



Department of
**Environment &
Conservation**

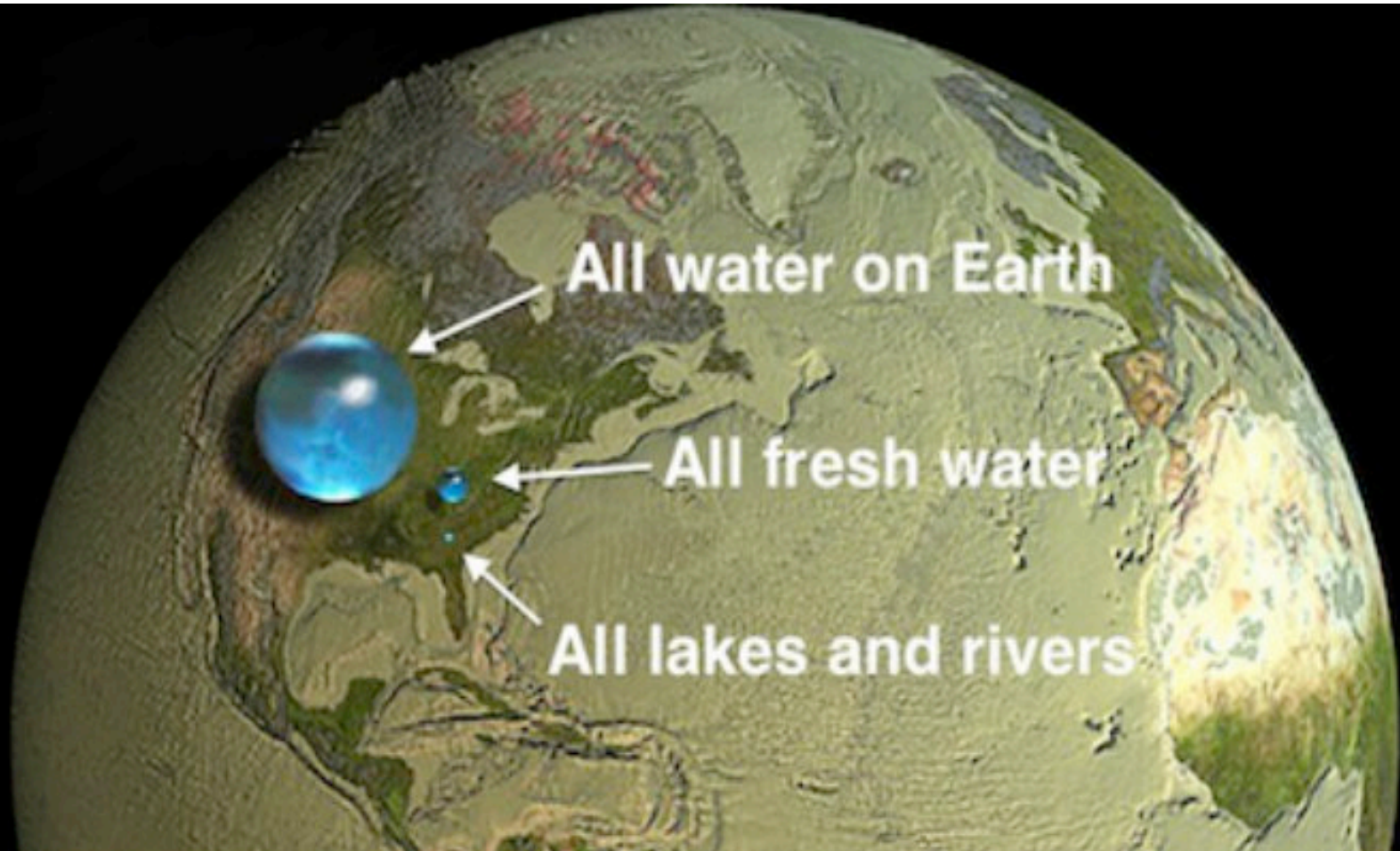
Food-Energy-Water Nexus in Tennessee Today

FEWSTERN

December 7, 2017

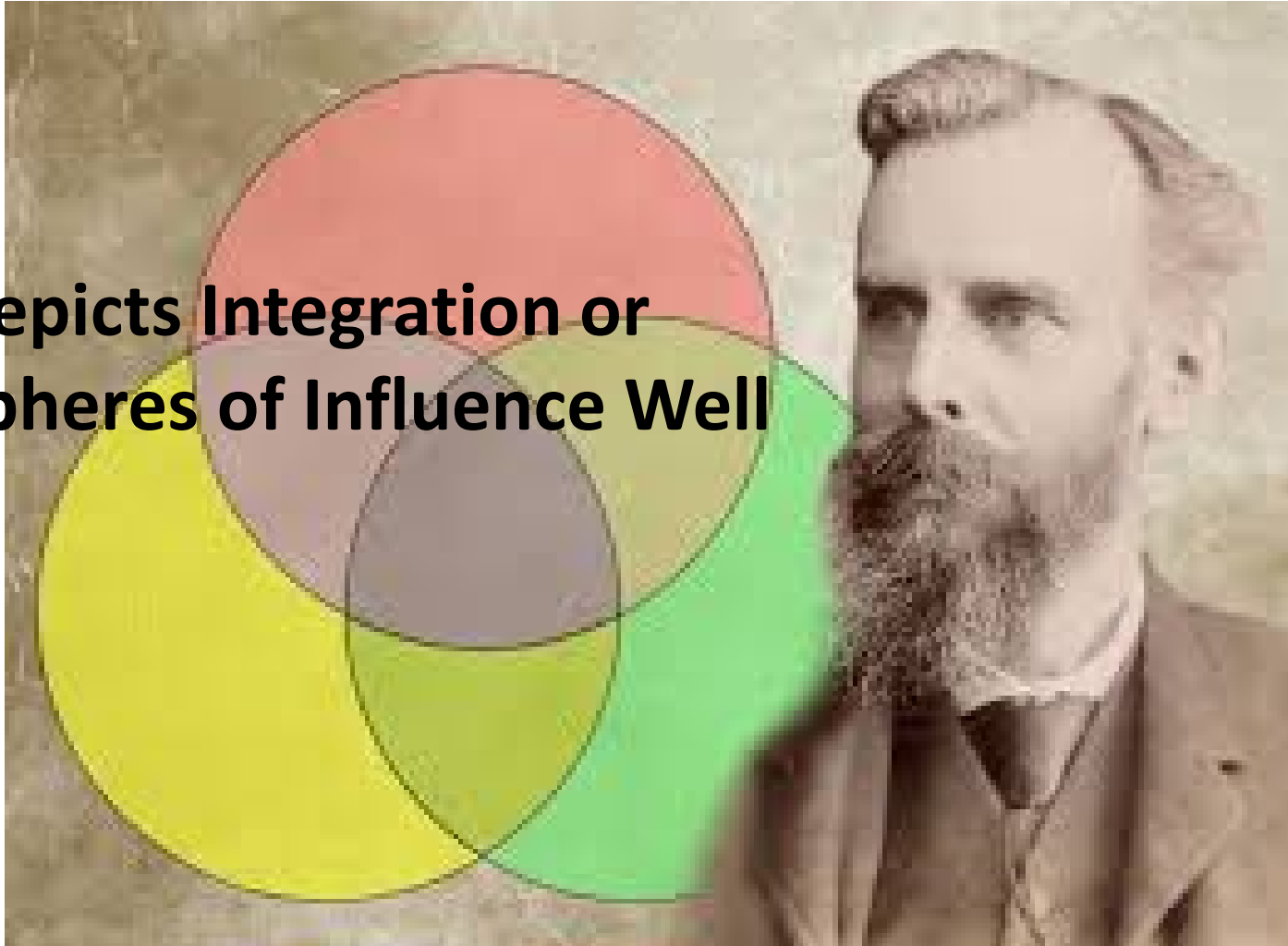
George Garden, PE BCEE – DWR Chief Engineer

