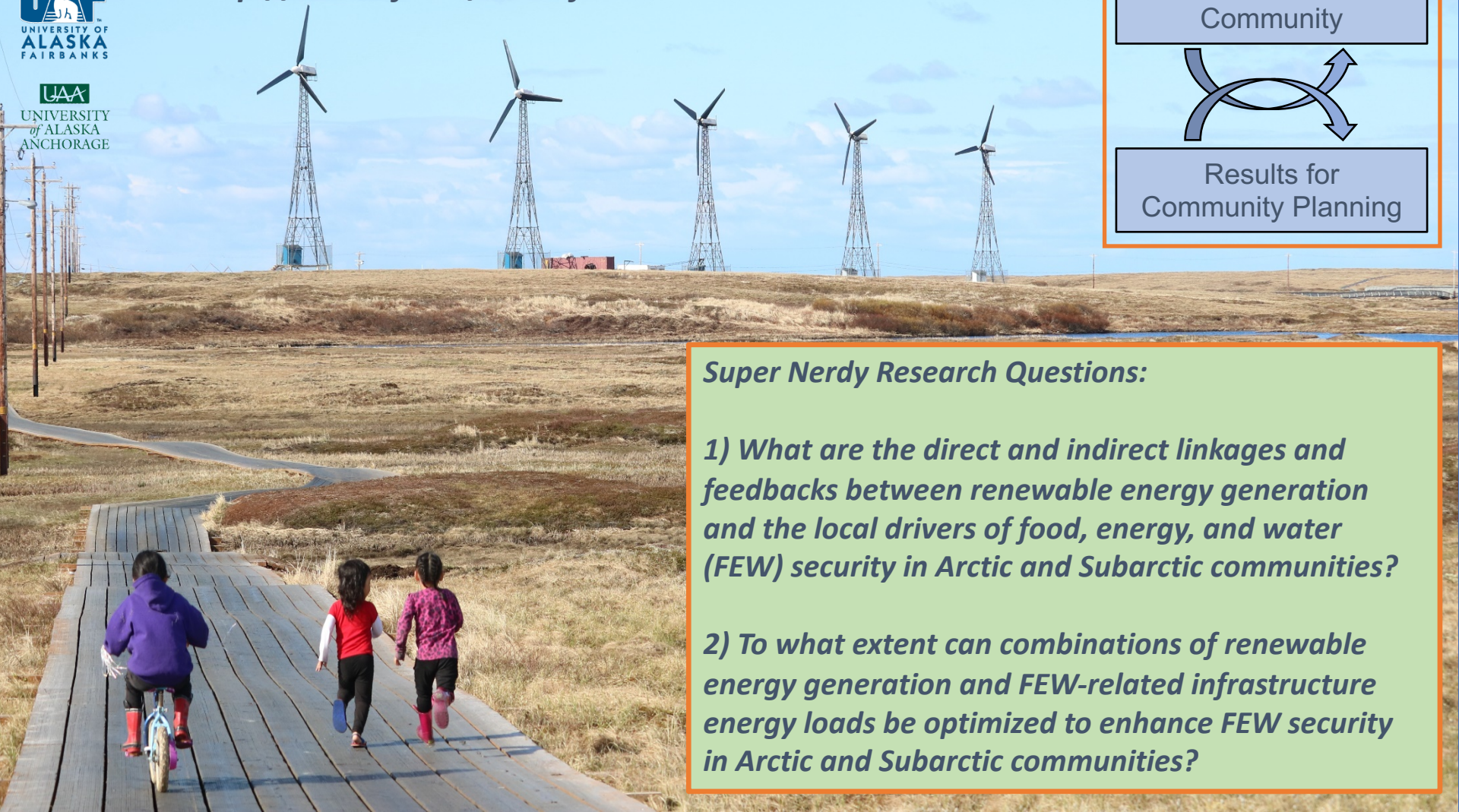
How Do Existing and Potential Renewable Energy Projects Affect Food, Energy, and Water Security in Rural Alaska?

#1740075

Project Duration: Sept. 2017 – Mar. 2022

Presenters: Erin Whitney & Jen Schmidt

http://ine.uaf.edu/microfews



Results for Scientific Community

Results for Community Planning

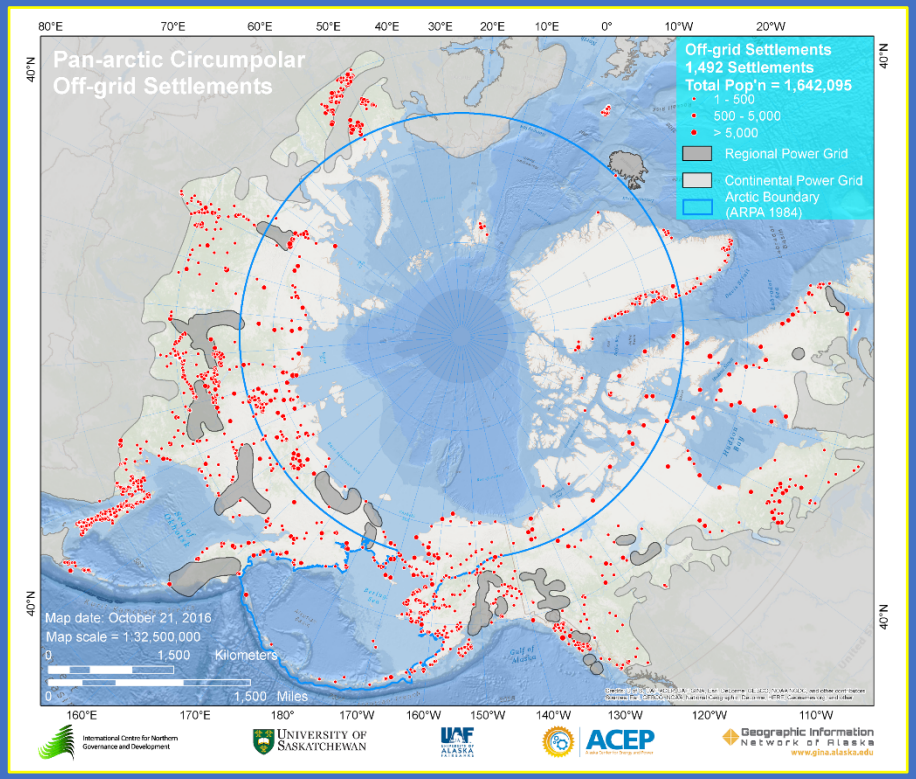
Super Nerdy Research Questions:

1) What are the direct and indirect linkages and feedbacks between renewable energy generation and the local drivers of food, energy, and water (FEW) security in Arctic and Subarctic communities?

