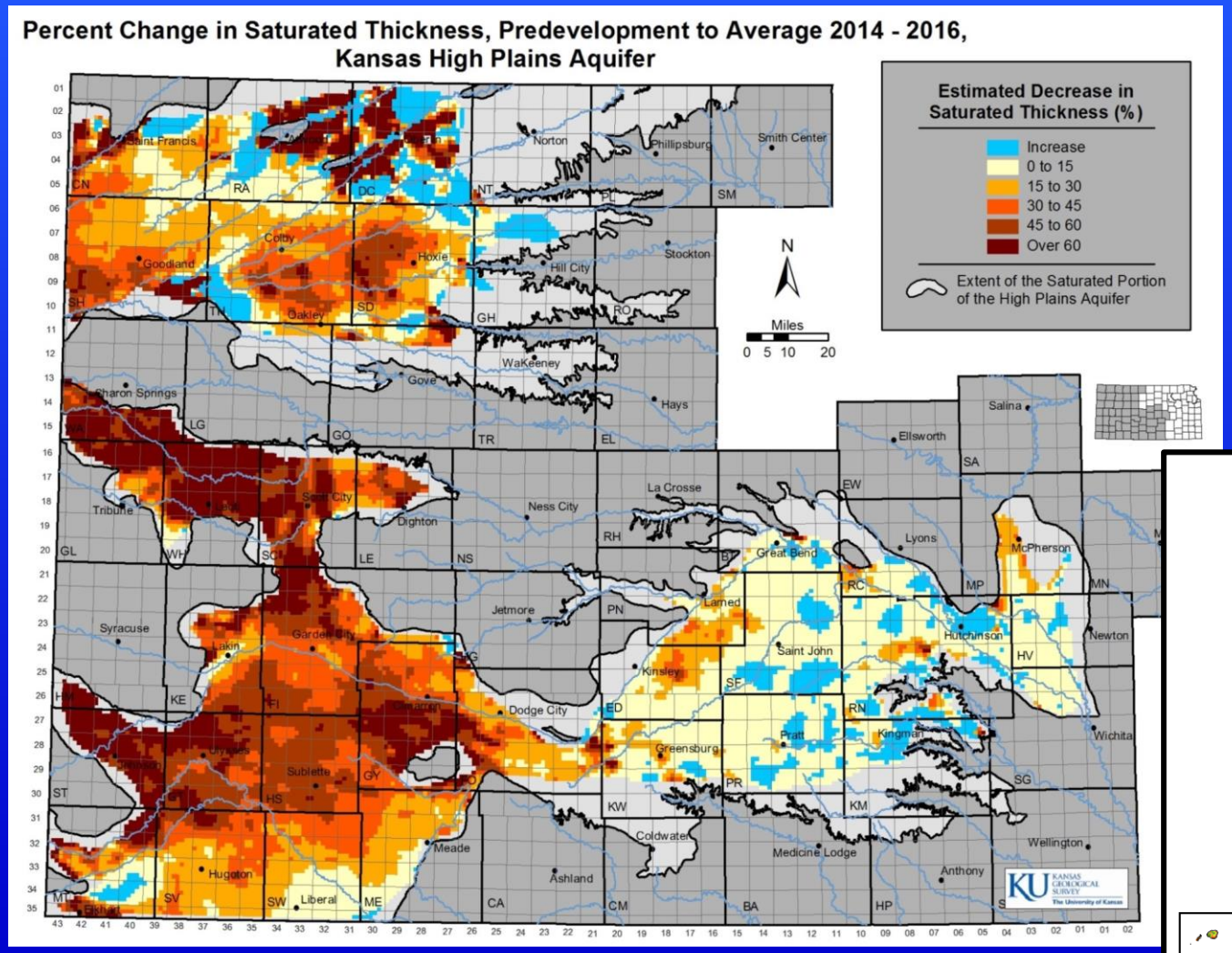
A Food-Energy-Water Calculator for Western Kansas

Mary C Hill (KU), Groundwater and uncertainty
Ruth Douglas Miller (KSU), Electrical energy
Danny Rogers (KSU), Agriculture
Joshua Roundy (KU), Climate, surface water, and drought indices