F-E-W (Which is more important?)



John Venn (circa 1880)

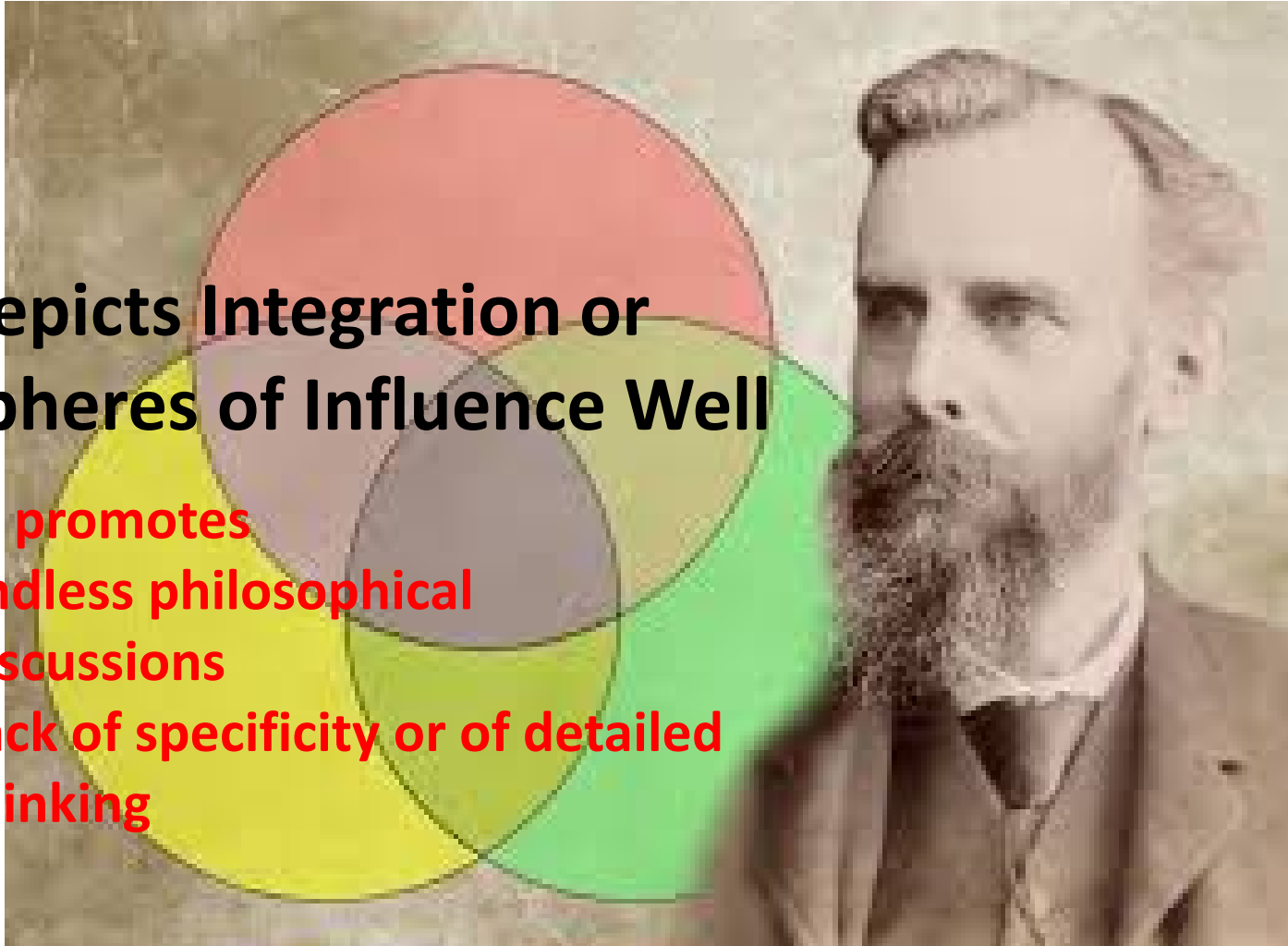
**Depicts Integration or
Spheres of Influence Well**



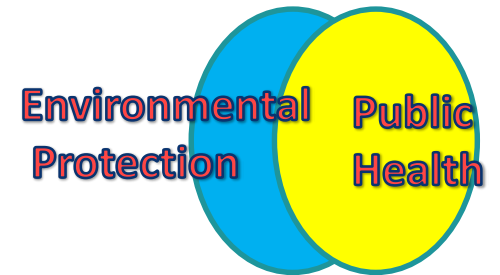
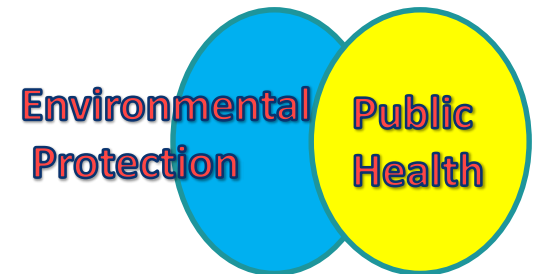
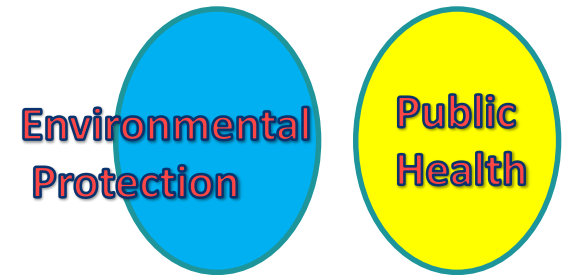
Depicts Integration or Spheres of Influence Well