2) To what extent can combinations of renewable energy generation and FEW-related infrastructure energy loads be optimized to enhance FEW security in Arctic and Subarctic communities?

Energy in Rural Alaska

- Most communities are located off the road system.
- Isolated communities, or “microgrids,” supply their own power.



Can be…

- Expensive
- Dependent on fossil fuels
- Environmentally unfavorable

The MicroFEWs Project

Sept. 2017 – Mar. 2022

UAA

Huntington Consulting

U. Calgary AINA/KLRS

Undergrad, Grad Students & Postdoc

UAF

Communities of Kongiganak, Tanana, Cordova, and Igiugig

http://ine.uaf.edu/microfews

Objectives of MicroFEWs

- Develop a FEW framework
- Collect community data
- Investigate modular systems
- Develop Energy Distribution Models (EDMs)
- Synthesize MicroFEWs model
- Conduct outreach and develop capacity

Overview of the MicroFEWs Process

Social Scientists

Community Inputs

How does the community value … ?

- Renewable Energy
- Food Security
- Water Security
- Energy Security

Both

Data Inputs

What are the quantitative pieces of info required?

- Powerhouse Electric Loads
- Dispatchable Load Profiles
- Renewable Resource
- Heating Loads

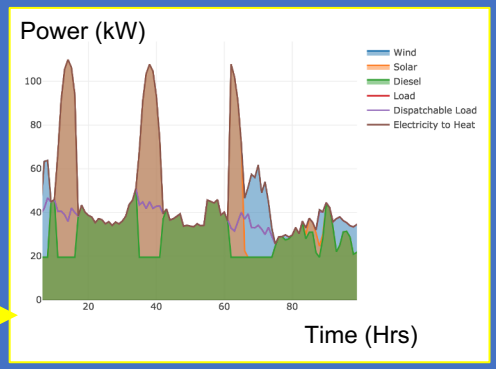
Engineers

EDM Outputs

What are the desired data outputs?

- Number of Dispatchable Loads
- Additional Renewable Capacity
- Time Series of Dispatch
- Total Outputs of Heating, Water, Food

Result Synthesis

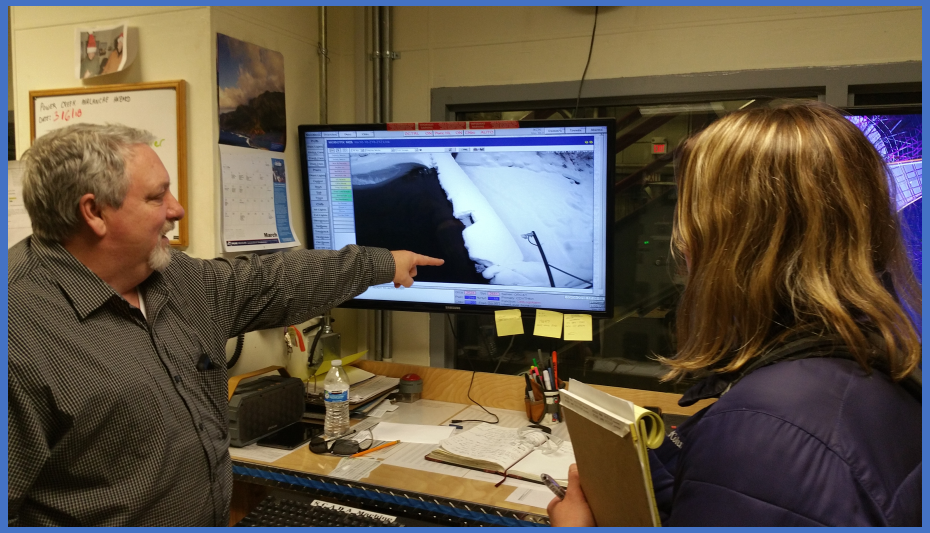


- How best to use excess renewables?
- Can demand profiles align better with renewables?

Iteration: Given resulting energy output and costs does this lead to other questions?

Approach

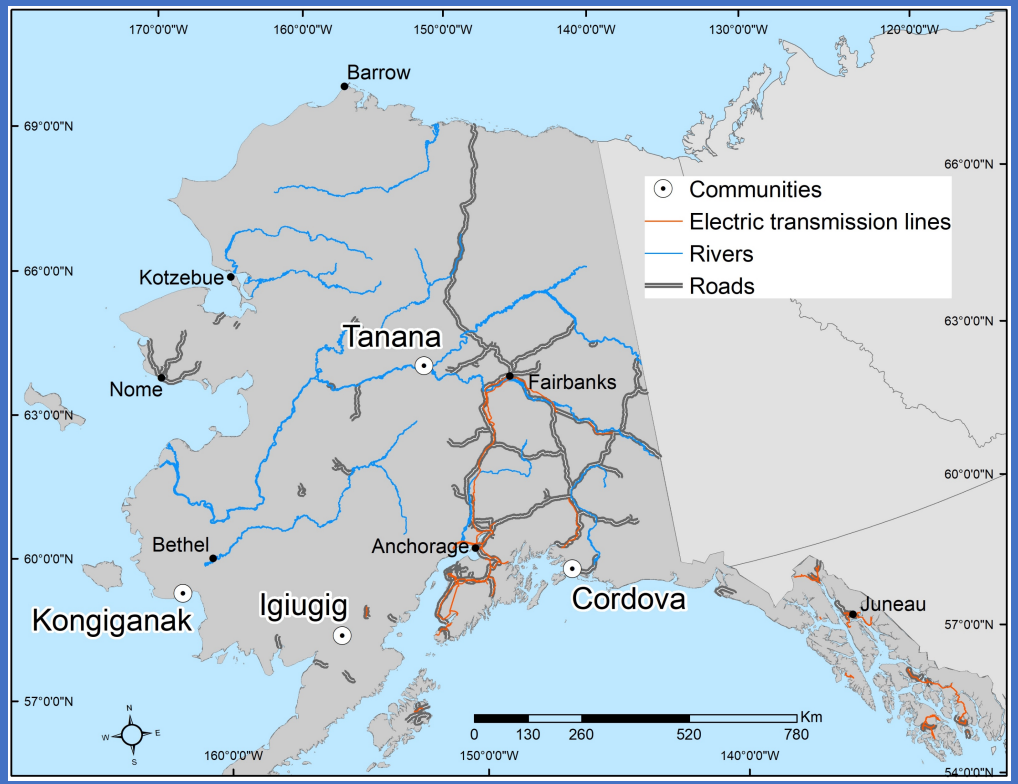
- Community-based participatory research
  - Listening
  - Respect
  - Reciprocal benefits
  - Bilateral transfer of knowledge
  - Forming relationships



Tobias et al. 2013.

