Energy. Water. Food. Climate
Considering decision-making at the nexus

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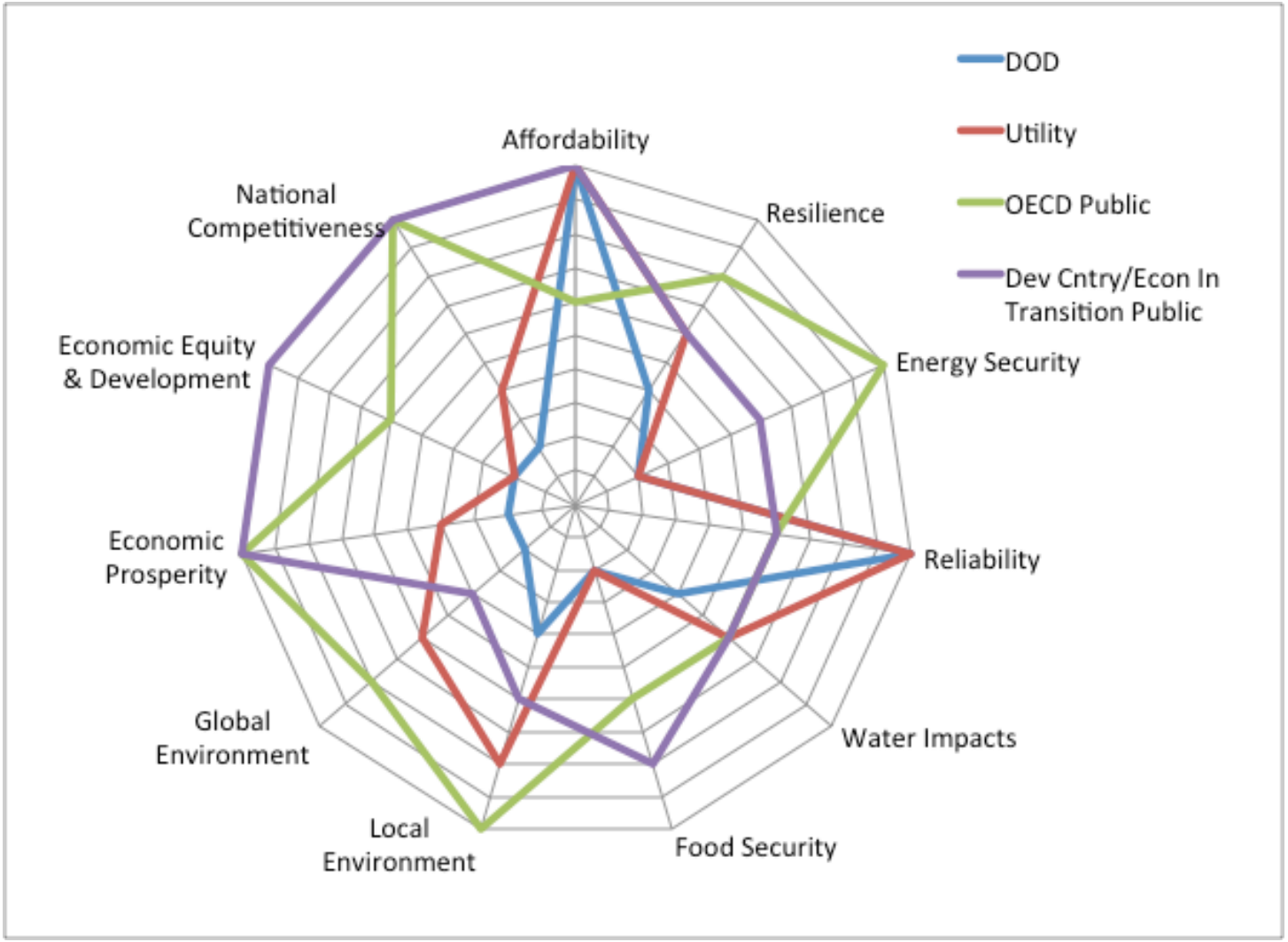
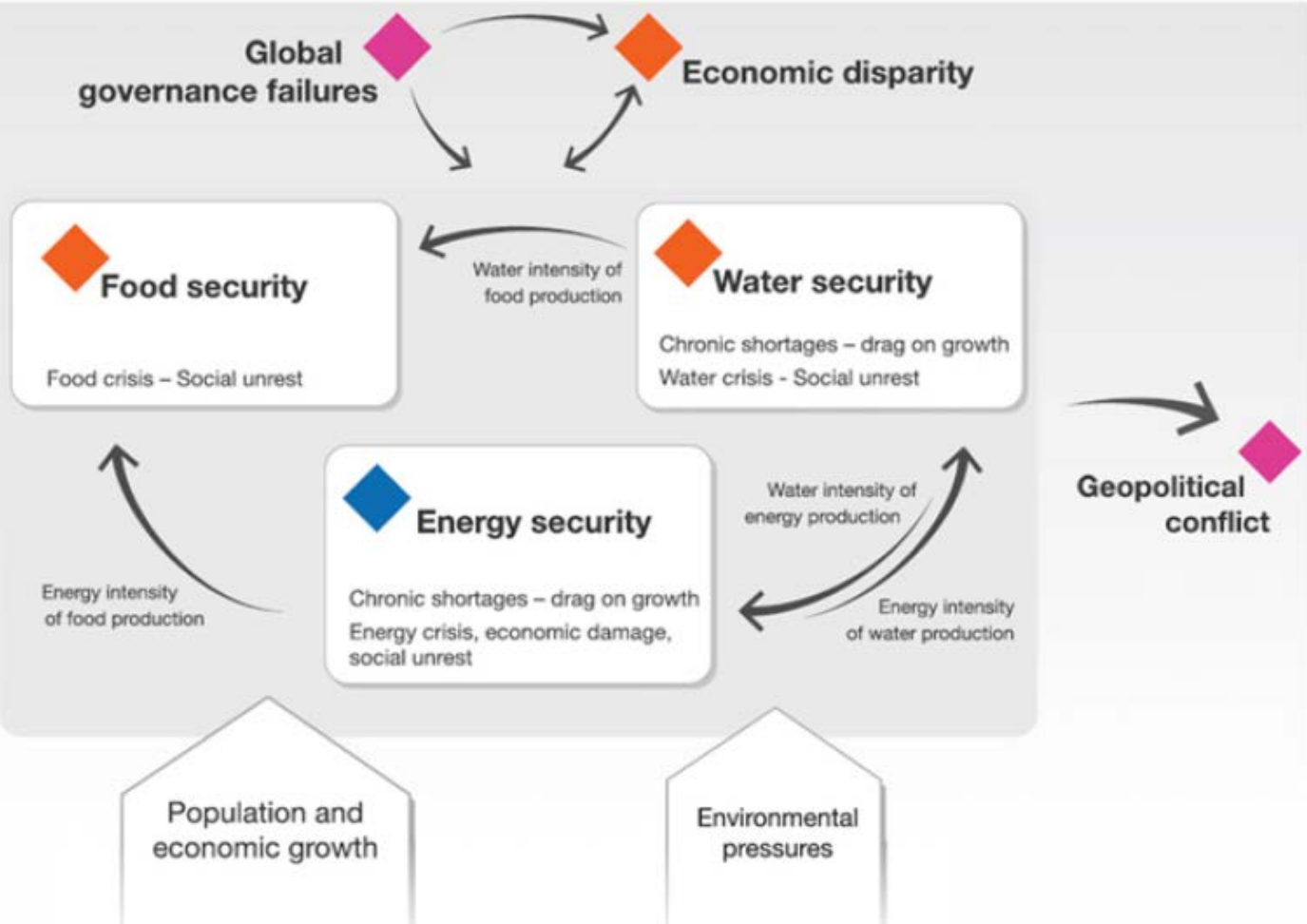
No Longer a Triangle