Also promotes

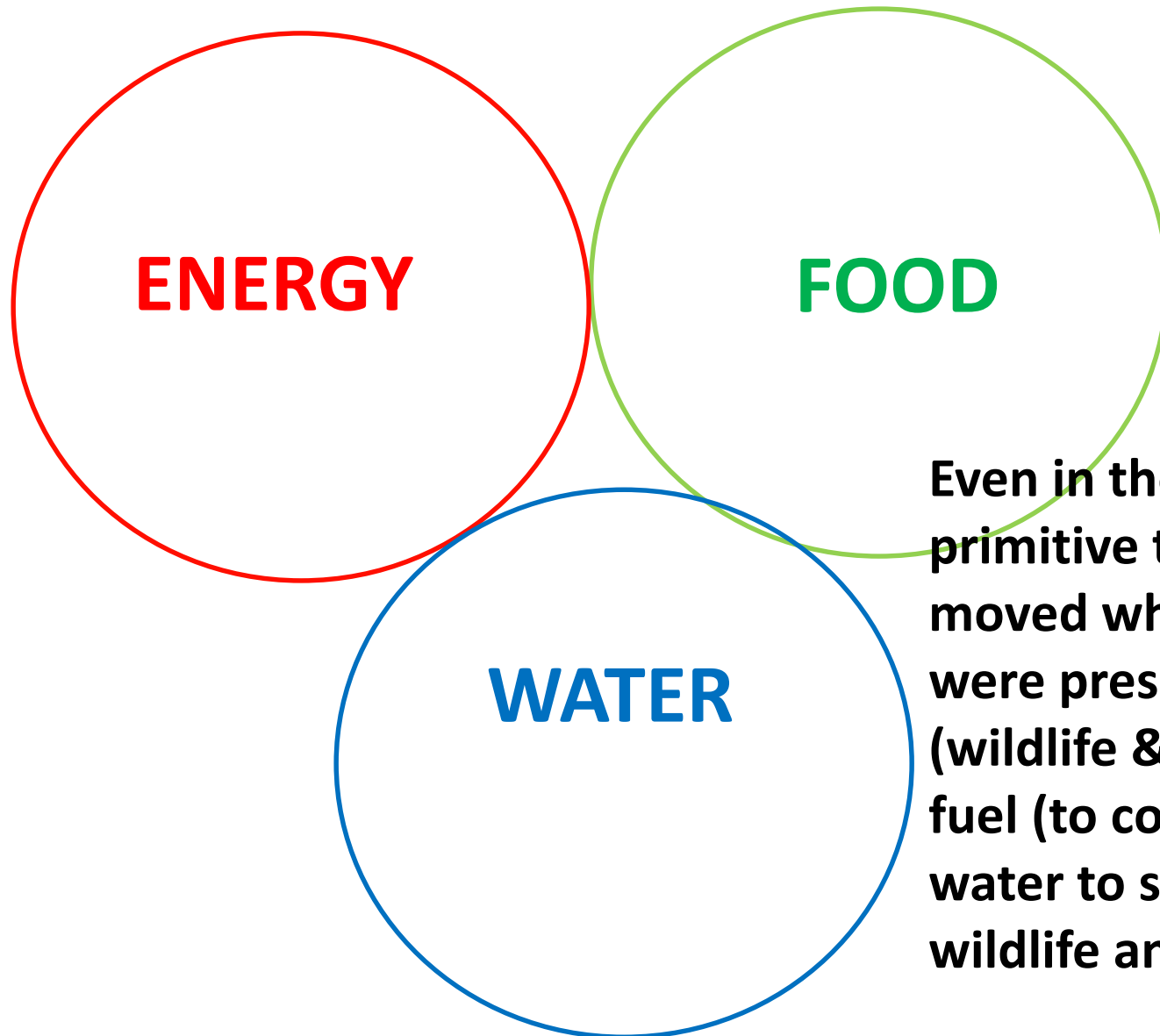
- Endless philosophical discussions
- Lack of specificity or of detailed thinking



Phase	Description	Resources to Environmental Protection	Resources to Public Health Efforts
Frontier Phase	No realization of synergy; low commitment.	\$	\$
Epidemic Phase	Acute effects recognized; synergy awareness; Public pressure & health costs rise.	\$\$	\$\$\$\$\$
Wellness Phase	Life spans increase; acute & chronic environmental impacts begin to be understood.	\$\$\$\$\$	\$\$\$\$\$\$\$\$\$
Synergy Conscious Phase	Distant future? A legacy to wipe out (or up)? The only chance to reduce \$\$.	? \$\$\$\$?	? \$\$\$\$\$\$?



Hunter-gatherer phase



Even in the most primitive times, man moved where all three were present: food (wildlife & plants) + fuel (to cook) and water to support wildlife and man.