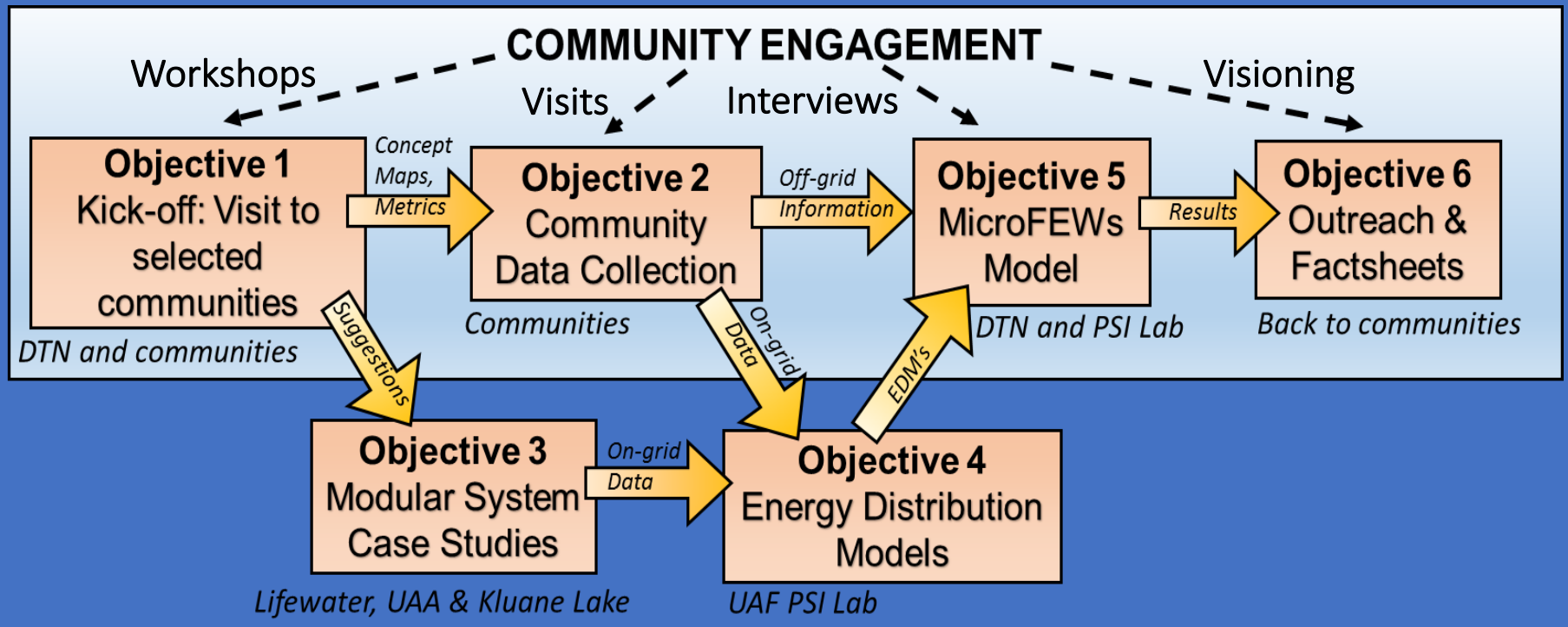
Communities

- Kongiganak – 98% Yupik, 650 people, wind
- Iguigig – 89% Yupik, 50 people, run of river
- Tanana – 78% Koyukon, 220 people, biomass
- Cordova – 8% Eyak, 2400 people, hydro



Process

Social science Engineering Convergence



Workshop

- Workshop (April 2018)
  - Communities want to learn from other communities
  - Incorporate local goals and need
    - Example: community assessment with interviews
  - Cardboard and energy possibilities
    - Collaborative proposal submitted

Community visits

- Community visits
  - Make connections
  - Learn what the communities' concerns are about food, energy, and water
  - Assess current status of renewable energy
  - Learn about their visions for the future of renewable energy and challenges
  - Data availability for modeling purposes

