Planting the Seeds to Examine Food Security Challenges in the Alaska Food-Energy-Water Nexus

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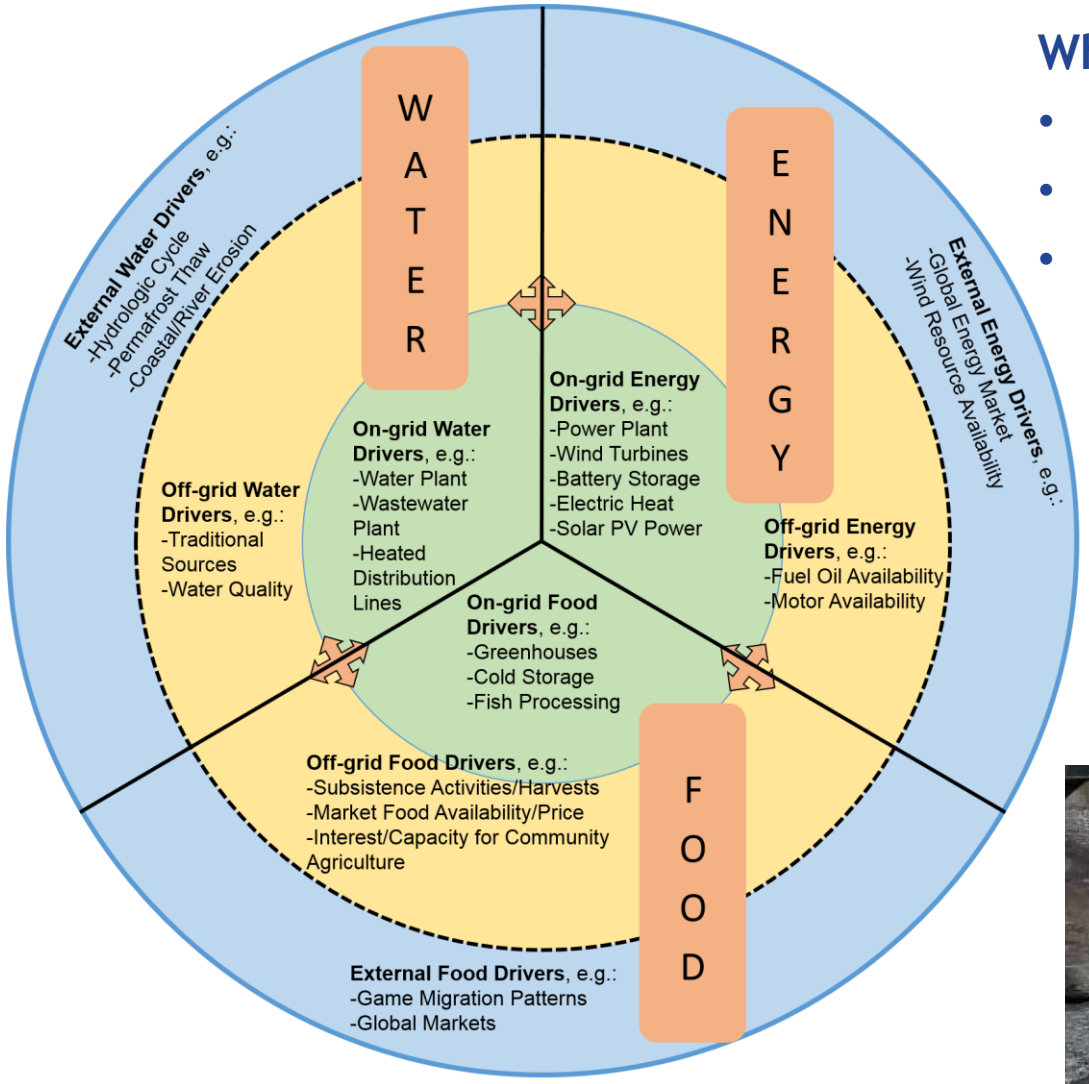
The Food-Energy Water Nexus



What is the Food-Energy-Water Nexus?

- It takes energy to clean and treat water and to grow food.
- It takes water to grow food and produce electrical power.
- It takes food to power us all to keep these systems running.

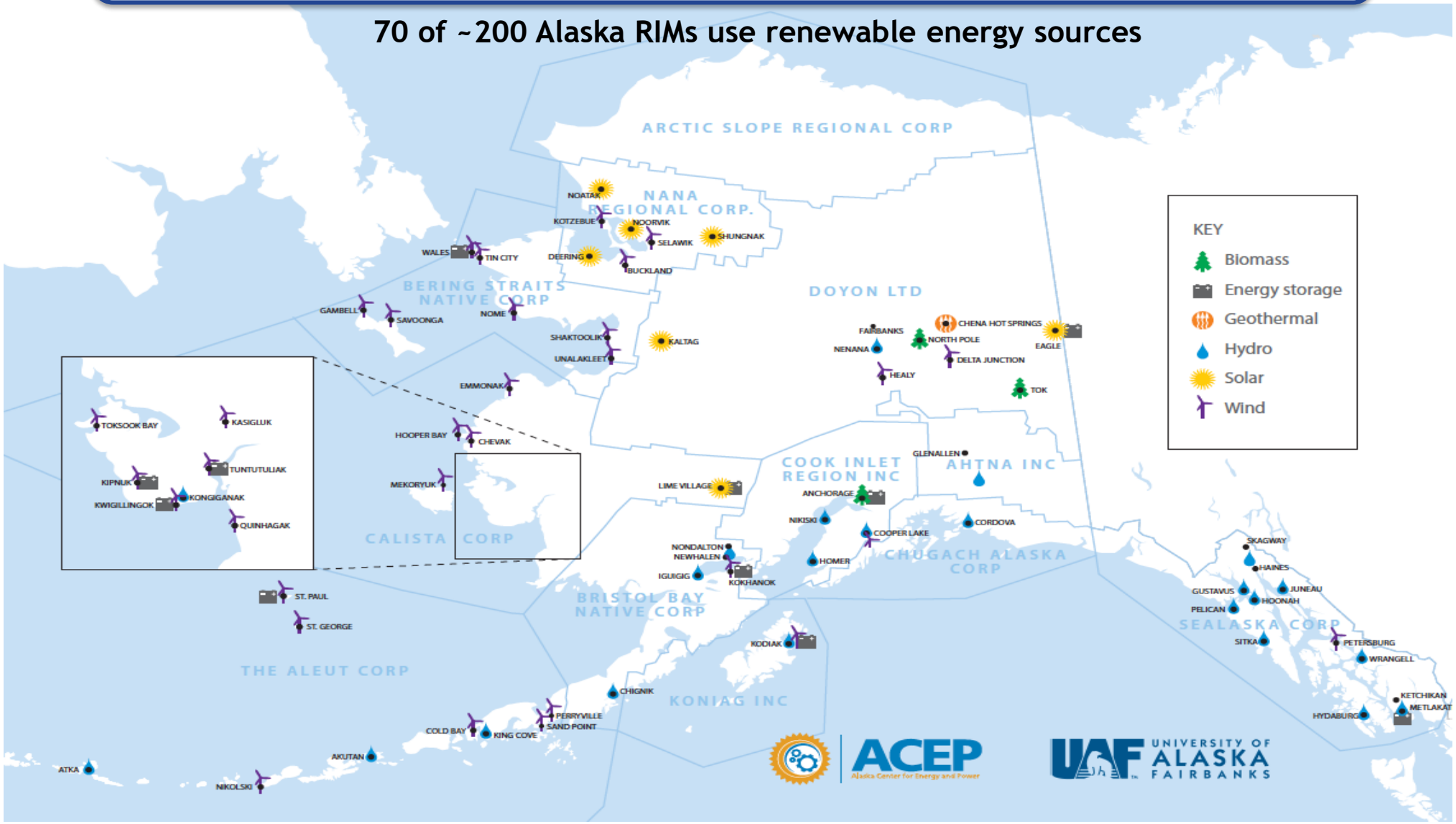
These three parts are optimized when considered as parts of a whole, holistic system.