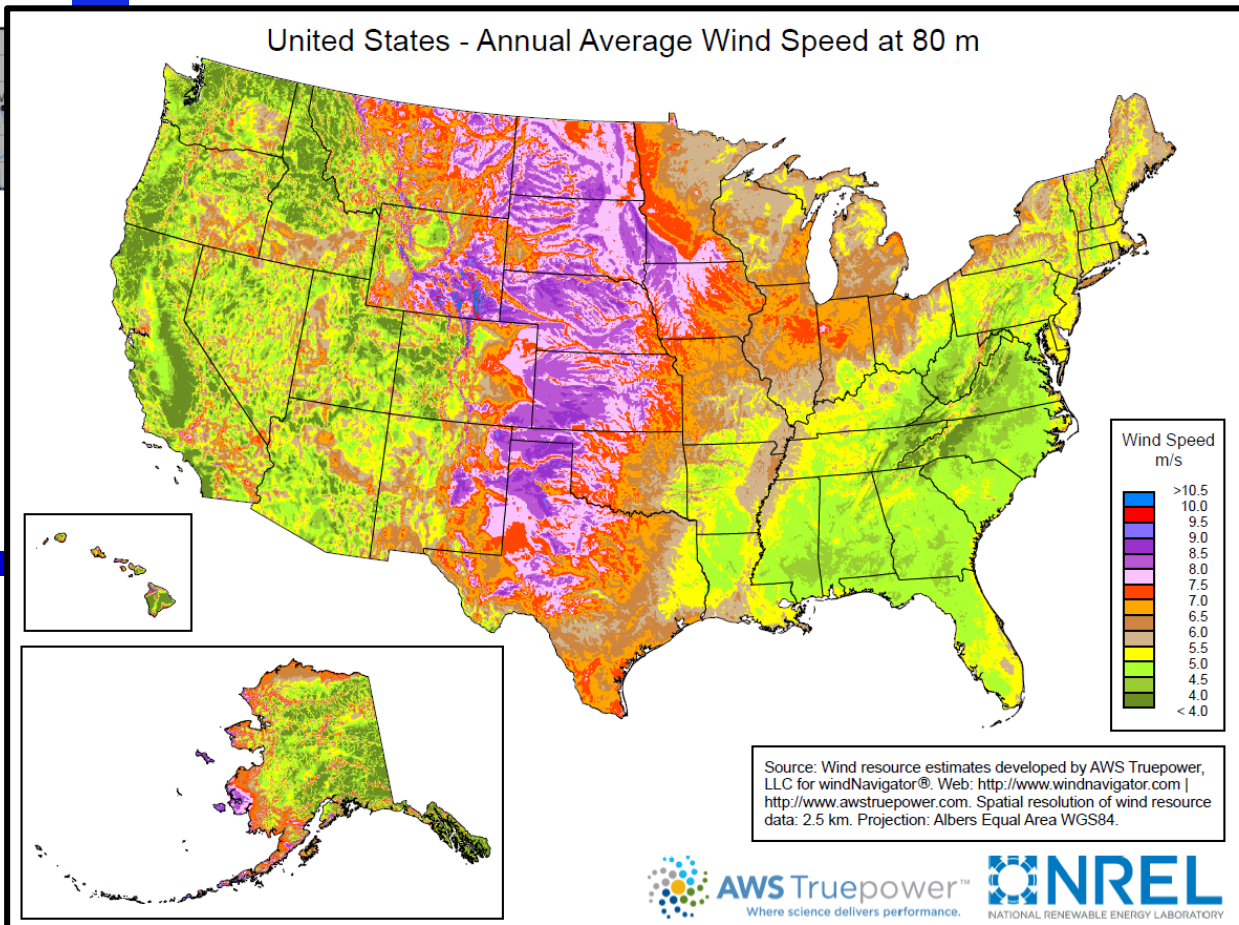
What is a Food-Energy-Water Calculator?

- Use the calculator to evaluate tradeoffs
  - Like a mortgage calculator but more complicated
- What tradeoff? Wind energy and agriculture
  - Wind energy income increase possible from change in Kansas regulations
    - Would allow more locally advantageous wind power development
  - Agricultural income decrease as farmers relinquish some water rights.
- Goals:
  - Conserve and extend usable life of the Ogallala
  - Maintain crop production into the future with less irrigation
  - Establish cover crops before the water is too depleted
  - Keep farmer revenues healthy by also harvesting wind energy
- The trade makes it more attractive politically



KGS

The region of depleted aquifer has some of the best wind in the country



Turning to turbines: By Cole Epley / World-Herald staff writer (Omaho, NB)

- "… land-lease payments of about $32,000 …" from 5-6 turbines

  But later in the article…

- "One turbine has changed my life"

- What is happening here??

