> society Forest provides environmental services: tourism. Park defenders carry the protest against the biomass plant: suspension (March 2023) of the authorization to operate the plant + protest against Hynovera project

Cost of transition; less energy produced; negative environmental externalities not yet controlled



ENERGY TRANSITION

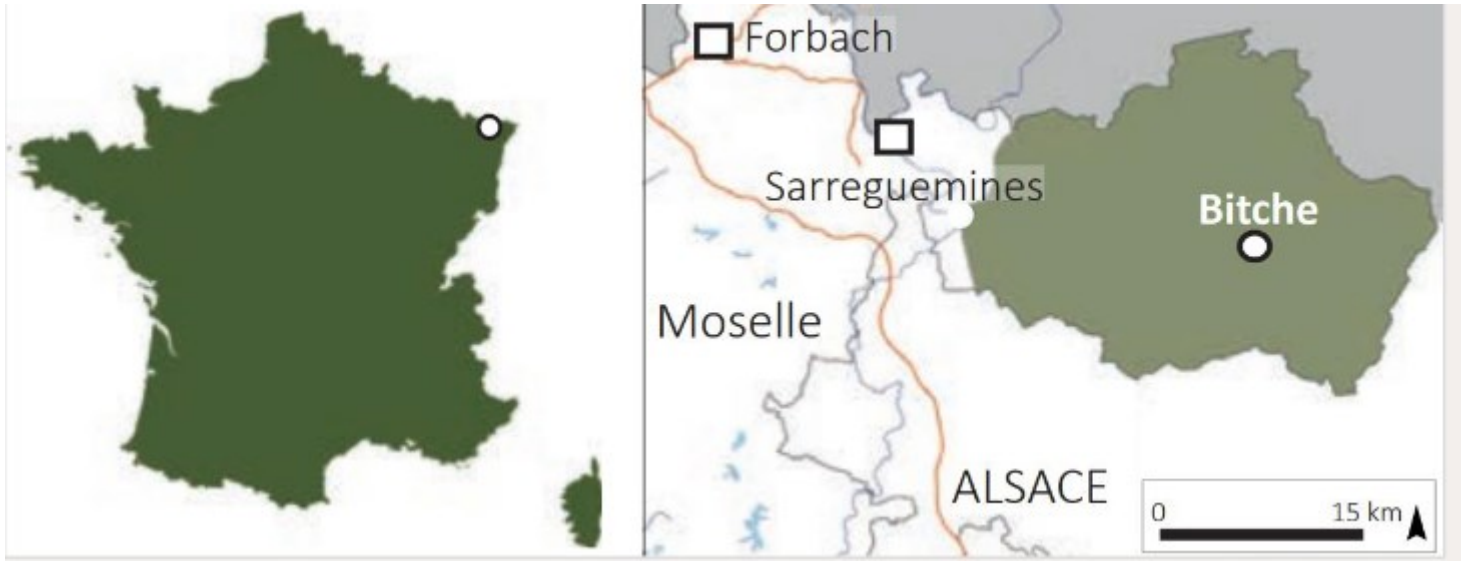




Map: Nina Montes de Oca

Is the scale of analysis, the 17 municipalities of the BMP, relevant for assessing the results, even if provisional? Should this analysis not be carried out on the scale of the metropolis, the region, etc.?