("all of the above" is difficult)

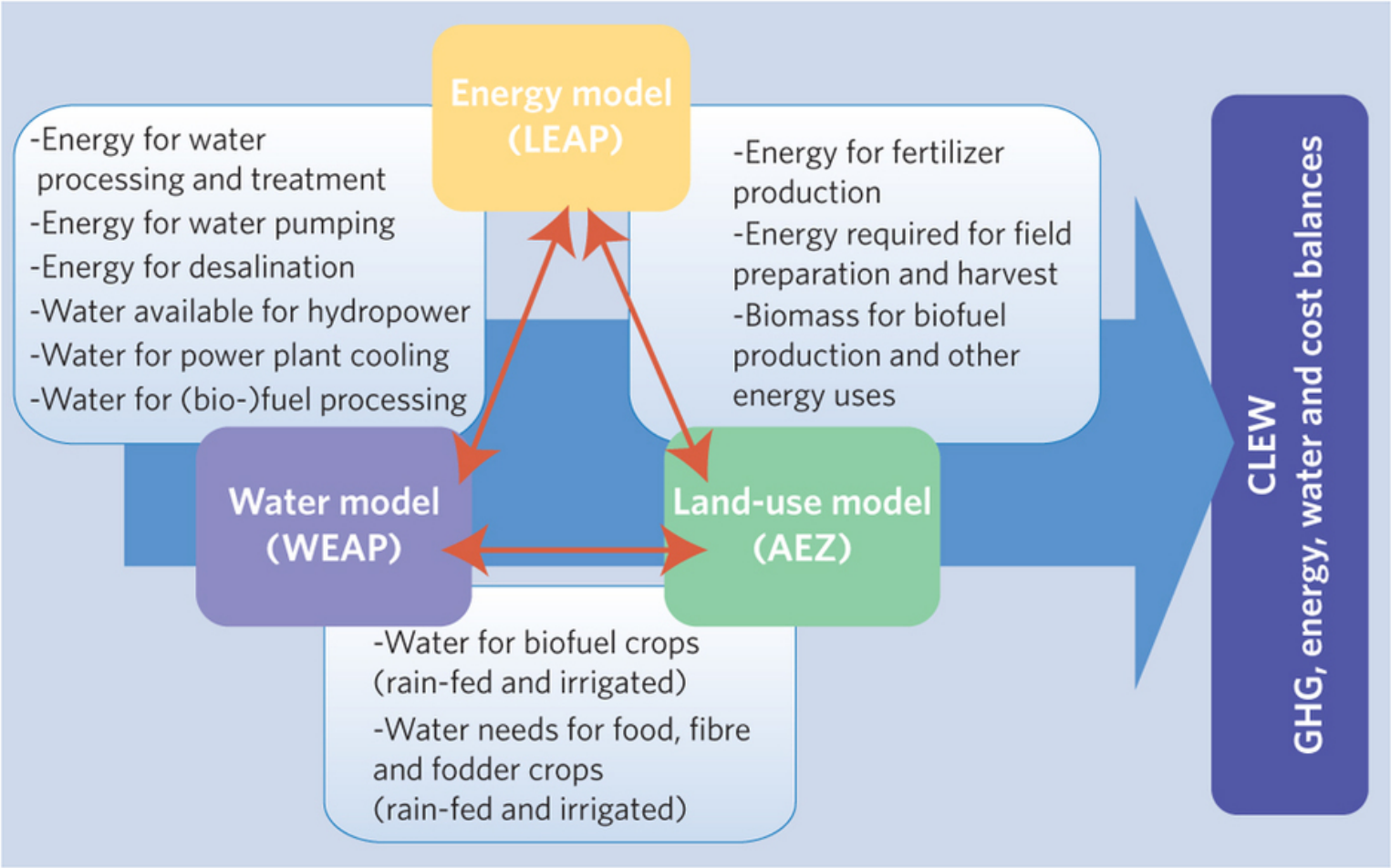


A security perspective



World Economic Forum, 2011.