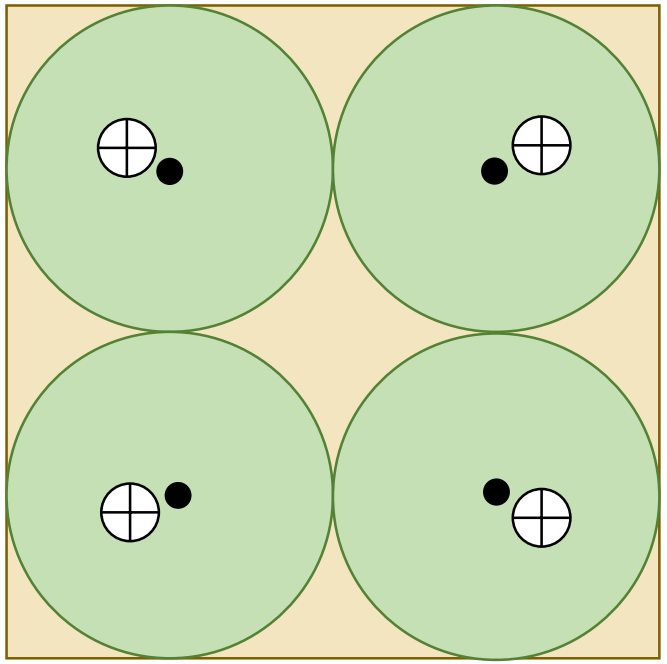
http://www.omaha.com/money/turning-to-turbines-as-commodity-prices-remain-low-wind-energy/article_2814e2cf-83a3-547d-a09e-f039e935f399.html
http://farmenergy.org/success-stories/wind-energy/new-crosswind-energy-project

Farm Net Income Cartoon

**Approximate relative values

Farm net income = 5**
From agriculture

Agricultural production



Electric use

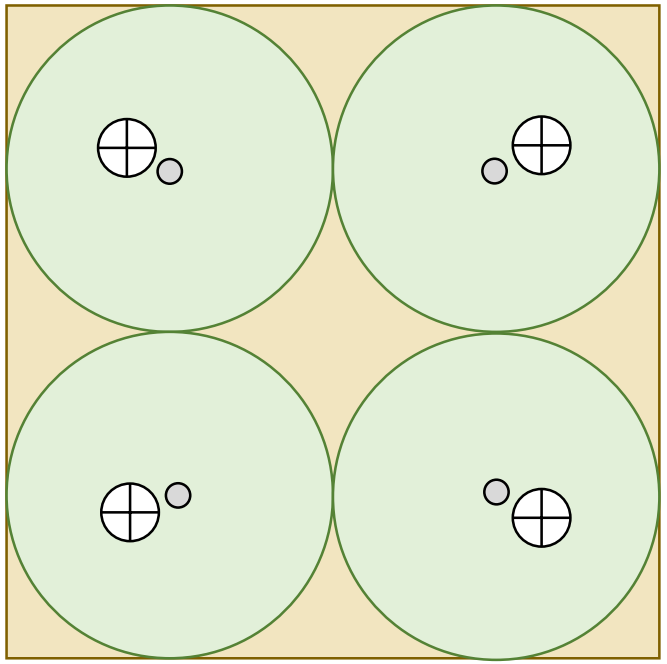
⊕ Electric meter

• Water well

Farm Net Income Cartoon

Farm net income = 3
From agriculture

Agricultural production



Electric use

Still important to keep this land producing agricultural goods for the country.