Agrarian phase



ENERGY

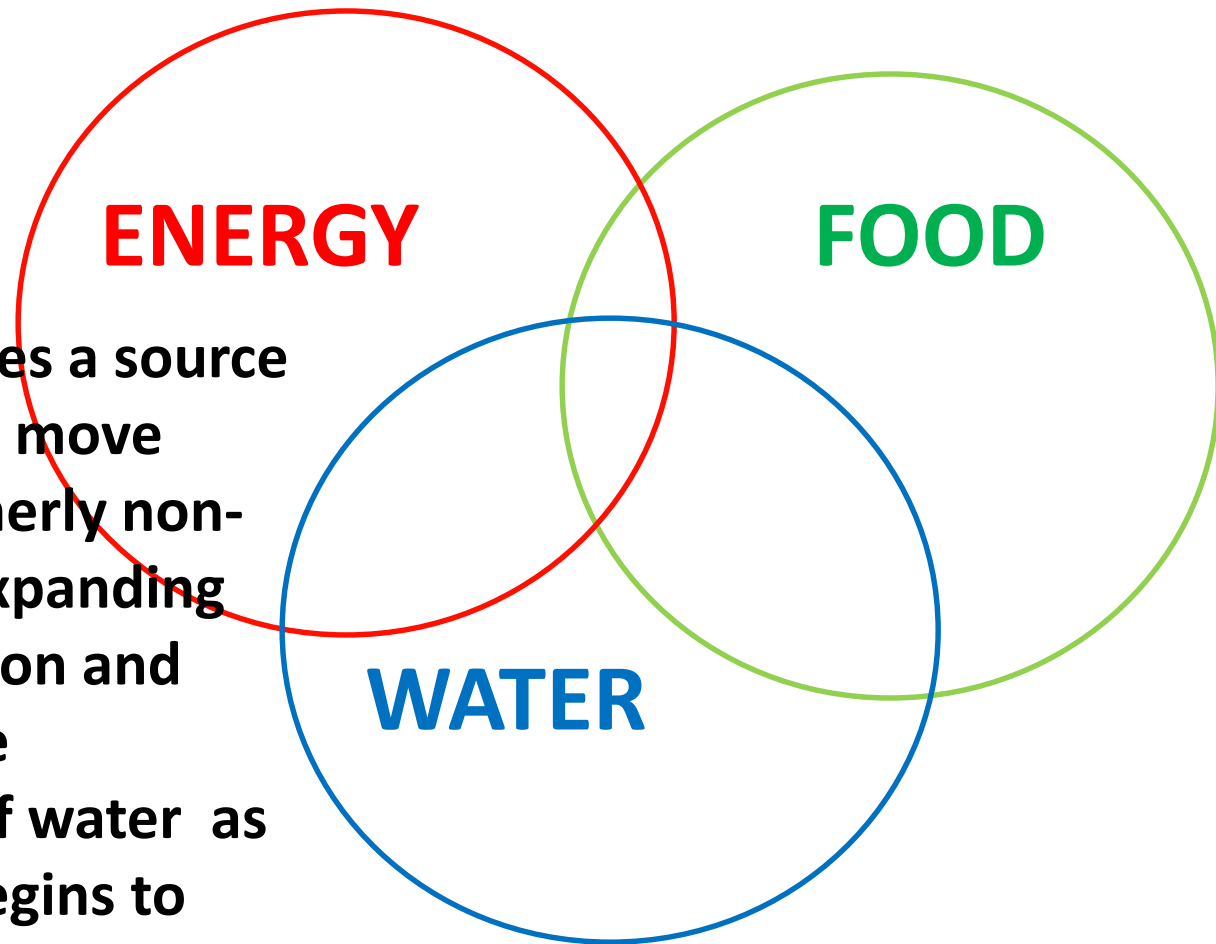
FOOD

Started moving where water was available to increase production of food stores and diverted water to agricultural locations.

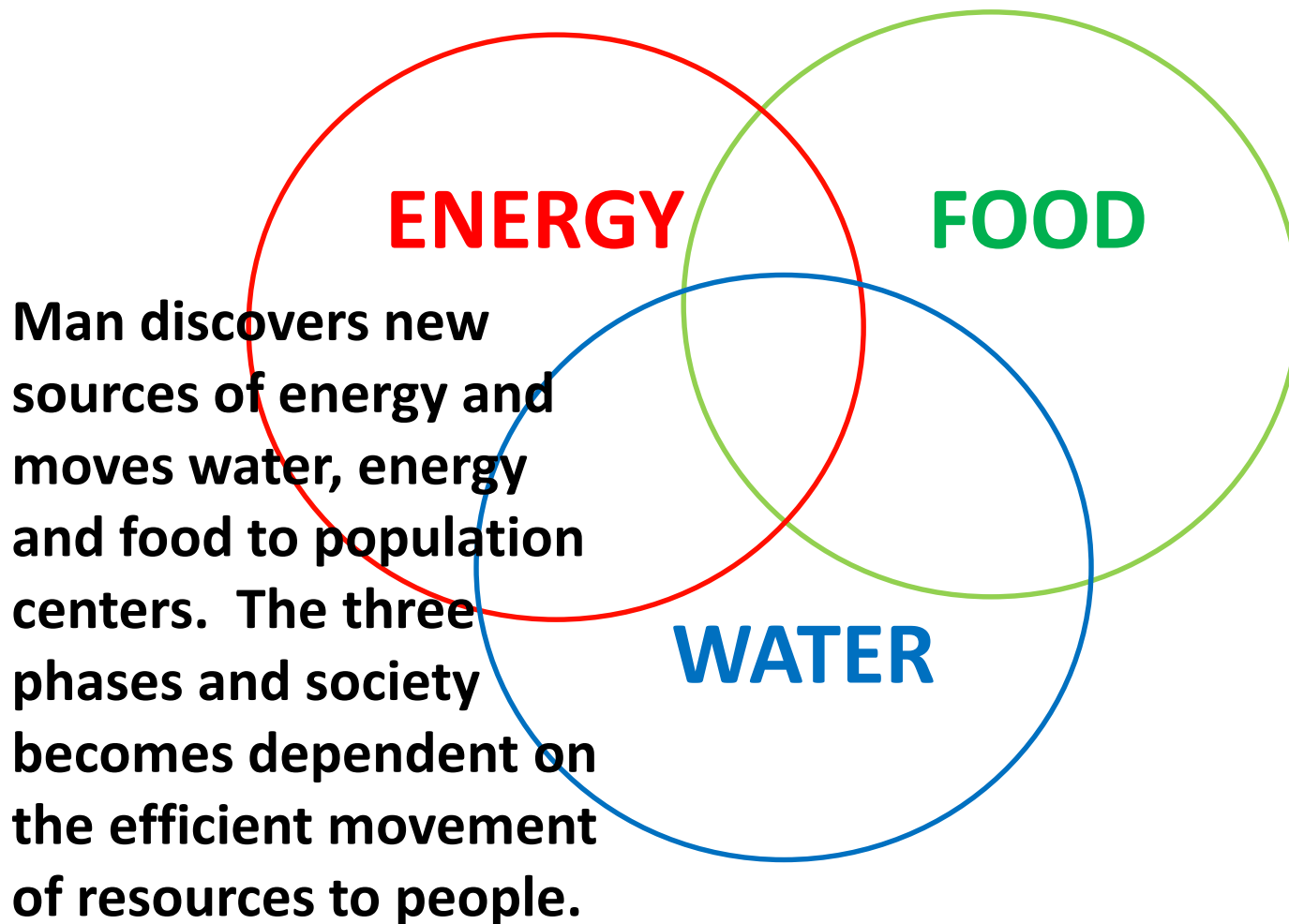
WATER

Early Industrial phase

Water becomes a source of energy; we move water to formerly non-arable land expanding food production and increasing the importance of water as population begins to grow more rapidly.