MicroFEWS: The Food-Energy Water Nexus in Rural Alaska

- How Renewable Energy Contributes to Food Security
- Renewables Directly to Heat
- Excess Renewable Generation to Heat
- Renewables to Electrical Loads (water pumping/reuse, electric heat, lighting)

Alaska's Remote Islanded Microgrids

70 of ~200 Alaska RIMs use renewable energy sources



Alaska has ~12% of the worlds microgrids that incorporate grid scale renewable resources. *(data from Navigant Research)*

Renewable Energy to Heat, Directly

Some renewables already are heat; why not use it as is?

- Solar
- Biomass
- Geothermal

Image sources: http://www.cchrc.org/solar-thermal-cchrc, https://www.garn.com/,

Renewable Energy to Heat, Electrical

For variable electrical generation, heat is a convenient “dump load” to shed excess generation without wasting it:

- Wind
- Solar
- Conventional hydro
- Hydrokinetic (maybe)

What is a “dump load?”

Dump or Dispatchable Loads

- What is a “dump load” or “dispatchable load”?
  - Not time-sensitive
  - Not frequency-sensitive
- Why is a “dump load” useful?
  - Utilize more renewable energy that would otherwise be wasted.
  - Stabilize electrical frequency on AC systems.
- Easiest usage?
  - Heat! Such as for greenhouses!

MicroFEWS Energy Distribution and Dispatch in Rural Alaska

VARIABLE RENEWABLES

Solar PV

Wind

Hydrokinetic (In-River)

FIRM ENERGY SOURCES

Diesel Electric

Hydroelectric (Dam)

ENERGY DISTRIBUTION & DISPATCH

FOOD PRODUCTION AND WATER TREATMENT

MODULAR SYSTEM LOADS

Lifewater Wastewater Treatment Module (350 W Max)

UAA In-home Water Reuse System (1.0 kW Max)

CropBox Hydroponic Module (14 kW Max)