⊕ Electric meter

◦ Water well

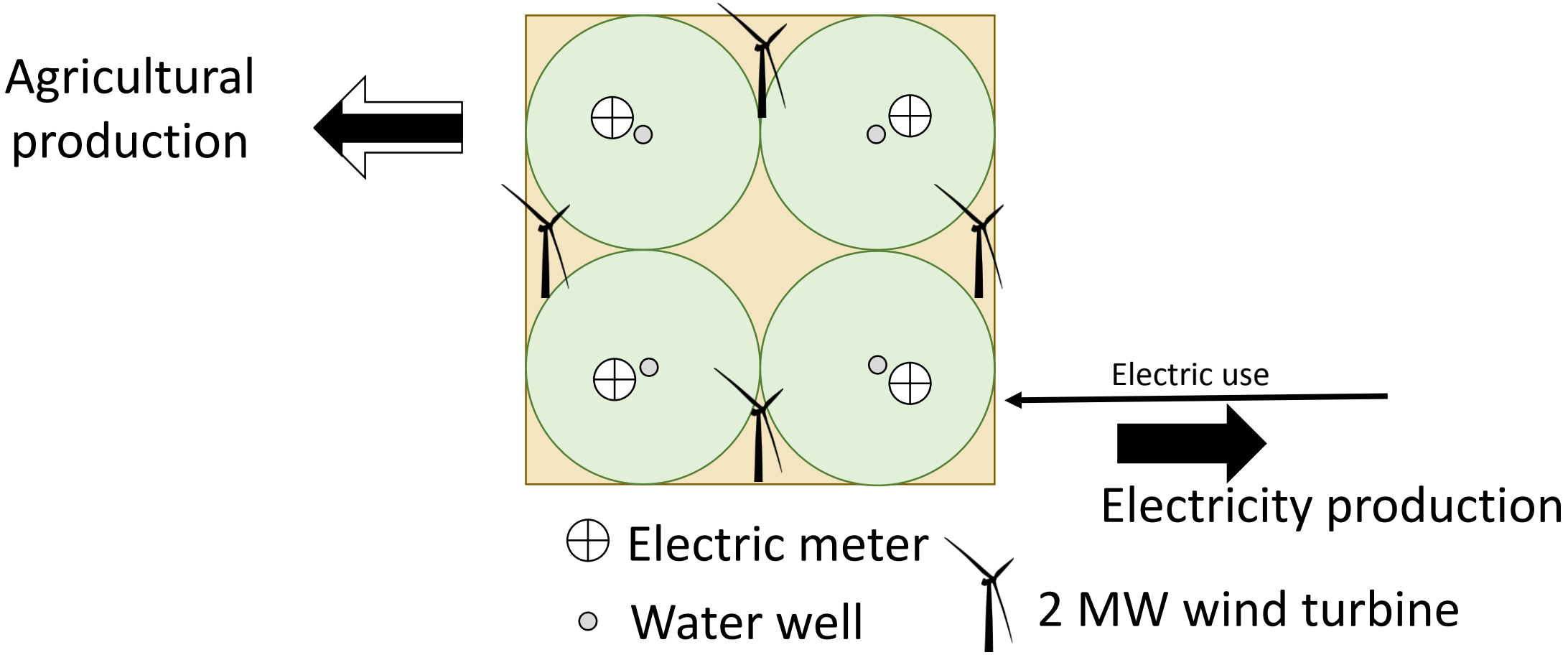
Farm Net Income Cartoon

Wind Energy Land lease agreement

No investment by the land owner

Farm net income = 3 + 0.5

From agriculture and land lease



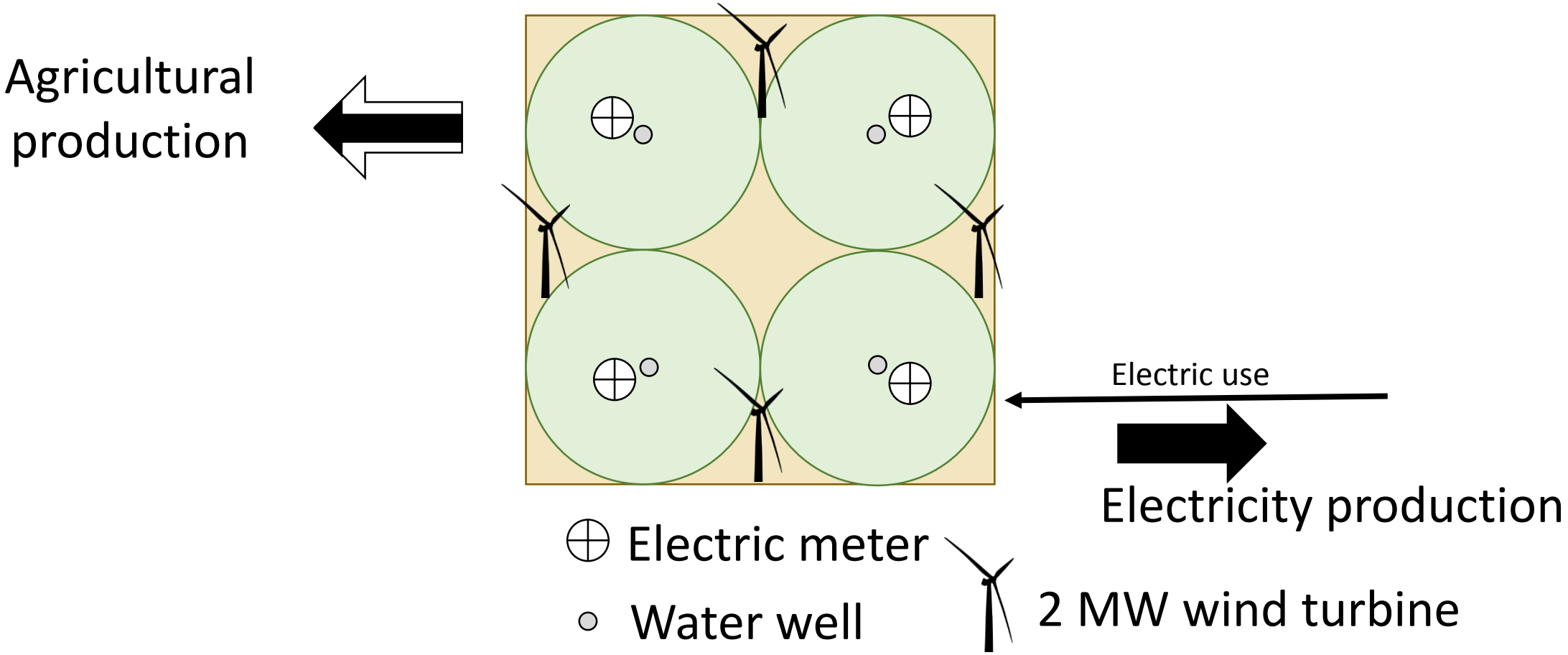
Farm Net Income Cartoon

Wind Energy Ownership

Investment by the land owner

Farm net income = 3 + ???

From agriculture and turbine



Calculating “What could this mean for me?”

- To forecast income (affects lifestyle, worth of land today, …), need expertise in
  - Food/agriculture
  - Energy
  - Water
  - Climate
  - Economics
  - Communication
  - Get data from web

Looking for solutions to a complex problem with no one easy solution

Faculty at KU, KSU, KGS, and others have expertise

The calculator

Users: define circumstances and preferences

Faculty: equations, numbers, web links, web searches, judgement. User modification supported.