- $300 for product
- 35% of product is from Cordova
- Transportation costs

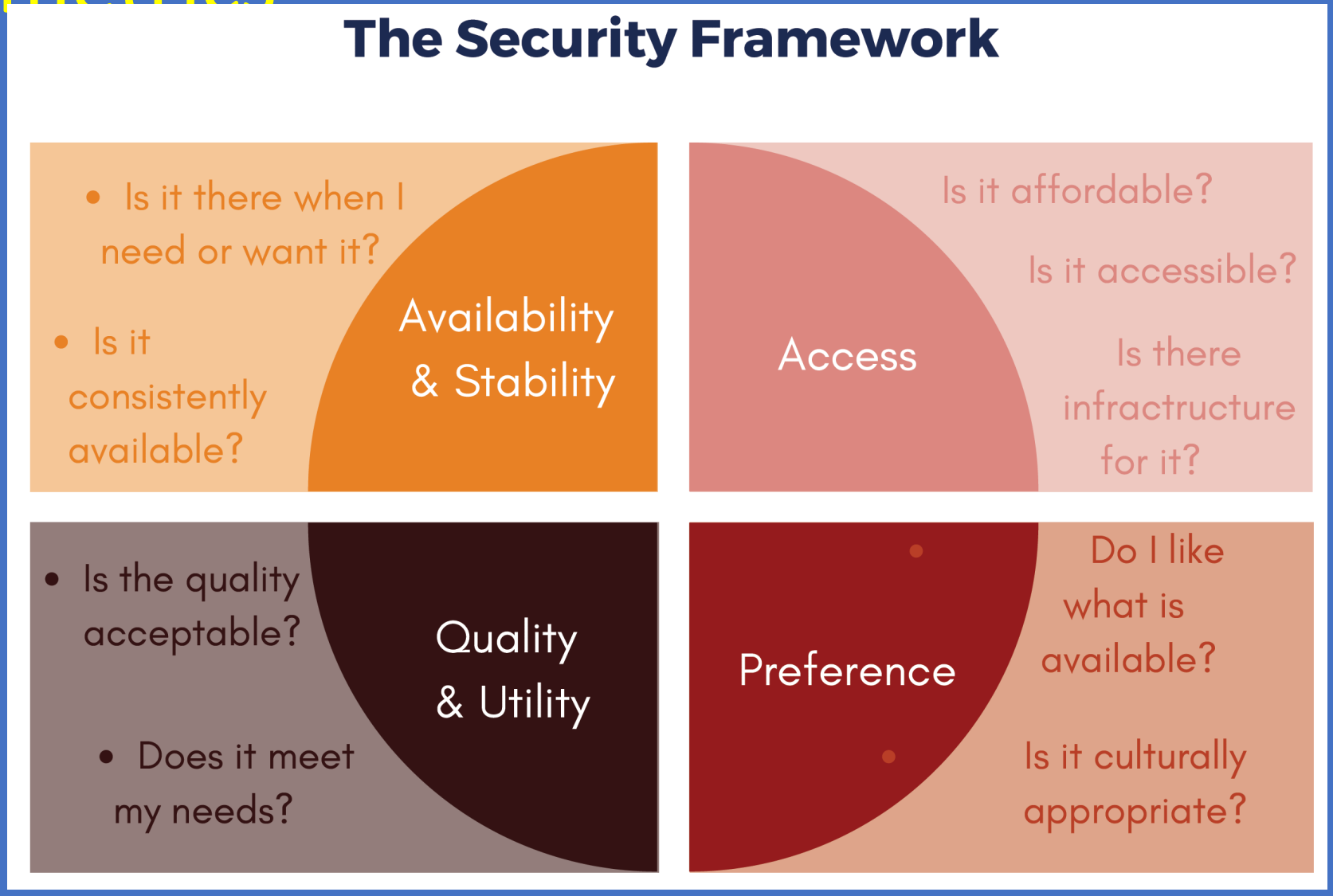
Conferences

- Events that bring together people from rural Alaska
  - What kinds of information are most useful?
  - What is the best way for communities to share knowledge with one another?
  - How do we make this information accessible to communities?
  - How can our project help?

Interviews

- Hire local people to help with interviews
- Hold community meetings
- Goals
  - Assess FEW security
  - Explore FEW nexus
  - Role renewable energy plays in security and desires for the future

Food, energy, water security metrics



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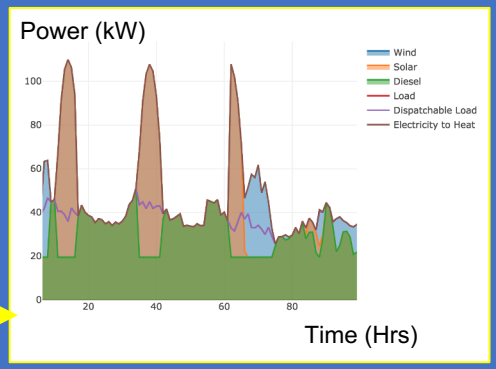

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Technical energy data collection

Data Needs:

Quantity, quality, reliability of food

Energy usage: seasonal & diurnal variations

Heat usage: quantity and type

Water usage, percentage of homes with piped water

Data Challenges:

High turnover in power/water plant operators

Privately owned utilities reluctant to share data

Flat usage fees for water

Heat loads difficult to identify when not all sources of heat are metered (e.g., wood heat)

Food data is diverse and difficult to collect systematically

Data Solutions:

Be patient, build relationships

Engage key community members from all stakeholder groups.

Use proxy data as appropriate.

Report results back to the communities, create a two-way knowledge exchange.

Include room in budget to pay people who provide time and data.

FEW Systems Modeling

OPPORTUNITIES

- Relative isolation of the communities provides avenues for modelling closed FEW systems.
- Renewable energy can be optimized using FEW dispatchable loads.
- Limited FEW infrastructure systems provide an opportunity to characterize the often complex FEW system dynamics.

CHALLENGES

- Existing larger FEW infrastructure models are not scalable to remote islanded FEW systems.
- High degree of non-linearity within the connections and energy flows of FEW systems.