ENERGY STORAGE SYSTEMS

Cold Storage

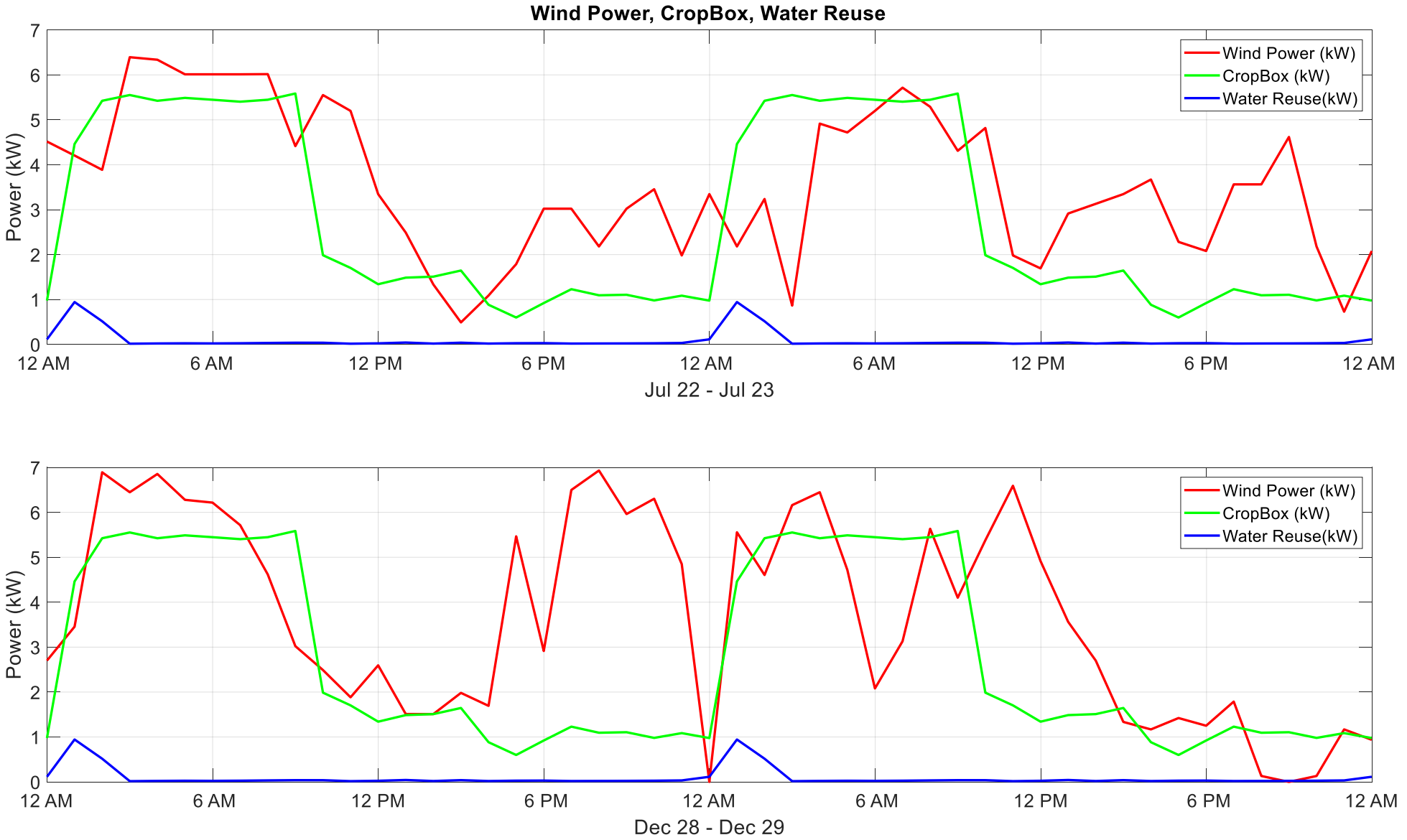
Battery

Flywheel

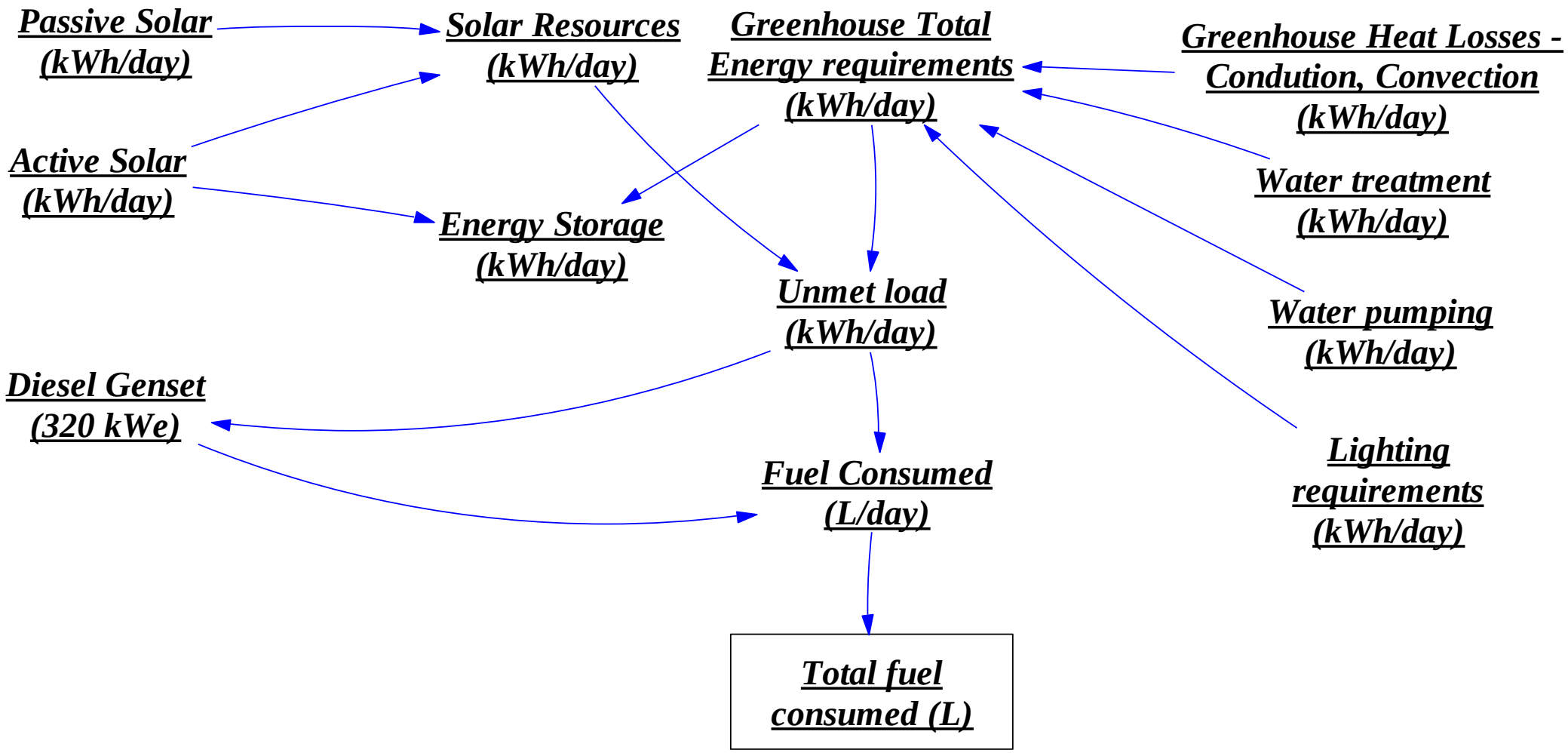
Electric Thermal Heaters

Photo Credit: Steffes Corporation

Example 1: Wind + Diesel → Dispatchable Loads (Water Reuse + CropBox)



Example 2: Passive Solar, Solar PV, Diesel → Water Treatment + Greenhouse



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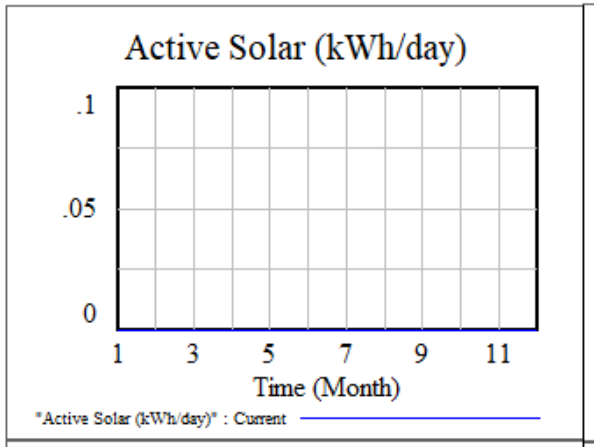