	2. Define Framework	3. Make Choices	Key knowledge (Select, then click here for defaults)	Consequences
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Water	Irrigation: **Fresh Groundwater** HPA map from KGS is **HERE** Stories from your region are **HERE**	Reduce irrigation by **25%** of **5** year average. Years to unable to irrigate? **Calculate** Soil condition? **Poor**	Precipitation **14" per year** Time to dry farming at historic pumping rates: **2054**. **See map** Years added per area-wide 25% pumpage reduction: **5-10**	Dryland farming delayed b years. Use 7 years. Appro year to start non-irriga farming is **2061**

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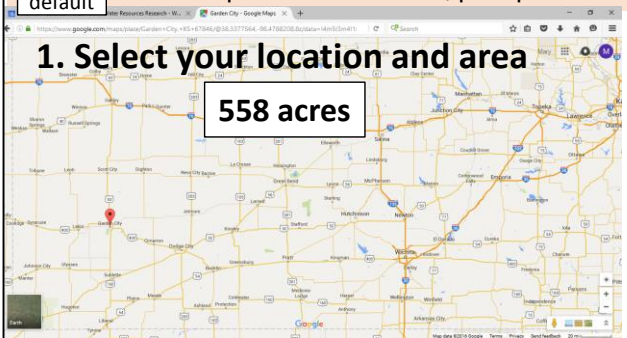

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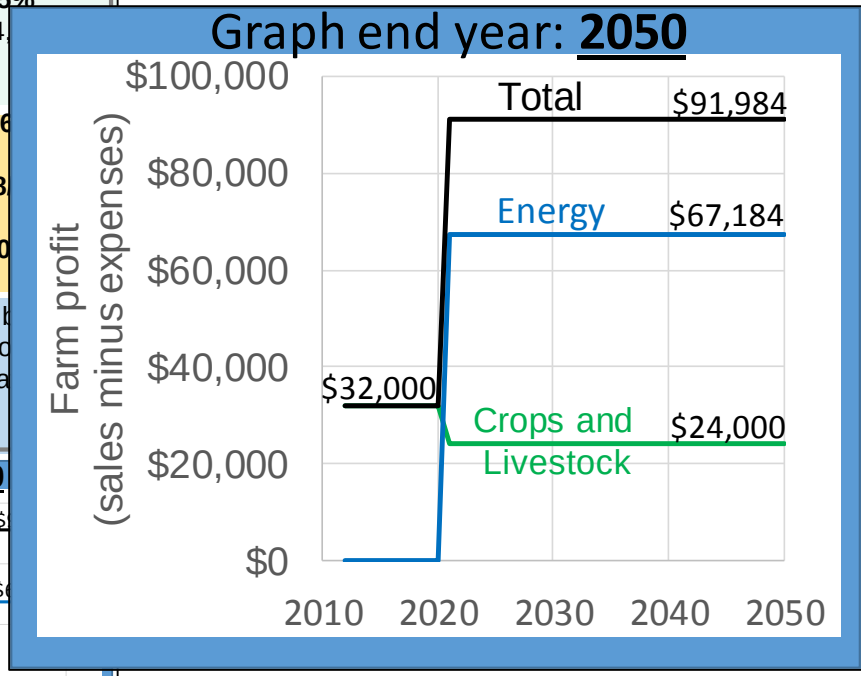
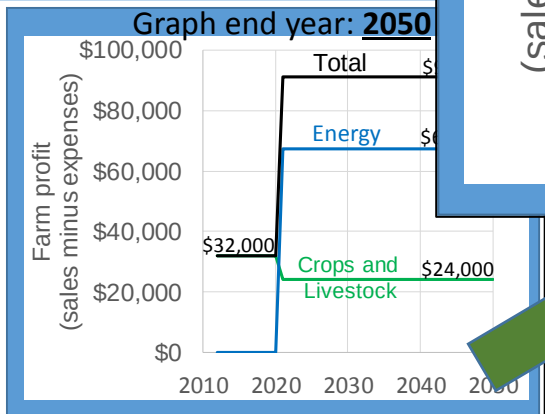
How does weather variability affect agricultural income? **Click here**