Analytics



Howells et al., 2012. *Nature Climate Change*

A system example

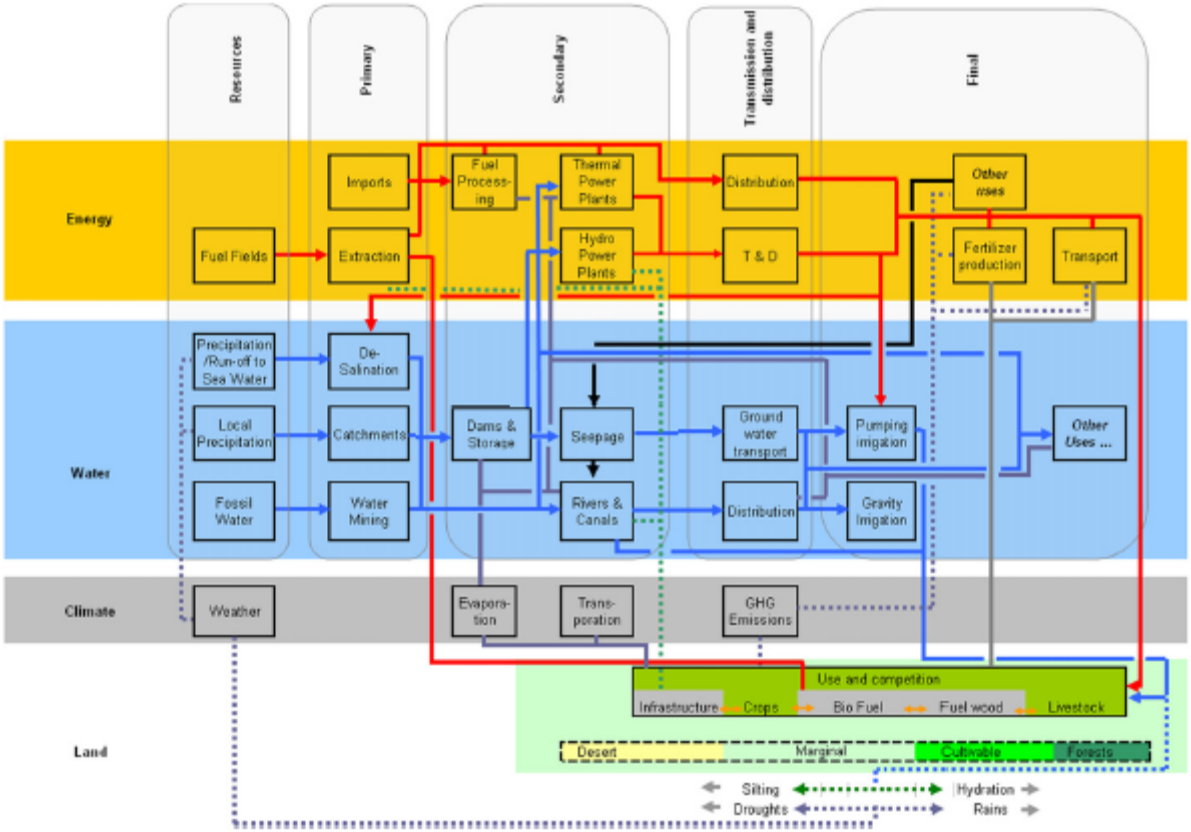
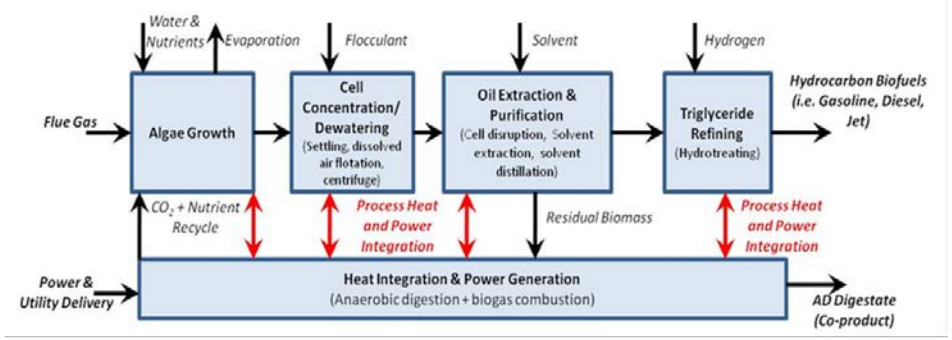
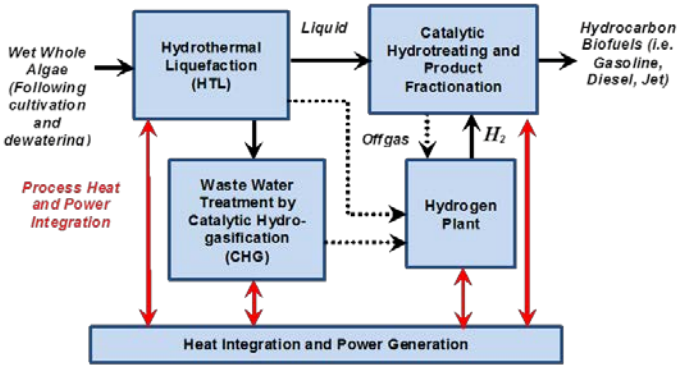


Fig. 4. Schematic of Ethanol production and energy/water/food interactions (IAEA (International Atomic Energy Agency), 2009).