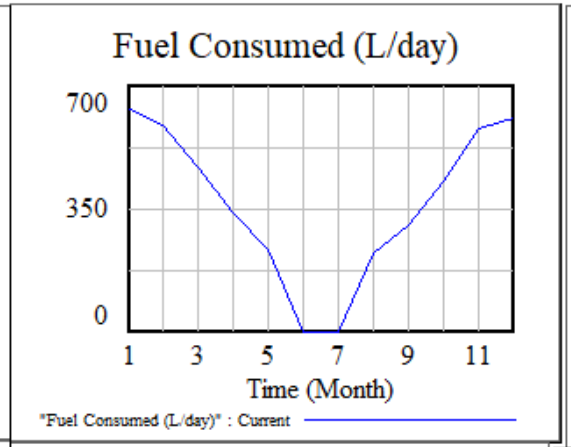

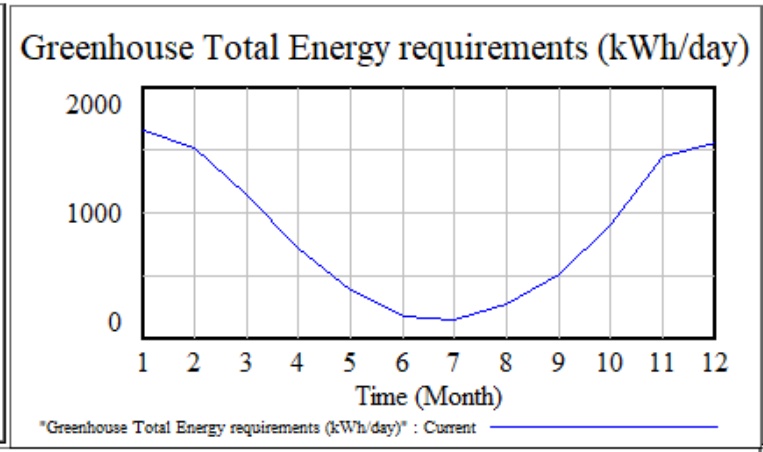

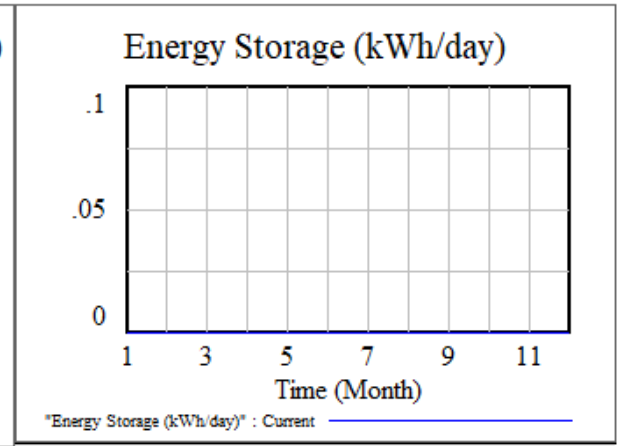

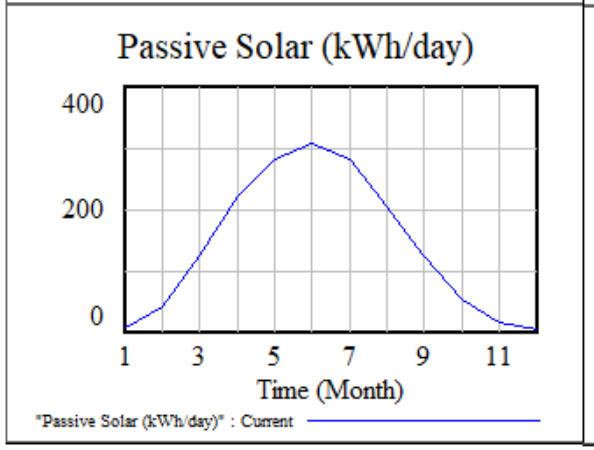

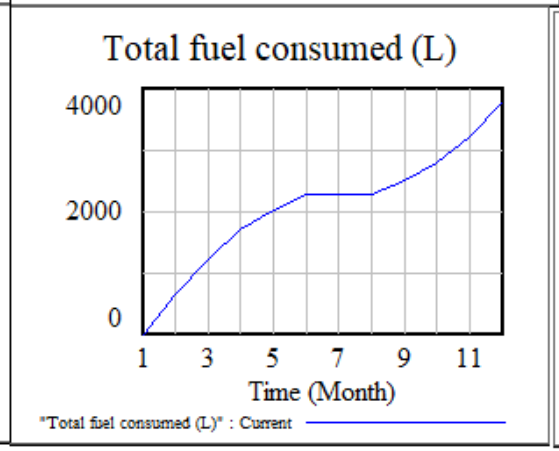

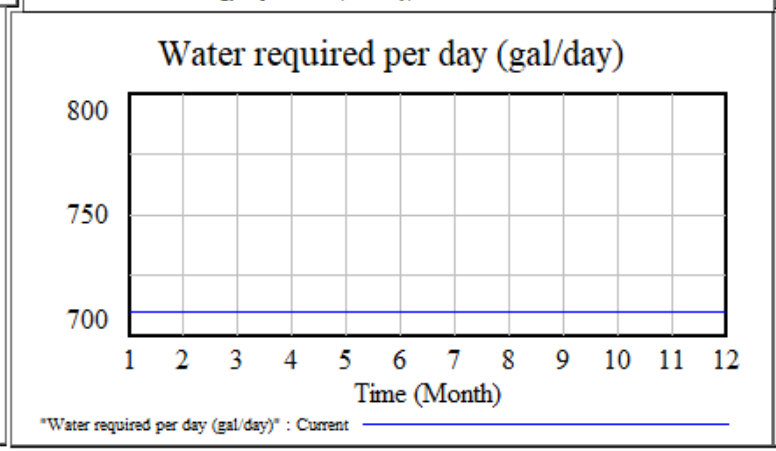

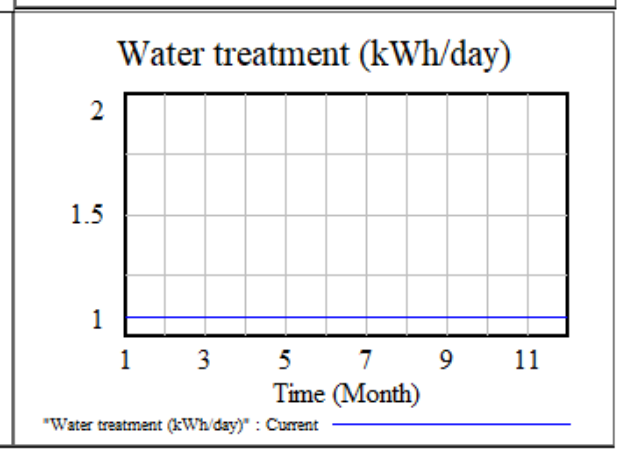