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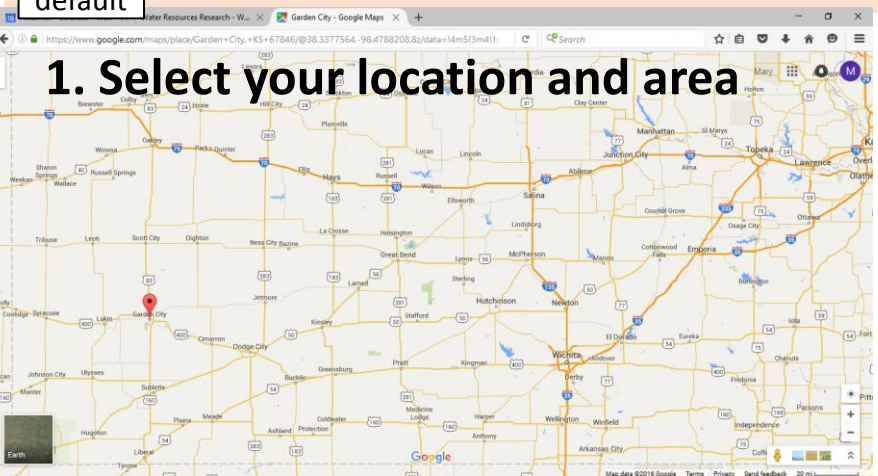
Agri-culture				
Wind and Solar Energy				
Water				

Climate

Click for default

1. Select your location and area



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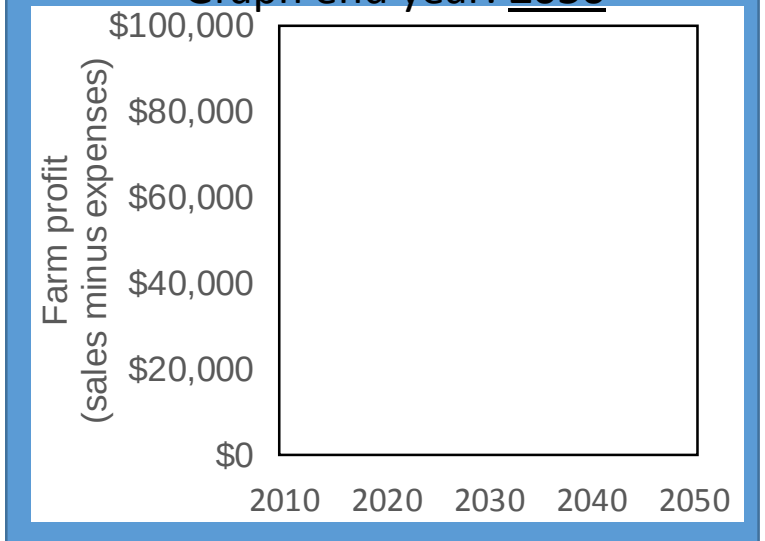
Graph end year: **2050**