Modern Industrial phase



Environmental-Industrial phase

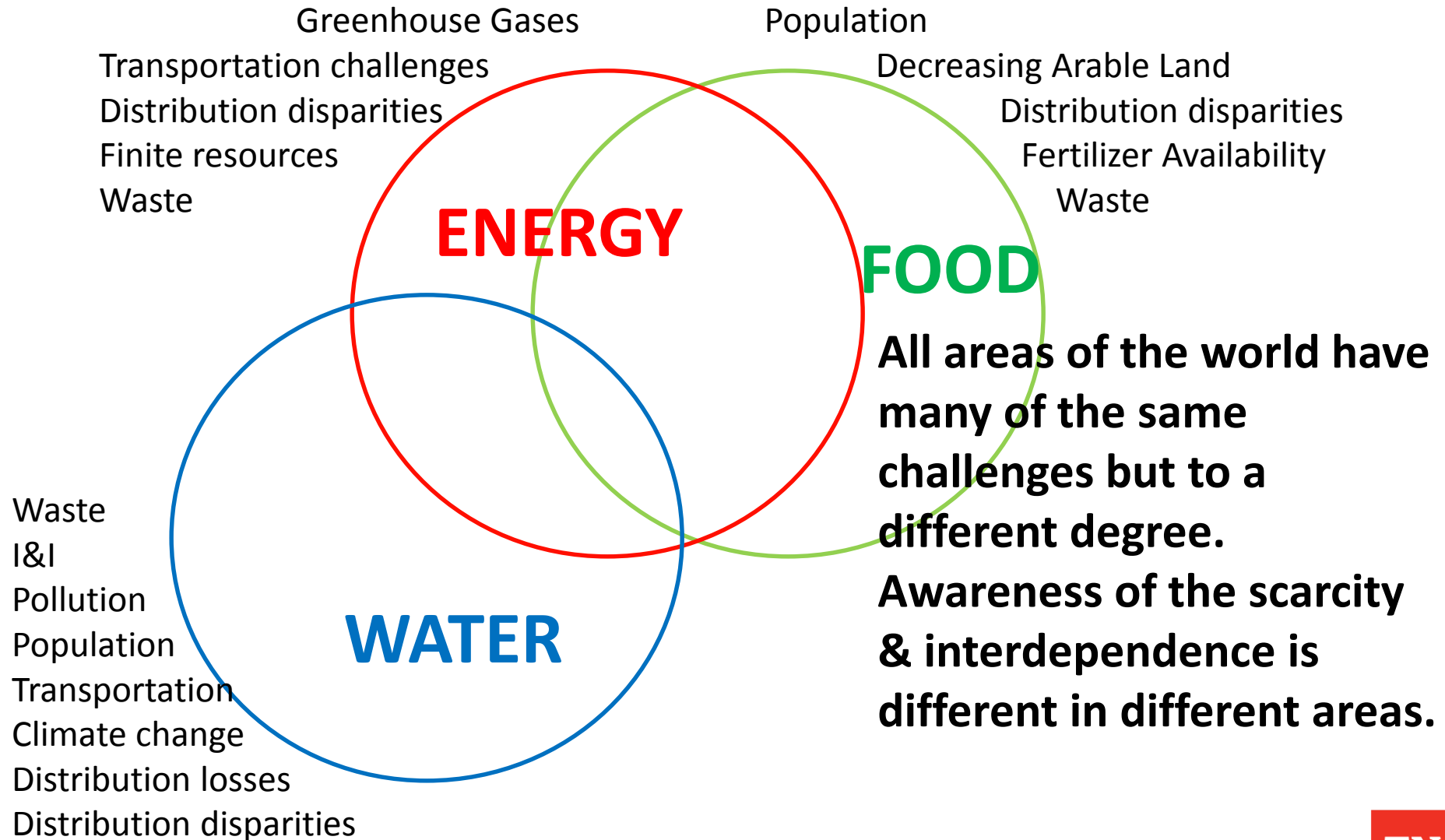
ENERGY

FOOD

With larger population we start to understand the interdependence of the resources and the destructive interference one of the other if there is over exploitation of one.

WATER

Tennessee Today (?)



ENERGY

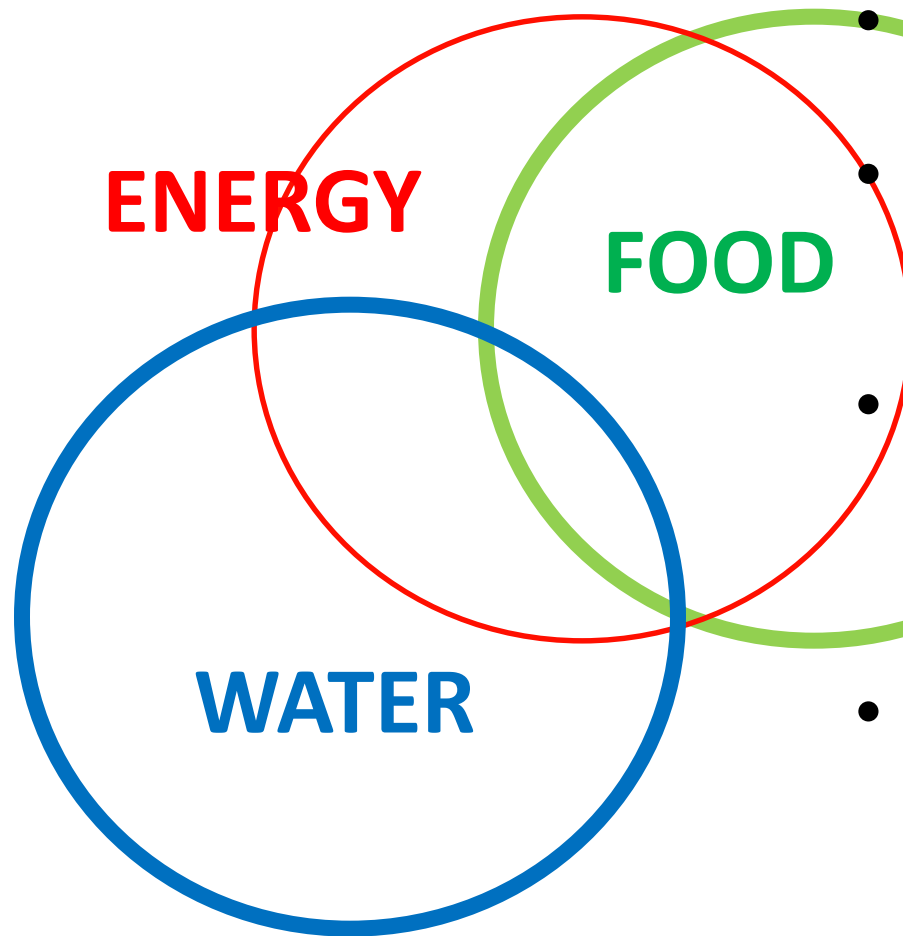
However, there is a real and growing appreciation for the energy costs to move food and water and maintain their availability to population centers.