Algal biofuels perspective

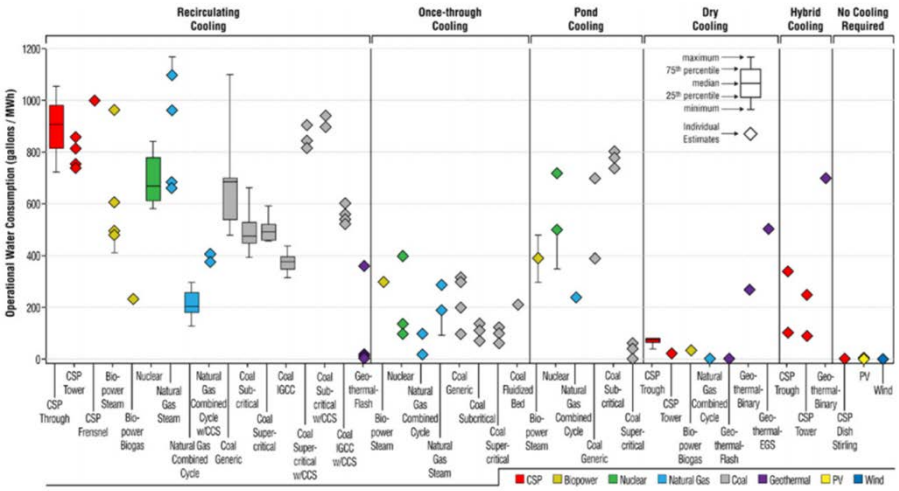
- **Revenue:** Optimize for revenues from all possible products ranging from biofuels to animal feed, carbon sequestration, and effluent and wastewater treatment, factoring in limits based on market size.
- **Food vs. Fuel:** Run "all-food" versus "all-fuel" scenarios and consider differences in terms of qualitative or quantitative impacts on energy, water, and food security, as well as to greenhouse-gas emissions.
- **Waste:** Look at wastewater and flue gas input impacts on pathways for food and fuel outputs.
- **Carbohydrates, Fat, and Protein:** Optimize outputs separately of carbohydrates, fatty acids, and amino acids and compare three results in terms of greenhouse-gas mitigation potential and revenue potential.
- **Process:** Look at ways in which production constraints (eg, cultivation system or input choices) impact product mix options.
- **International:** Look at international impacts in terms of trade, food production, and competition with existing biofuels markets.

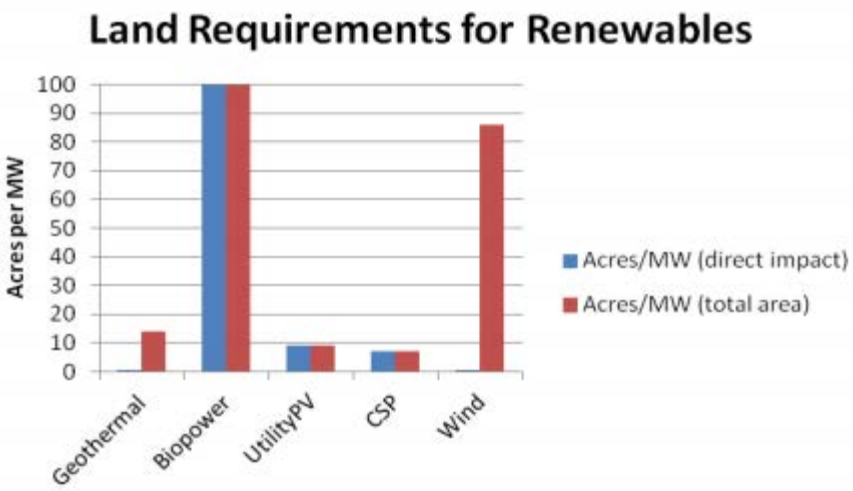




Energy and Water :: Energy and Land

Typically, nexus discussions tend to favour one perspective despite explicitly trying to address an integrated issue (nexus from water perspective, nexus from energy perspective, etc.)





Thank you

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