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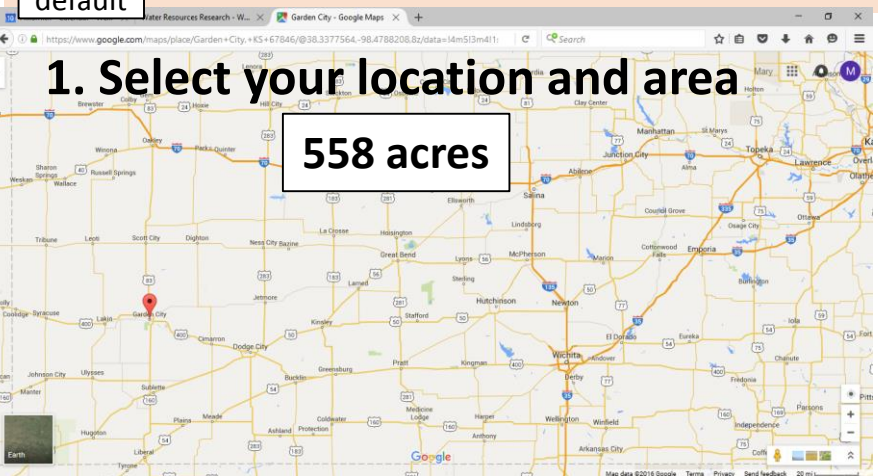

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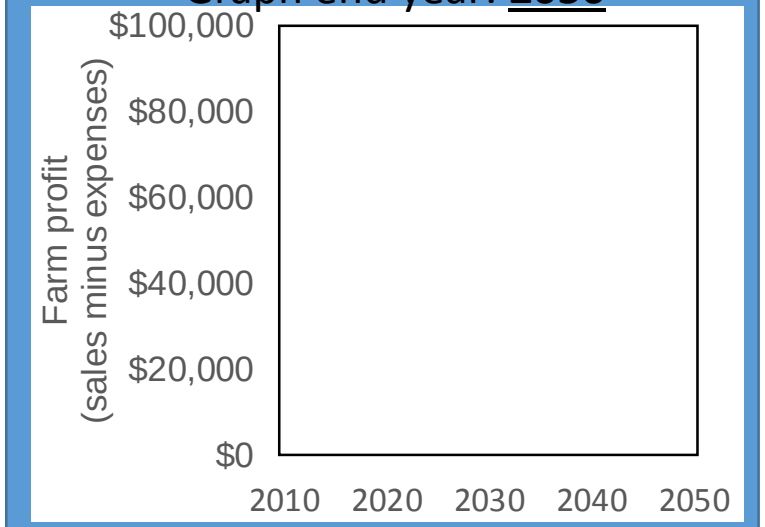

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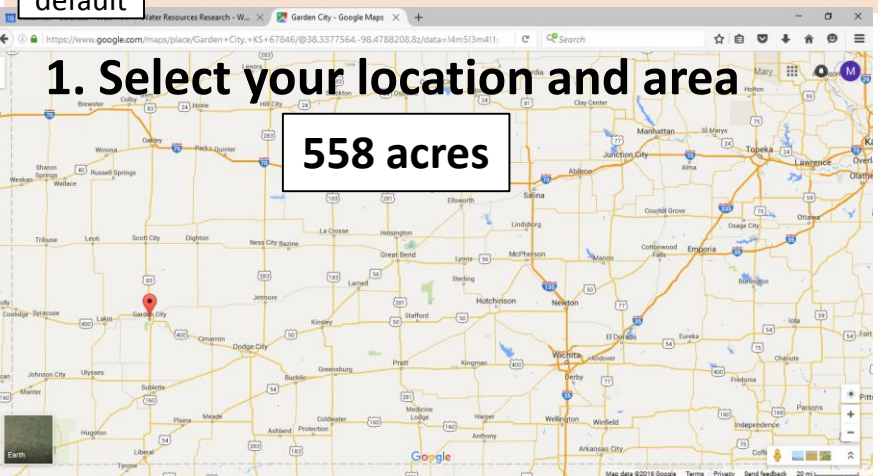

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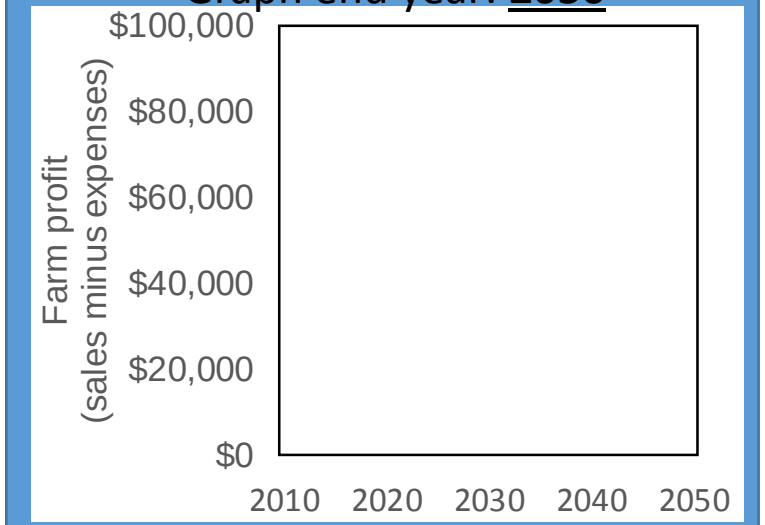