WATER

FOOD

FOOD \cap WATER =

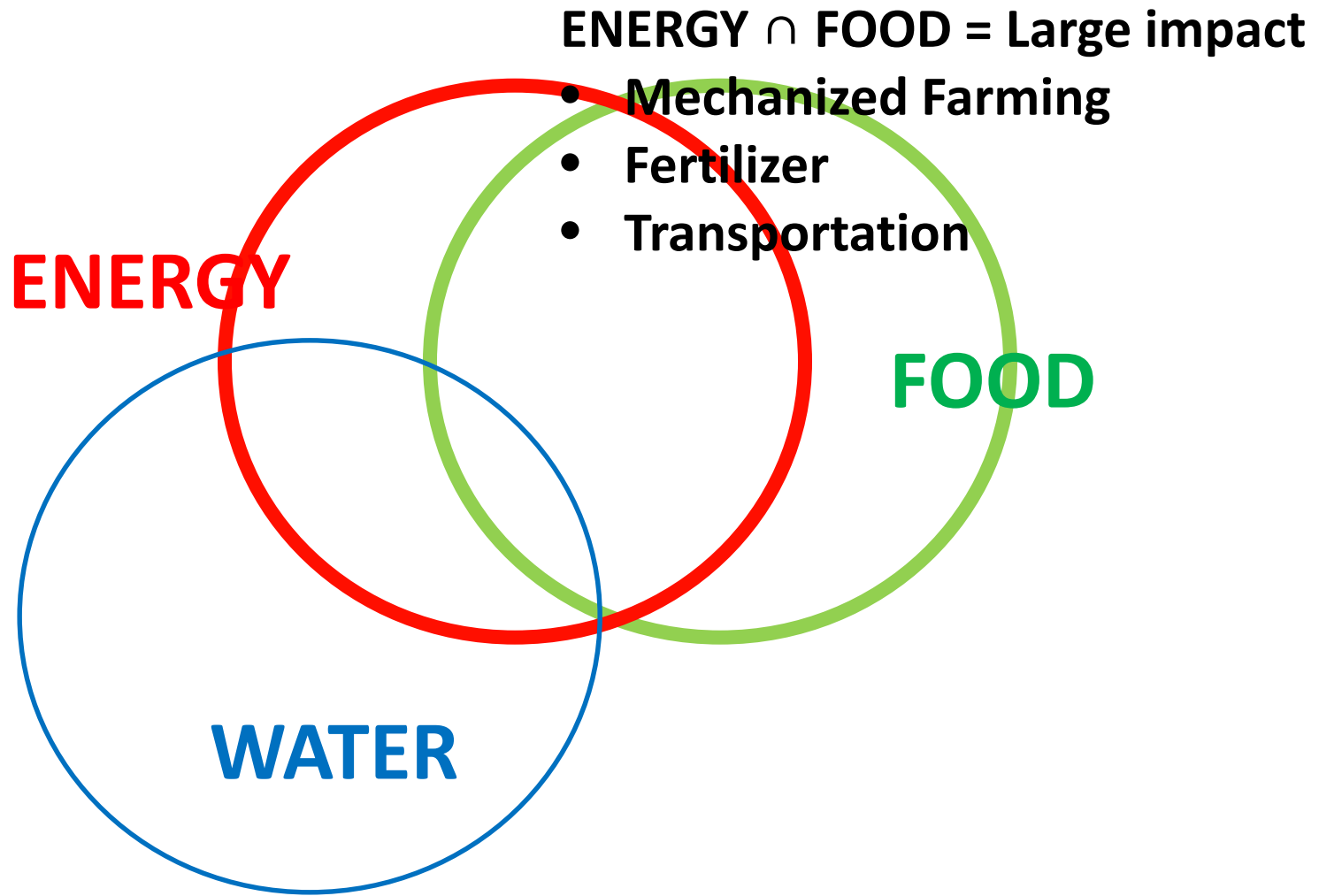
- **Smaller impact**
- **Relative abundance of groundwater and surface waters**
- **Primarily livestock impact during short term droughts**

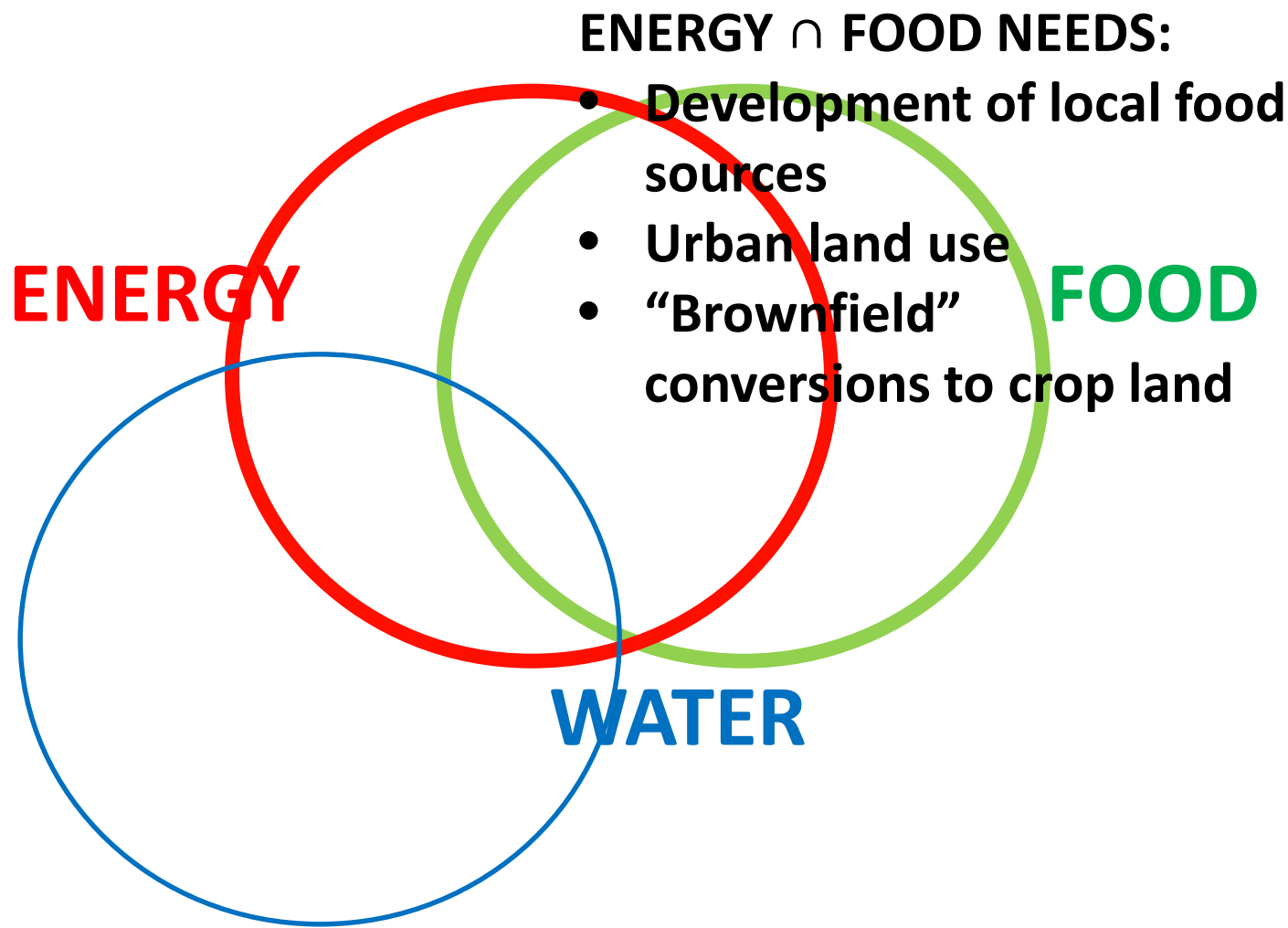


FOOD \cap WATER NEEDS:

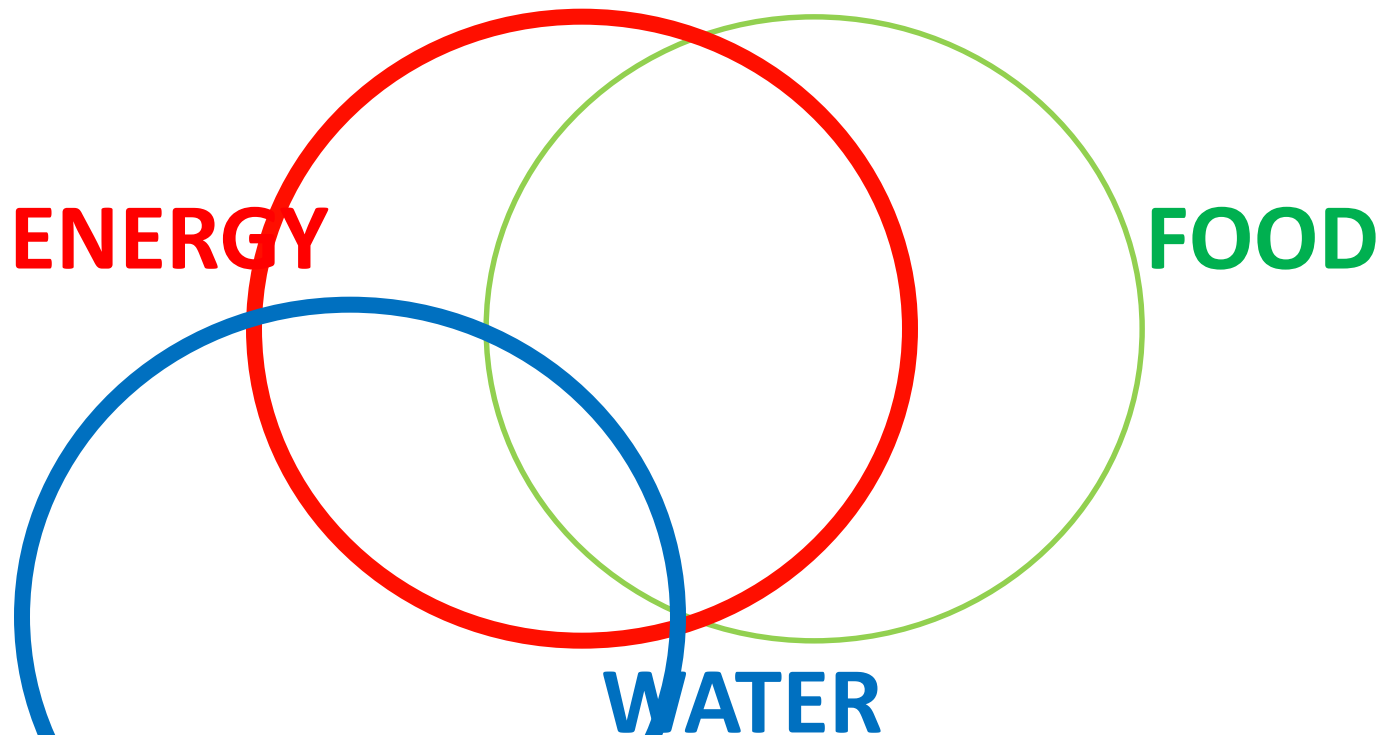
- Shift from nutrient removal to nutrient recovery
- Public health impacts from use of reclaimed water on food crops
- Implementation of different levels of treatment from single WWTP for different reuses.
- Societal acceptance of reclaimed water as drinking water source.

Tennessee Today for F-E (?)





Tennessee Today for E-W (?)



ENERGY \cap WATER = Large impact

- Mechanical efficiencies
- Wastewater Optimization
- Water loss and infiltration reduction

ENERGY

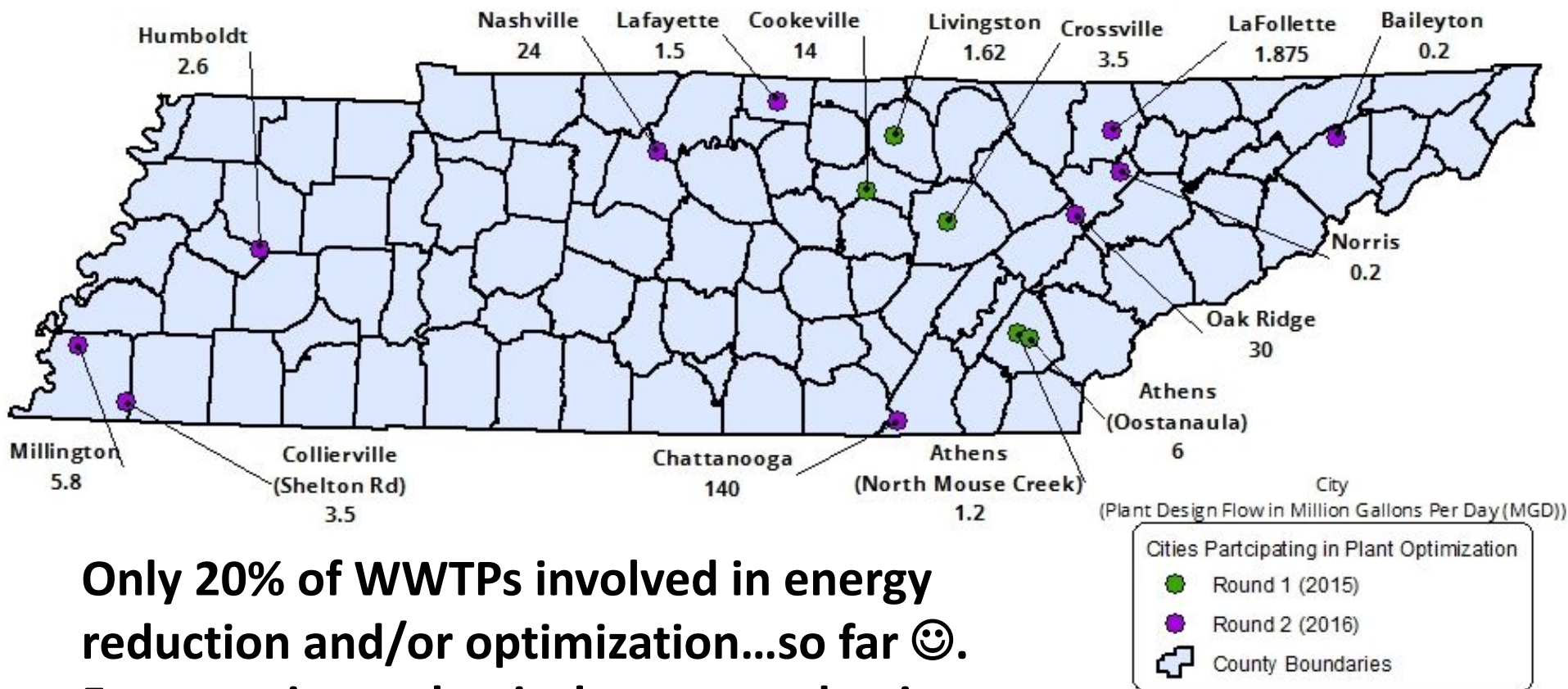
FOOD

ENERGY ∩ WATER NEEDS:

- Water loss detection and repair methodologies
- Low energy conversion from reclaimed to potable water source.
- Restoration of pipeline integrity in potable and wastewater
- Tools for WWTP optimization (denitrification)

WATER

Wastewater Treatment Efficiencies & Optimization → Savings



**Only 20% of WWTPs involved in energy reduction and/or optimization...so far 😊.
Far more in mechanical energy reduction.**

Resources Needed for WWTP Optimization

- Scientific curiosity
- Professional pride
- Respect for ratepayers
- Instant data
- Adjustable equipment
- Automated controls
- Executive champion
- Regulatory support

- **MONEY IS NOT THE LARGEST RESOURCE REQUIRED!**



Tennessee Today for F-E-W (?)