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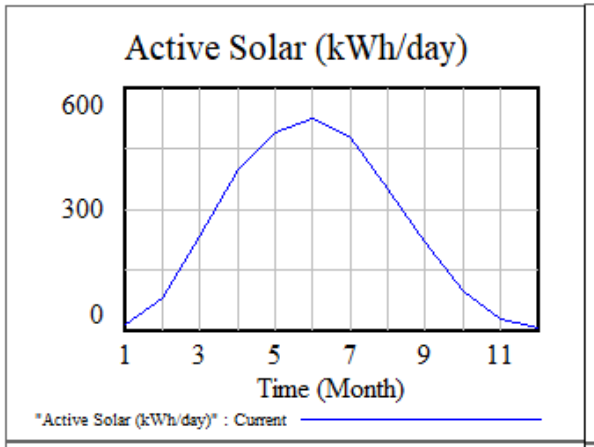
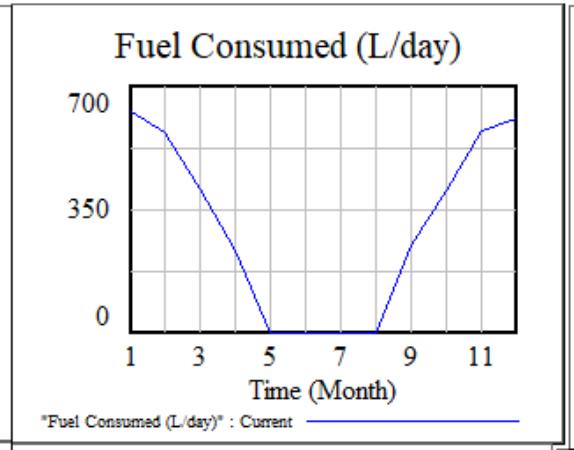
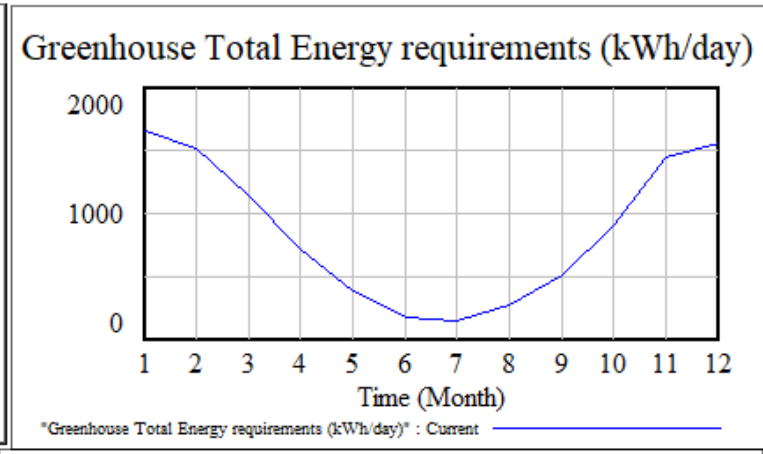
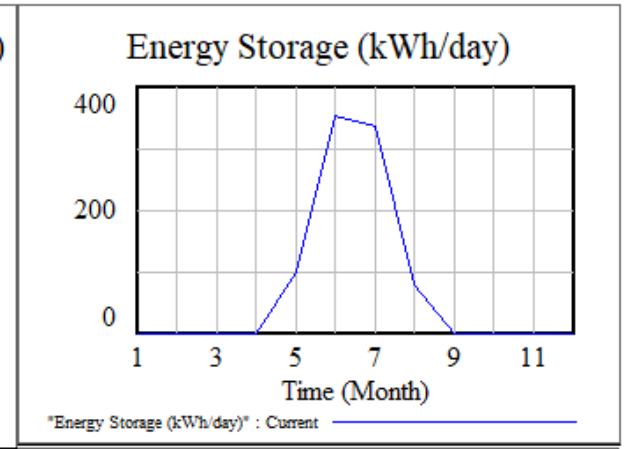
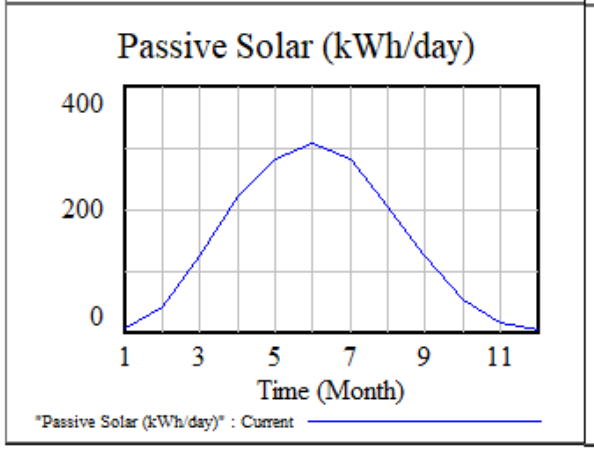
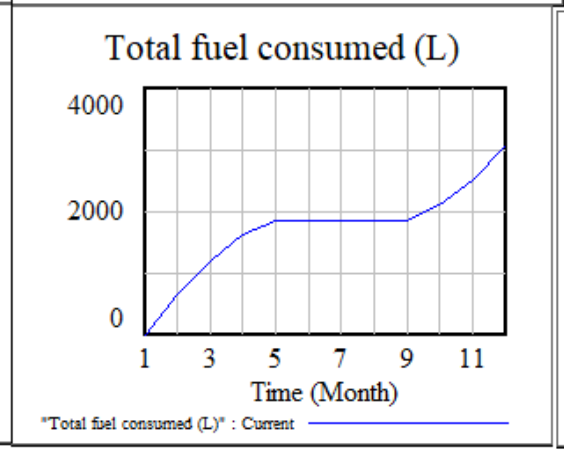