III. C- The case of Pays de Bitche

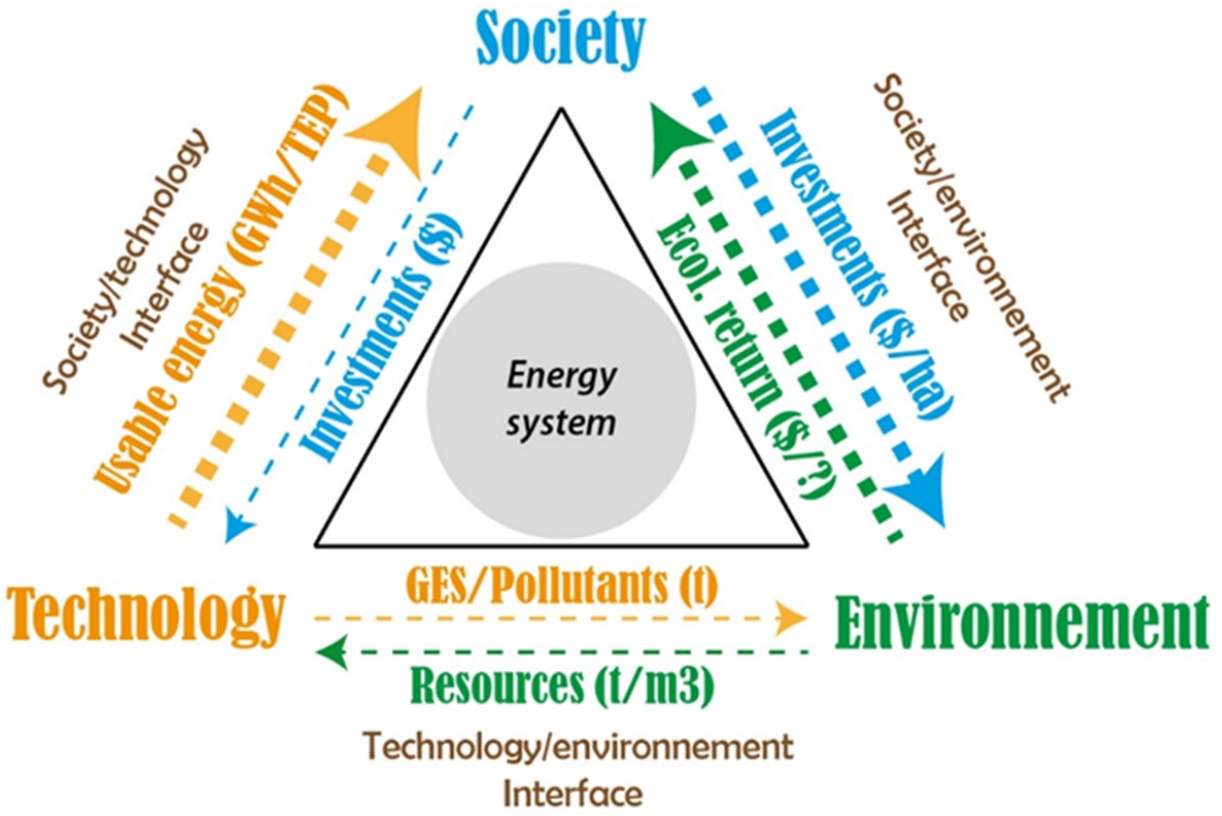


Rural / Forest Territory; Landlocked and border
≈600 km2 - 46 municipalities; ≈35,000 inhabitants - 59 inhab./km²

Opening of a biomass (wood chips) boiler for public buildings of Bitche

Production of 2,100 MWh/year, i.e. 181 tones of oil equivalent saved/year = 87,000 euros/year
Total projected cost of the operation = 1,365,000 EUR including 1,019,000 EUR from ADEME and FSIL supports
Energy supply for a set of public buildings since 2019; today not all of the buildings planned for connection are connected.