Cordova FEW System Dynamics

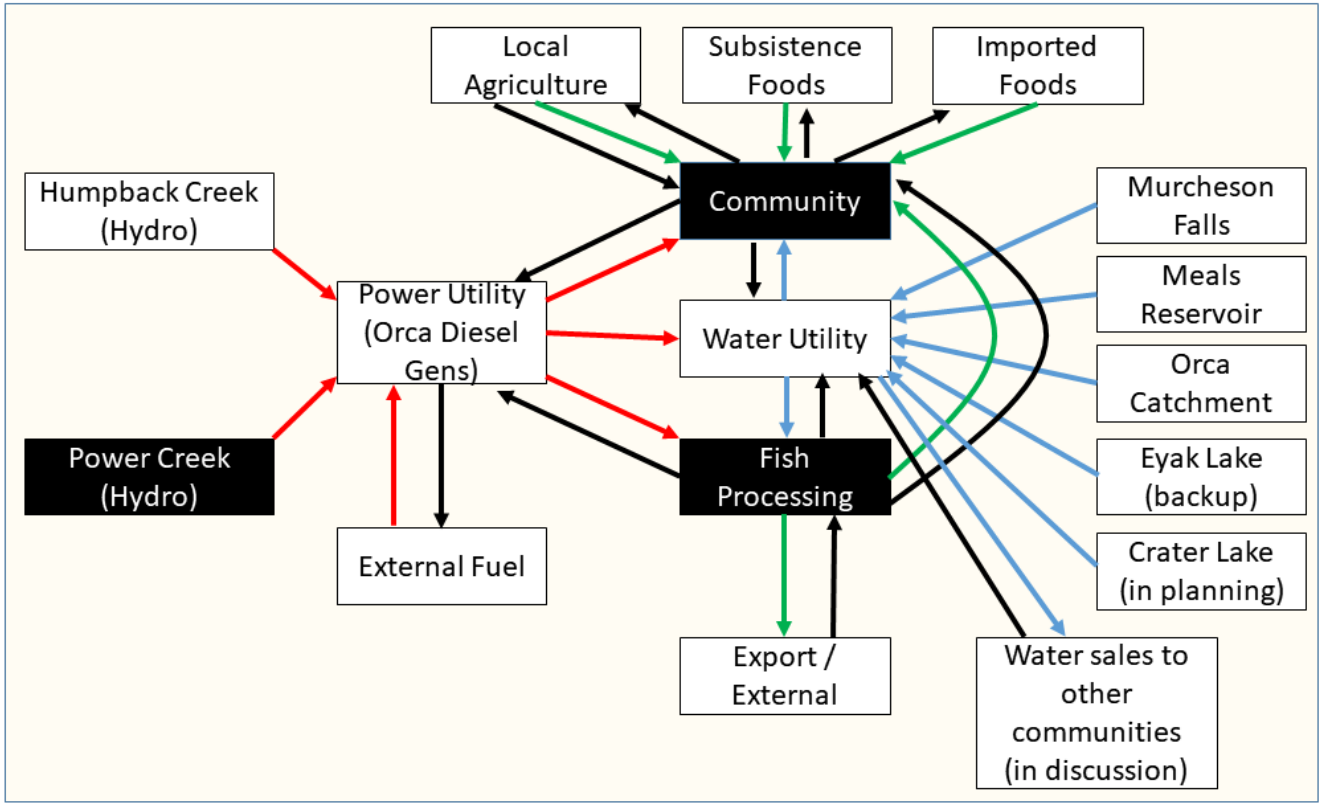
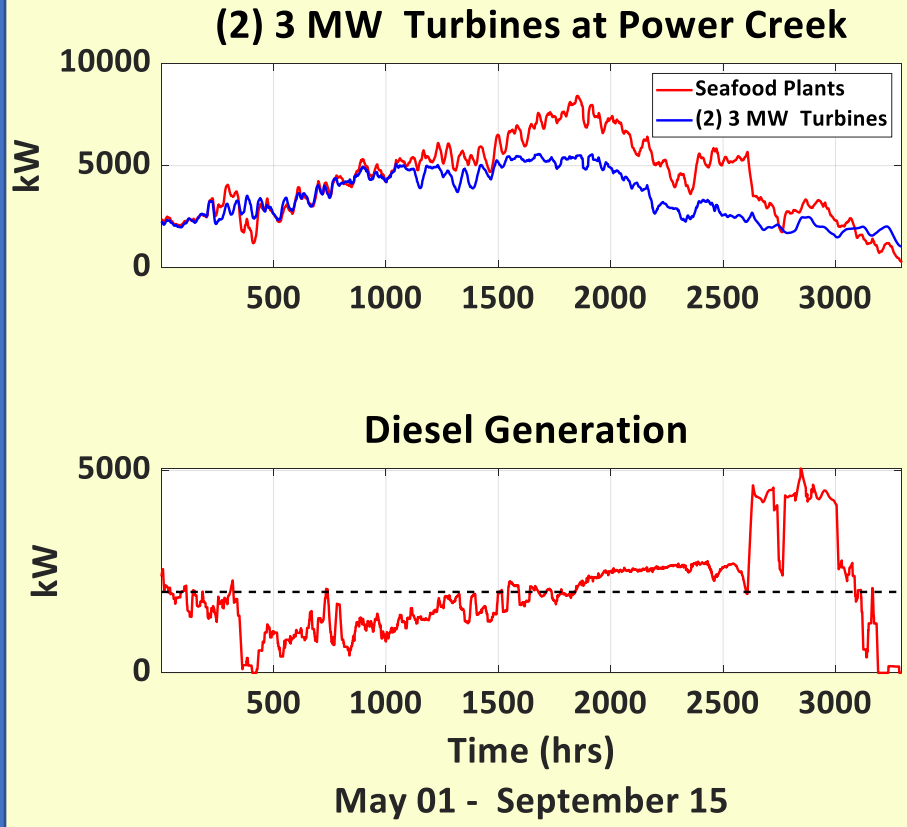
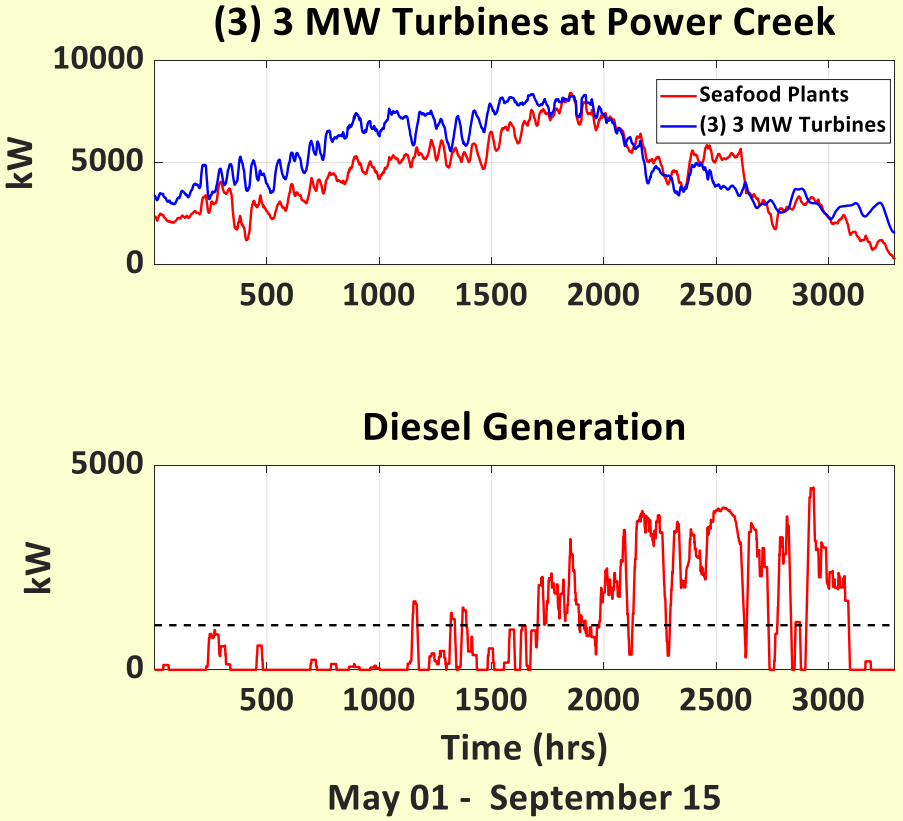


Figure 4. Framework for FEW synthesis. Energy (red), water (blue), food or food product (green), and revenue (black) flows are illustrated by the colored arrows.

Whitney, E., Schnabel, W.E., Aggarwal, S., Huang, D., Wies, Jr., R.W., Huntington, H.P., Schmit, J.I., and Dotson, A.D. "MicroFEWs – A Food-Energy-Water (FEW) Systems Approach to Renewable Energy Decisions in Islanded Microgrid Communities in Rural Alaska," *Environmental Engineering Science*, https://doi.org/10.1089/ees.2019.0055. (June 2019).

Two vs. Three Wind Turbines in Cordova





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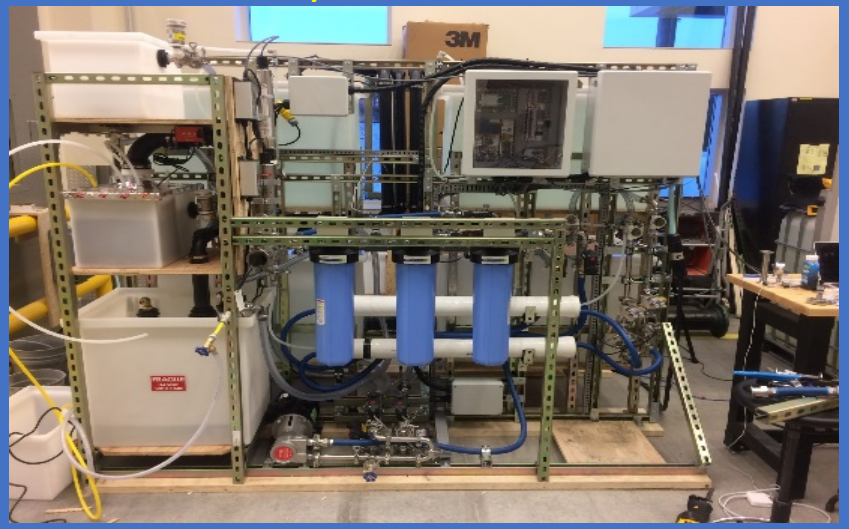
Modular Systems & Kluane Lake Research Station (KLRS)

CropBox

Water Reuse system



Lifewater system

KLRS

Sambor, D.J., Wilber, M., Whitney, E., Jacobson, M.Z.