ENERGY

FOOD

FOOD \cap ENERGY \cap WATER = Limited examples:

- Local Reclaimed WW \rightarrow Agricultural Reuse
- WWTP \rightarrow methane + Class A biosolids \rightarrow soil
- WWTP biogas energy + biochar \rightarrow soil
- WWTP \rightarrow compost \rightarrow soil

WATER

A Successful Example of F-E-W

Gasification Plant → Heat → electricity (ENERGY)
& Beneficial “biochar” → uses? → soil supplement or feed
ops ammonia adsorption (FOOD)
Feed for the beast?

- 10% Biosolids w/o digestion (WATER)
- 10% Ground-up used tires
- 80% Chipped used pallets or brush



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Solar panels → green energy (ENERGY)

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Solar panels → green energy (ENERGY)

Shut down high energy ATAD

A Successful Example of F-E-W



Another way to be green...

MWS Central WWTP

Legend

Biosolids-->Anaerobic Digestion --> (Methane Gas -->fuel for heating digester and kiln to dry) --> marketable pellets for soil augmentation

ANAEROBIC DIGESTERS
with flexible storage tank
tops

**Kilns and
Pelletizers**

Lower City Island

Metro/Second & Hume

East Germantown

1000 ft



TN

Google Earth

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ENERGY

FOOD

FOOD ∩ ENERGY ∩ WATER NEEDS:

- **New energy conversion technologies in the market place**
- **By-product uses for water and wastewater residuals**
- **Cost effective decisions relative to centralization – decentralization with respect to water and wastewater distribution and collection systems.**

WATER

US-China FEWSTERN Process

Food-Energy-Water Systems Transdisciplinary Environmental Research Network



Identify challenges ← Stakeholders → Politics →
Policy → Governments

US-China FEWSTERN Process

Food-Energy-Water Systems Transdisciplinary Environmental Research Network



Identify challenges

← Stakeholders → Politics →
Policy → Governments



Implement Research

← Industry + Foundations +
Governments

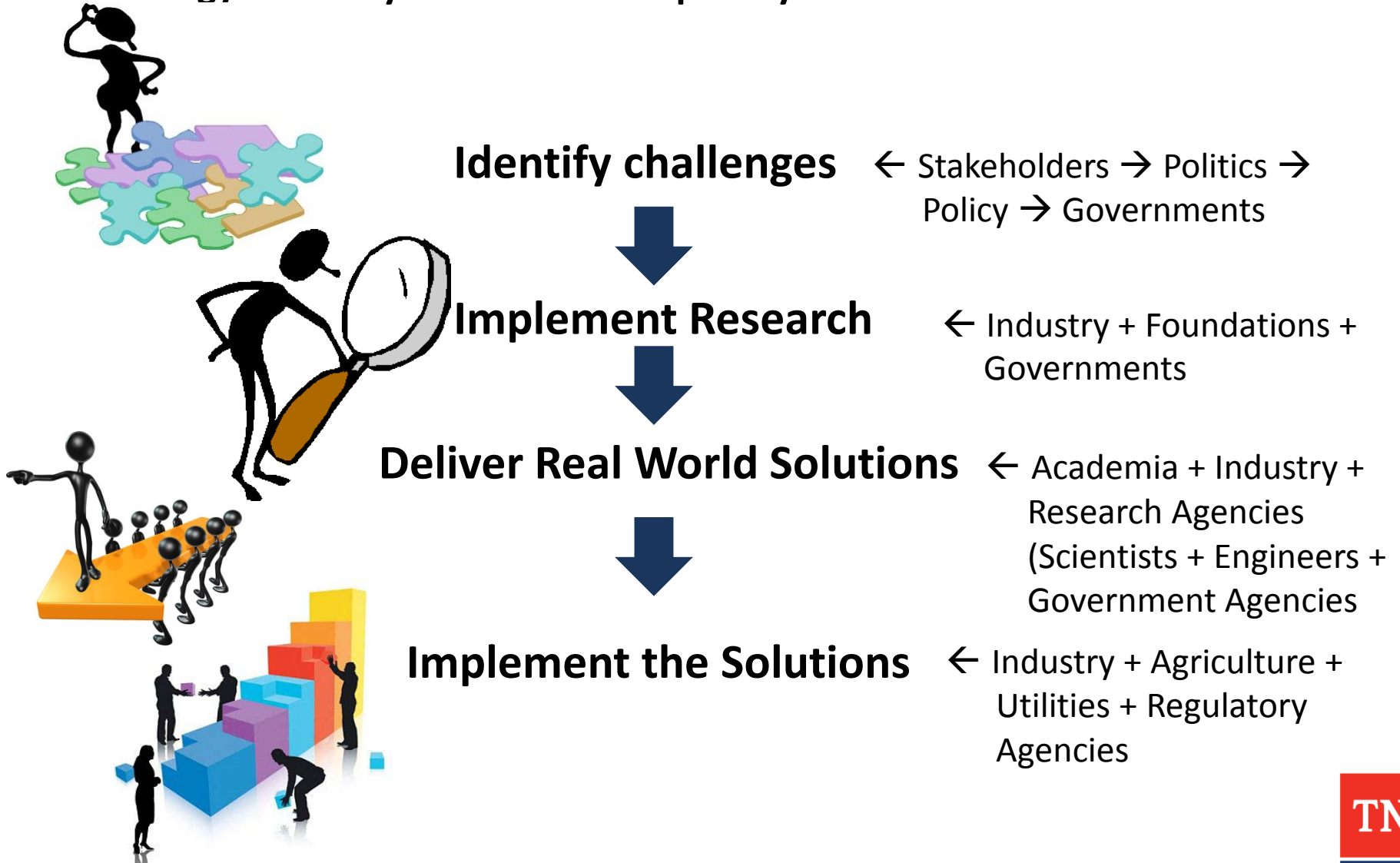
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US-China FEWSTERN Process

Food-Energy-Water Systems Transdisciplinary Environmental Research Network



Thoughts on Research

- **Integration is critical for overall productive solutions that minimize sub-optimization.**
- **In the USA (with its profit-driven economy) academia and government are the drivers for integrated thinking.** (We probably can learn from China's naturally top down approach which lends itself more easily to integrated thinking.)



Contacts? Questions?

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