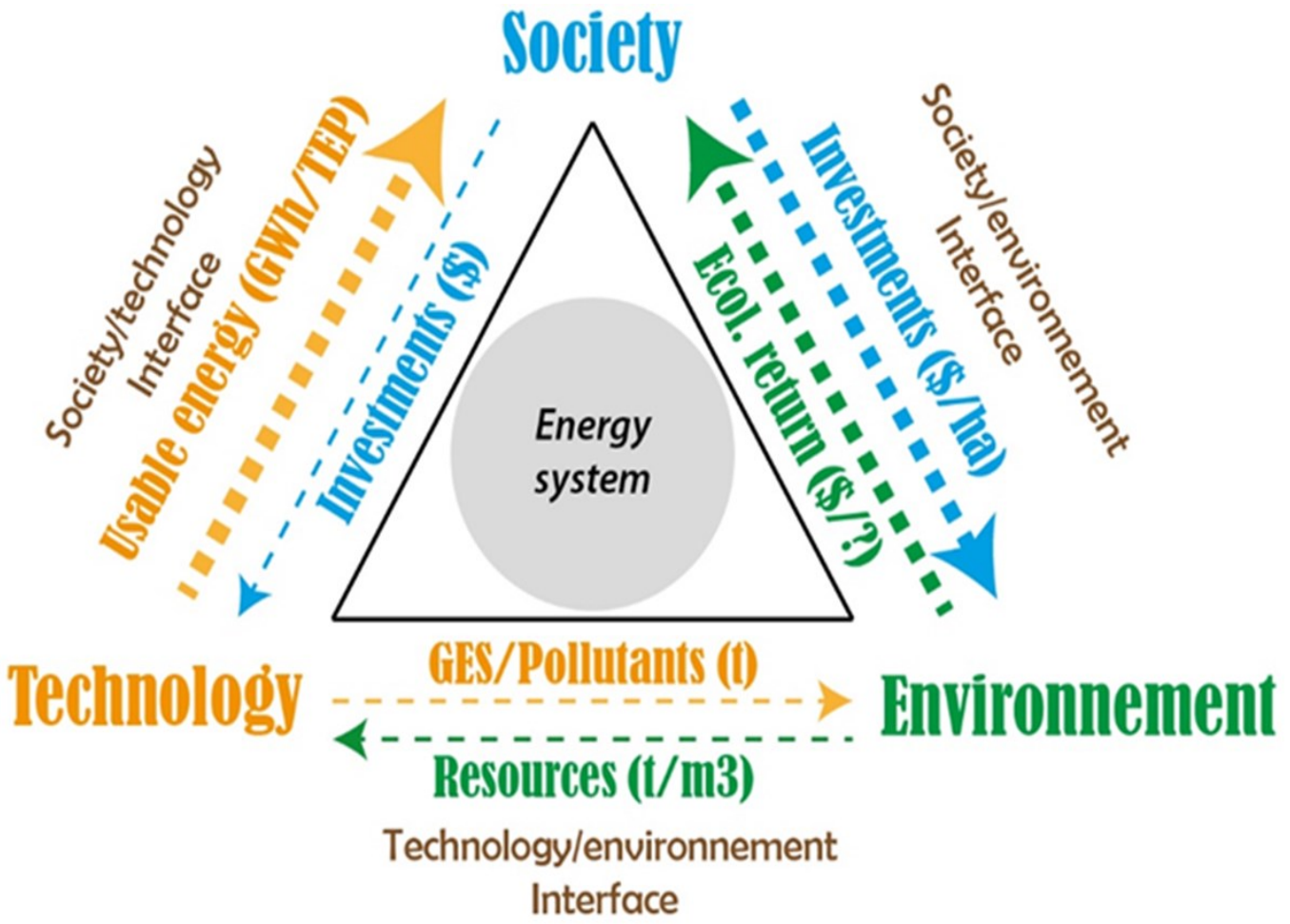
=> What individual/collective technical and/or economic locks are playing a role on the biomass energy transition in the territory?



⇒ What type of energy transition in the Pays de Bitche? What perception and "percolation" have the opening of a biomass boiler on the local society?

=> A biomass-energy transition: in which "energy landscape"? Origin of the energy resource? Changes in the forestry practices of the territorial sector?

PdB: opening of a biomass (wood chips) boiler for public buildings of Bitche



Society-Technology
Firewood seems to still represent an important part of the individual energetic strategies

Technology-Society
1 or 2 others project of biomass power plant for public buildings are in preparation in the territory

Society- Environment
In 2016, 71% of the territory's GGE emissions were "offset" by the carbon sequestration of the territory's forests = important territorial issue of preserving forest growth =

Environment –Technology
Only 61% of wood-energy is consumed locally. An increase of 67% of the consumption of wood-energy (ex the residential sector) would balance the territorial production / consumption

Technology-Environment
Total energy consumption in 2016 of 791 GWh PCI
of which 15% of wood-energy -> 50% by the residential sector, of which 27% of wood-energy

Environment - Technology
Most of the energy consumed in the territory is imported (fuel oil, natural gas, etc.). The local production only covers 28% of territorial needs!

IV. First elements of conclusion and perspectives

Lessons from the 3 case studies

- Difficulty of measurements and metrics
- Especially in the society/environment relationship where the qualitative dimension is essential: questioning, debates, conflicts
- Less GHGs but more other inputs and uncertainties about the environmental services that nature will continue to provide
- Transition is expensive and the distribution of costs is a source of tension
- Uncertainties about the maintenance of productive capacity, whether the barriers are technological or societal
- The multi-scalar dimension (open systems) is one of the difficulties to apprehend the measurement of the energy system

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Lessons on the STE nexus as a tool for analyzing the OHM' s socio-ecosystem

- Need to document at least the 6 ENERGON cases in order to increase generality
- Nexus STE is an interesting tool to cross the social, technical and environmental dimensions of each socio-ecosystem in a systemic approach
- While socio-ecosystems are already disturbed by the disruptive event (DE), ET acts as an additional element of disturbance, raising the question of a chain of systemic crises
- The adaptation of socio-ecosystems: closure of production sites; development of new means of production... questioning the resilience capacities of territories.
- However: difficulty of measurements and metrics, blockages and locks show that energy transition remains an equation with several unknowns