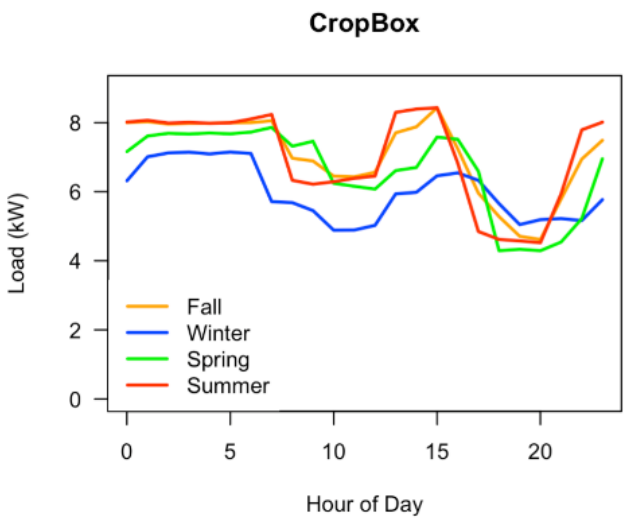
Development of a Tool for Optimizing the Use of Solar and Battery Storage for Container Farming in a Remote Arctic Microgrid

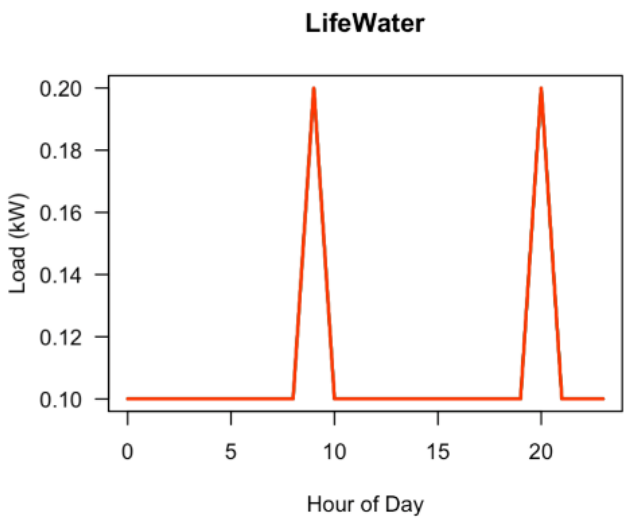
MDPI Energies, 13, 5143 (2020). https://doi:10.3390/en13195143

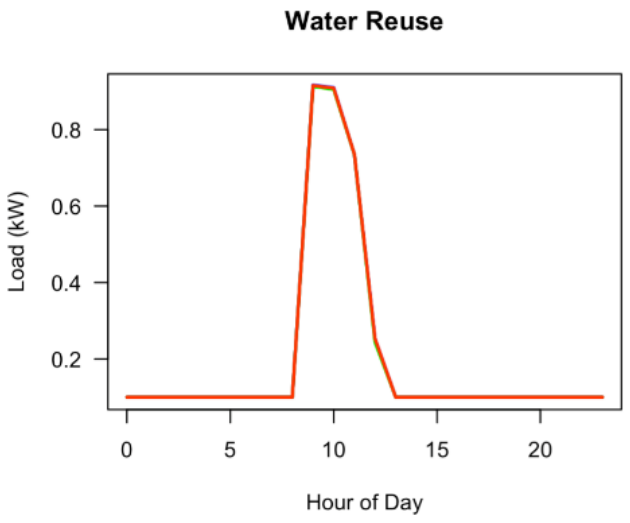
- Past attempts to grow food indoors in these remote areas have proven uneconomical.

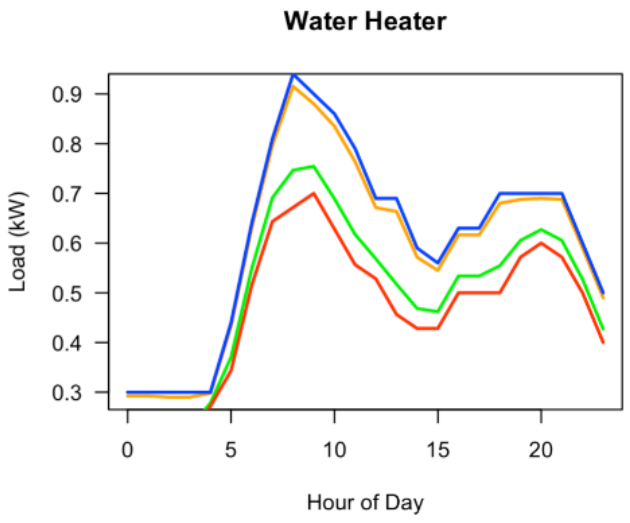
- Appropriate demand-side management of specific loads can reduce total costs - even in an Arctic climate.