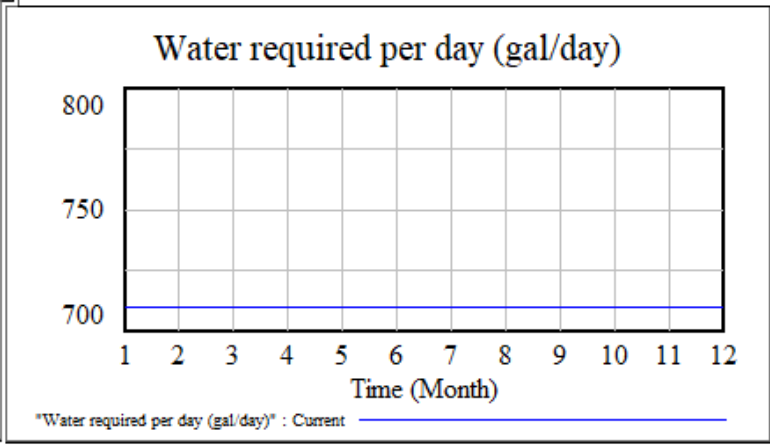


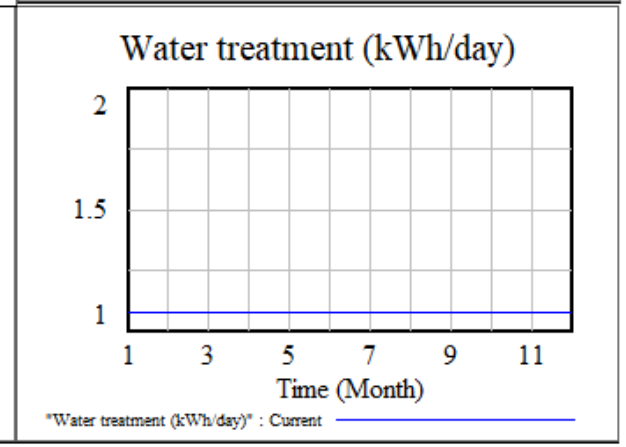












Example 3: Kongiginak Wind → Heat System

Diesel off with wind + energy storage + distributed heating

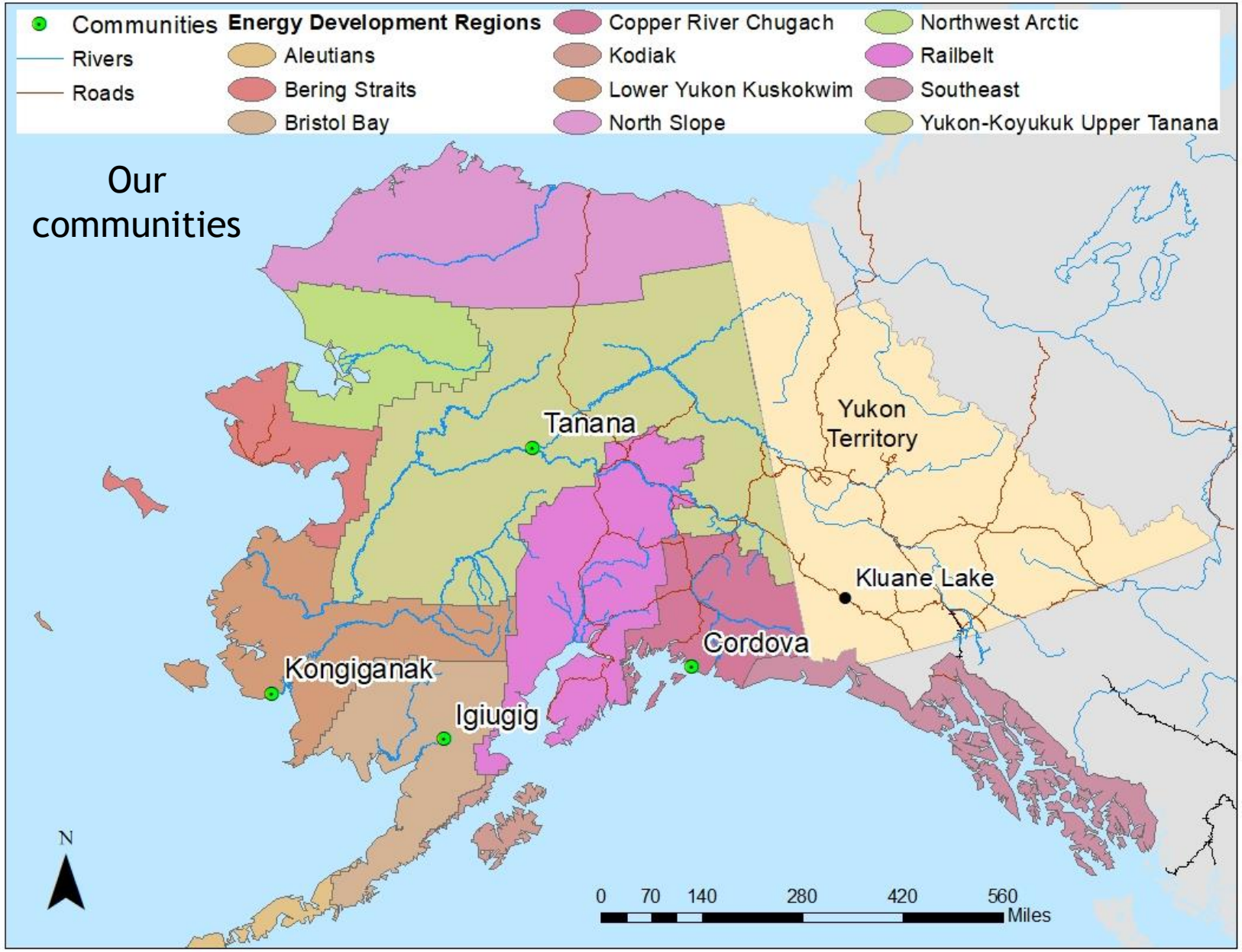
Renewable energy → reduced diesel fuel use by about 20-30%
Renewable energy + batteries → reduced diesel fuel use by about 50-64%.

20+ thermal electric stoves installed in elder and low income homes

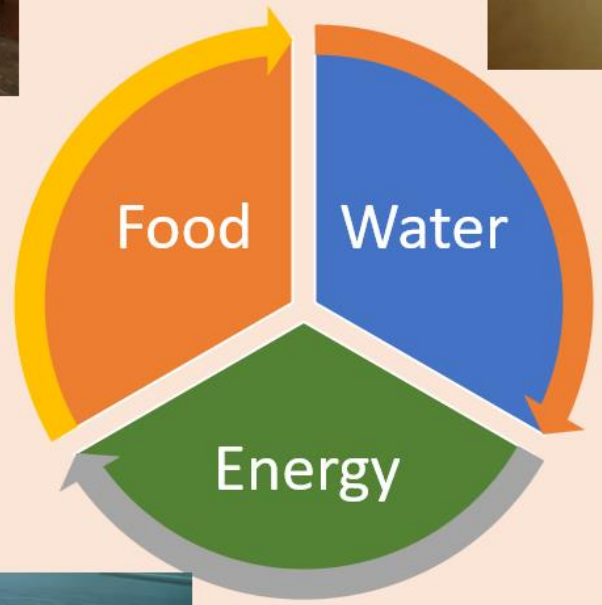
5 - 95 kW Windmatic direct drive wind turbines (30-40% wind penetration annually)

VIDEO: https://www.youtube.com/watch?v=90n9ga3SOQQ

Our communities

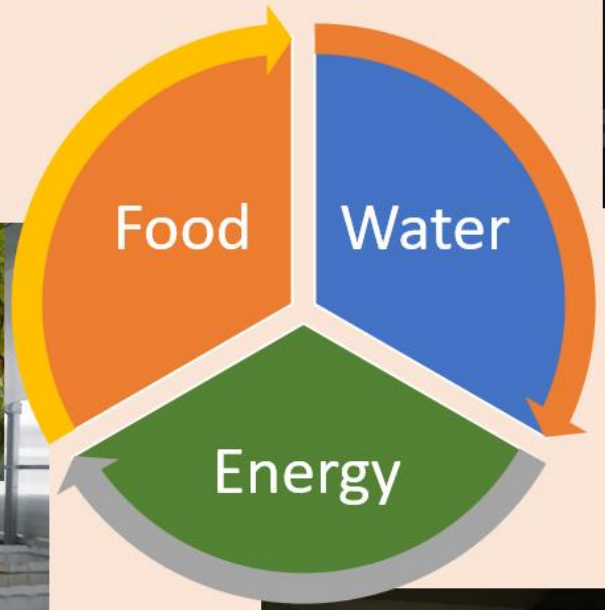


Kongiganak

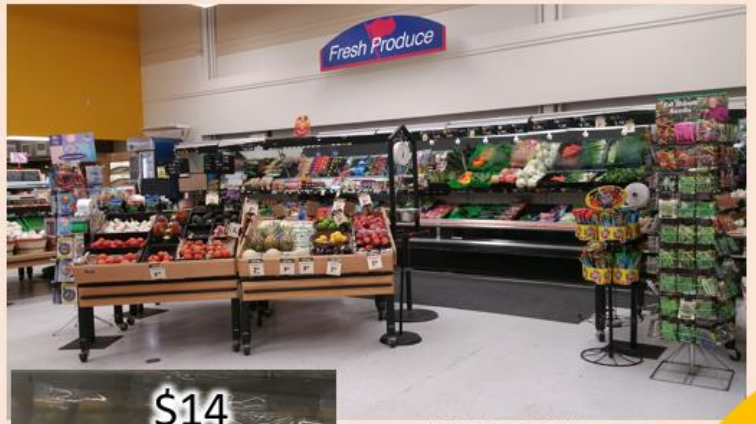


http://www.iesconnect.net/projects/kongiganak-wind-heat-system/

Tanana



Cordova


Fresh Produce


$14
DARLING'S FERMENTS


Fresh Oysters
$10.00
$10/dozen


Food
Water
Energy

Food Production Components

LOCAL FOOD PRODUCTION IN RURAL ALASKA

- Challenges
  - Funding
  - Lack of piped water
  - Short growing season
  - Takes energy
  - Poor soil
  - Upkeep for projects (labor/education)
  - Consistency (animal/fish populations go up and down)
  - Storage ?

ADVICE FOR RURAL ALASKA COMMUNITIES?

What advice would you give to communities in rural Alaska?