Wind Resource Assessment for Dispatchable Modular Loads





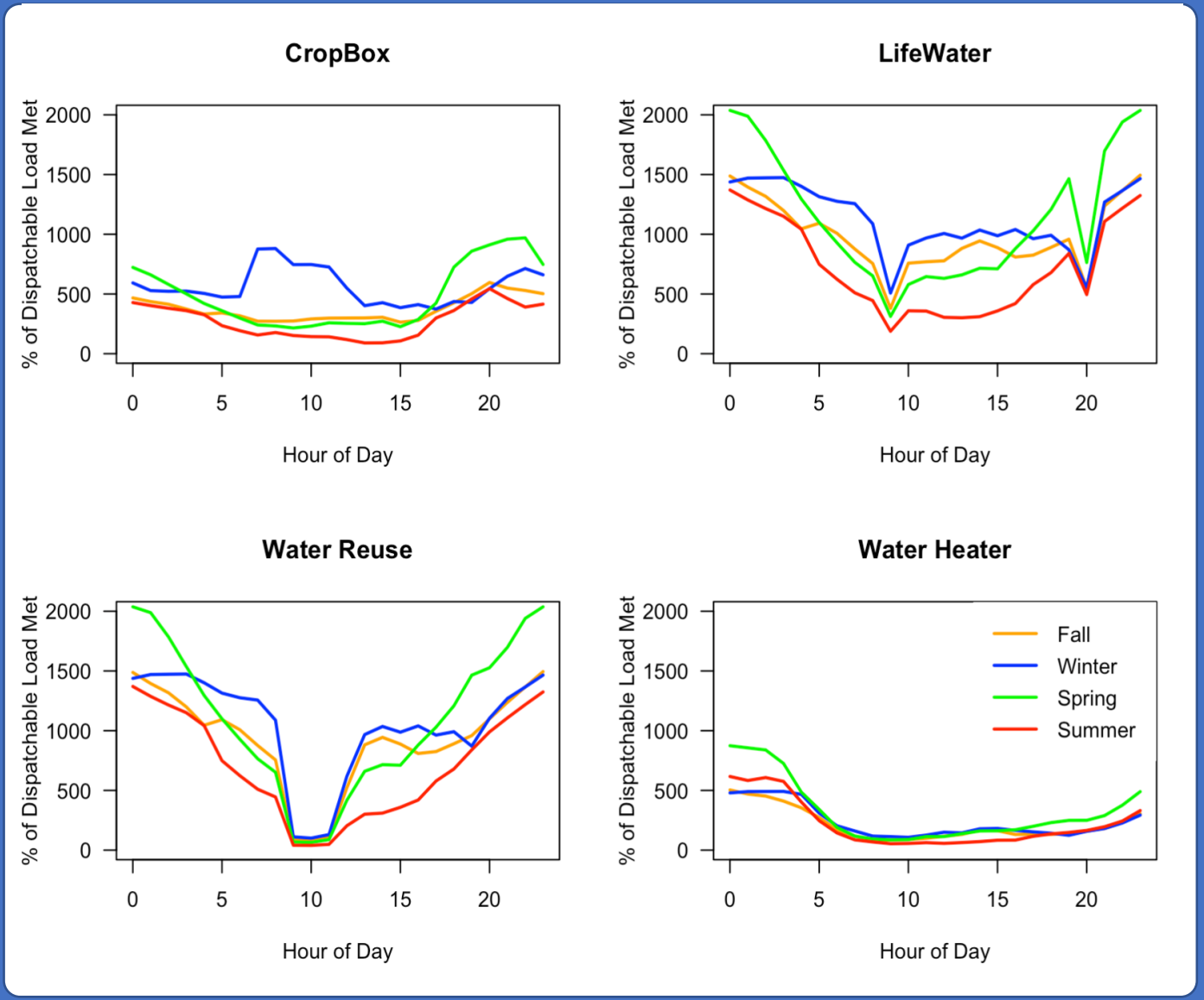




Average seasonal load profiles of one unit of each dispatchable load

Wind Resource Assessment for Dispatchable Modular Loads

Hourly and seasonal percent of each dispatchable load met by excess wind generation from a Wind Energy Solution 32 100kW wind turbine.



FEW systems

Kongiganak







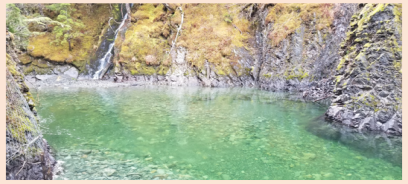
http://www.iesconnect.net/projects/kongiganak-wind-heat-system/