Funding

Energy

Lack of piped water

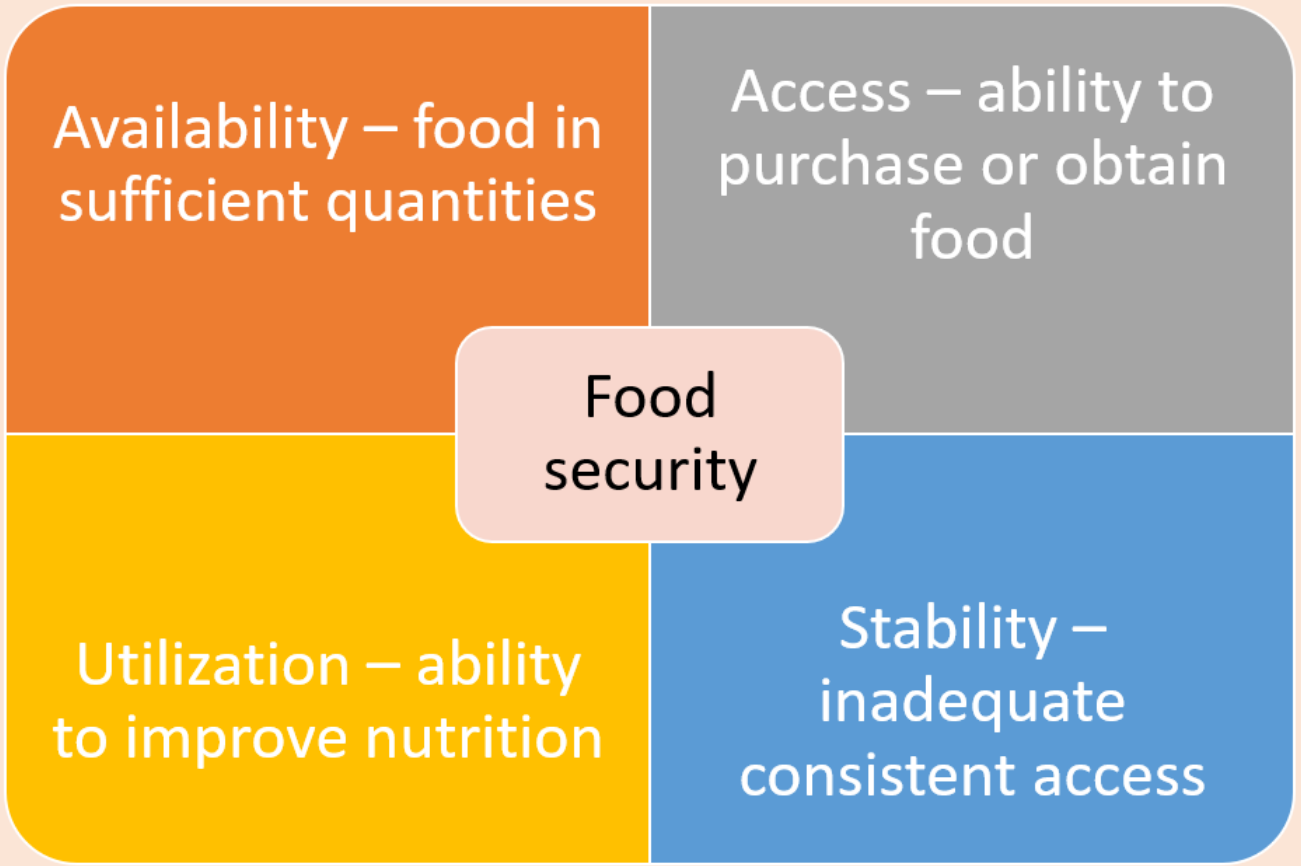
Lack of piped water

Up keep

Poor soil

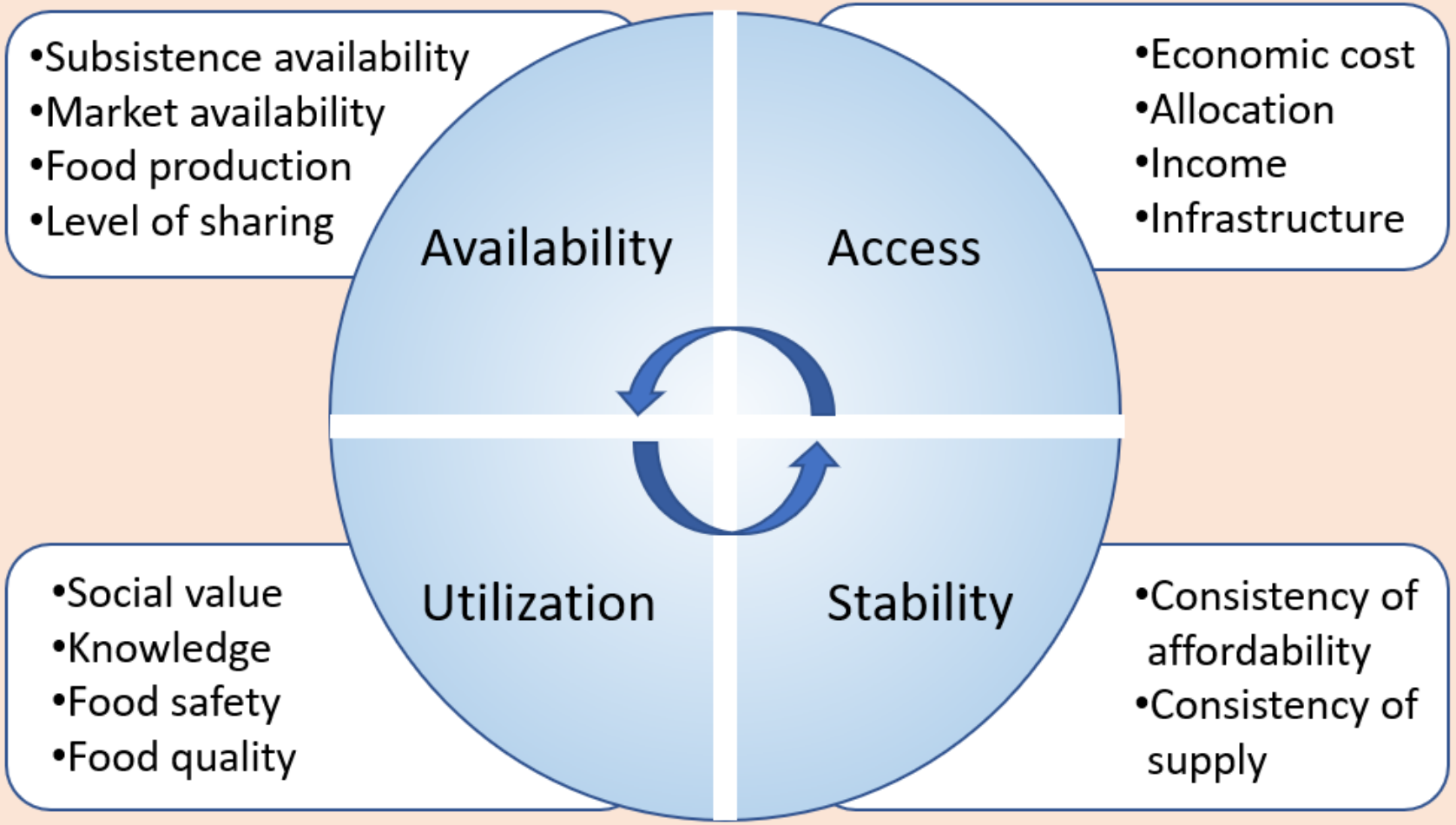
What is food security?

Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. - 1996 World Food Summit



Walch, A. et al. 2018. A scoping review of traditional food security in Alaska. International Journal of Circumpolar Health 77(1)
FAO 2008. An introduction to the basic concepts of food security. Food and Agriculture Organization of the United Nations

What is food security?



Examples of food security extremes

	High	Low
Availability	Animal/fish populations abundant	Animal/fish populations scarce
	Large local store	No local store
Access	Food is too expensive	Low cost food
	Working coolers in store	Broken coolers in store
Utilization	Nutritious food is available	Only foods poor in nutrition are available
	Culturally relevant food is available	Lack of subsistence or locally harvested foods
Stability	Little change in availability of goods at the store	Never know what the store will have
	Prices do not fluctuate and are predictable	Prices vary based on season, transportation, etc.

Thank you!
Any Questions?

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Questions We Have for You!

- What are your top three concerns about Food Security?
- Do you have any ideas for helping a community with no agriculture history to kick off an ag culture?
- We have set one of our project goals to maximize renewable energy usage to minimize cost. Do you have any thoughts on this?
- What are your food storage challenges?
- What do people want to grow in your community? Cabbages, per Tim Meyer? Or fresh herbs?
- To produce more local food vs. to make food tastier vs. to sell for profit?
- How do you define food security?