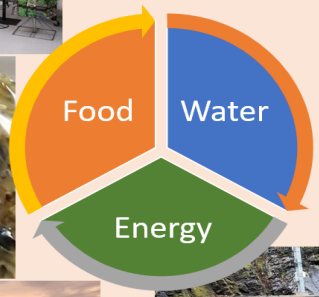
Tanana

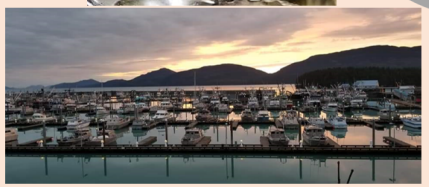





Cordova

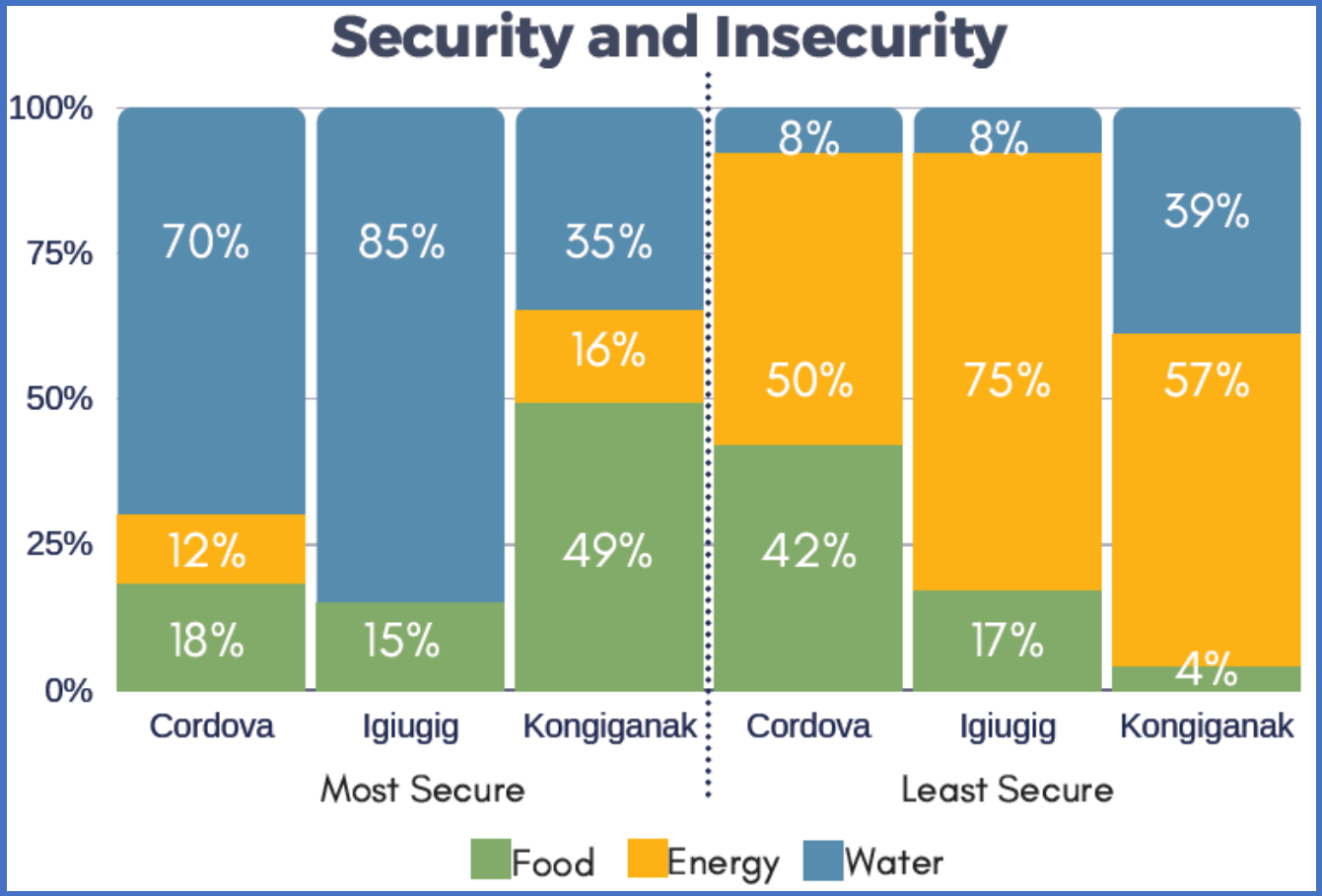



Results: FEW security

Surveyed Households	
Igyararmiut (Igiugig)	13
Kangirnaq (Kongiganak)	51
Cordova	50
Total	**114**



http://ine.uaf.edu/microfews/objective1

Results: Drivers of FEW insecurity

	Igiugig	Kongiganak	Cordova
Food	Access & Quality	Access & Quality	Access & Quality
Energy	Access (Affordability)	Access & Availability	Access & Quality
Water	Access & Availability	Access (Infrastructure)	Access (Infrastructure)

- **Access**: is it affordable, accessible, is there infrastructure to support it?
- **Quality**: does it meet my needs?
- **Availability**: is it there when I need it? consistently available?

http://ine.uaf.edu/microfews/objective1

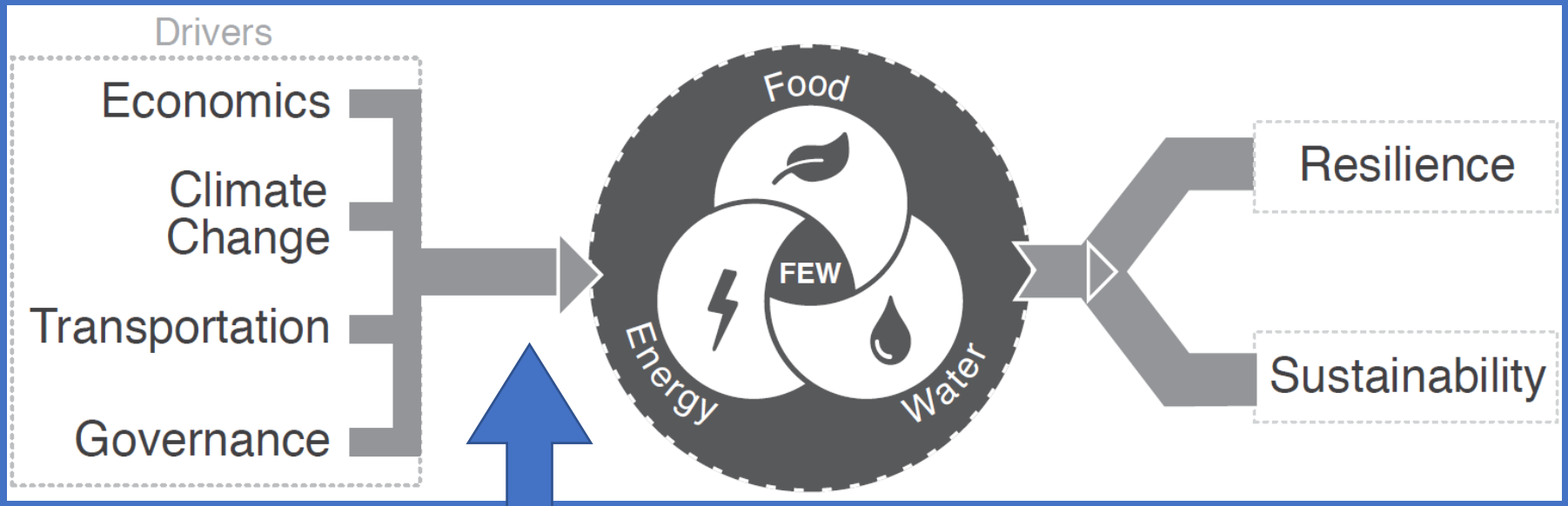
Results: Renewable energy surveys

- Satisfaction with current renewable energy is mixed
- 99% of households want more renewable energy
- Reliability is a barrier to renewable energy

What type of renewable energy do you want more of?

	IGG	KKH	CDV	ALL
SOLAR	62%	60%	46%	56%
WIND	31%	18%	28%	26%
BIOMASS	0%	2%	4%	2%
RIVER	15%	0%	2%	6%
TIDAL	-	-	38%	13%
HYDRO	0%	2%	26%	9%
UNSURE	15%	10%	10%	12%

Results: FEW nexus



Ferry
Bypass mail
Local governments

Actionable Results

- Solar visioning process (just starting)

Outreach

- Website
  http://ine.uaf.edu/microfews
- Videos
- Blogs
- Brief reports
- Online K-12 home school classes
- Facebook
- Twitter

Synergies: MicroFEWs and CASES

MicroFEWs

- Develop a FEW framework
- Collect community data
- Investigate modular systems
- Develop Energy Distribution Models
- Synthesize MicroFEWs model
- Conduct outreach and develop capacity

CASES

In northern and Indigenous communities:

i. Co-develop and apply tools for assessing … and enhancing the social and economic value of renewable energy

ii. Determine conditions … for successfully introducing renewables into the energy mix

iii. Facilitate knowledge-sharing between partners and communities

iv. Create a knowledge sharing platform to facilitate long-term capacity building.

v. Training and workforce development

https://renewableenergy.usask.ca/Projects/CASES.php

Potential of Renewable Energy: Kongiganak – an Energy Success Story

Film by Amanda Byrd

https://youtu.be/90n9ga3SOQQ (Project website: http://ine.uaf.edu/projects/microfews/communities/)

Thank you!

Project goes until March 2022

Visit our project website:
http://ine.uaf.edu/microfews

Contact information:

Jen Schmidt jischmidt@alaska.edu

Erin Whitney erin.whitney@alaska.edu

Additional Material

What do FEW connections look like in Tanana?

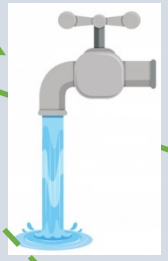
Making Heat

Wood Depot

Photo courtesy of Chas Jones

Using Heat

Public water



Public worker buildings: Firehouse, VPSO, Triplex, Teacher housing

Residential houses, City & Tribal offices

Example: Food, Energy, & Water (FEW) in Rural Alaska

Energy

Food

Water