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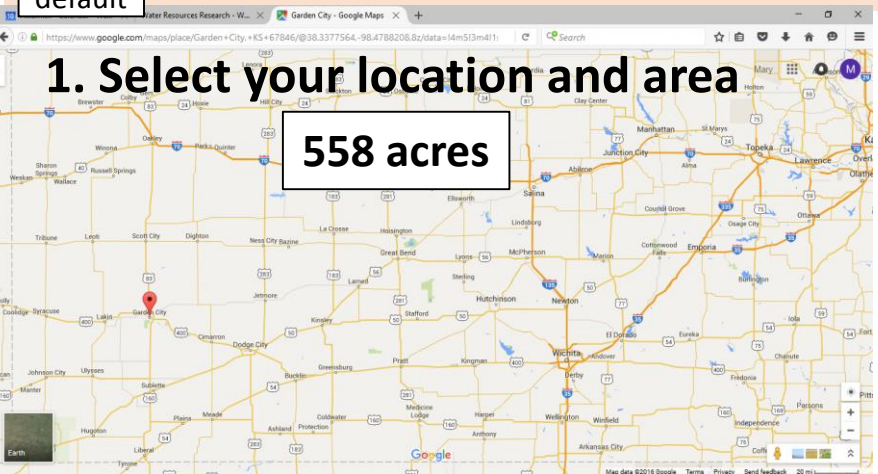

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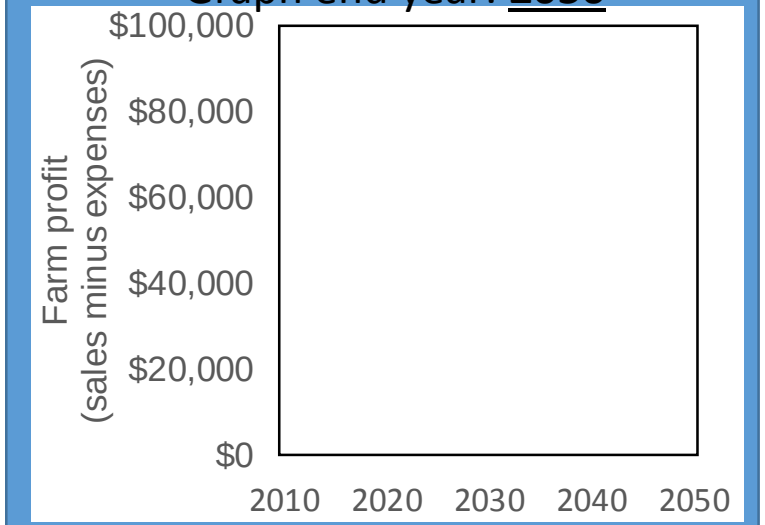

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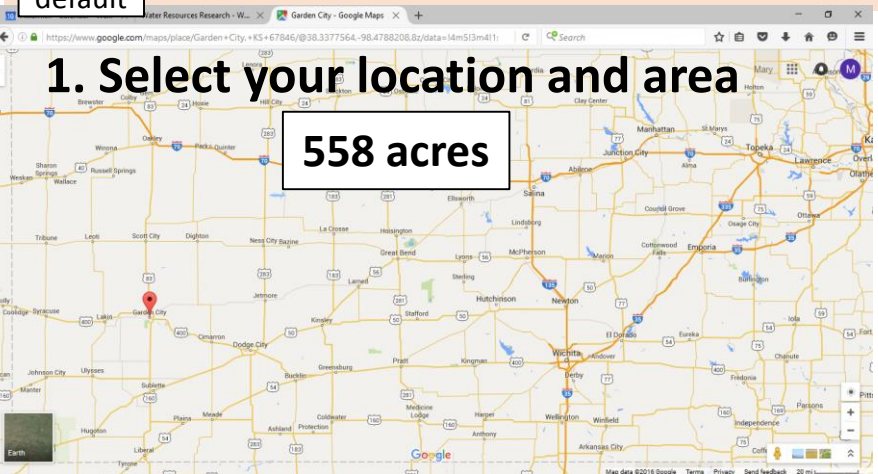

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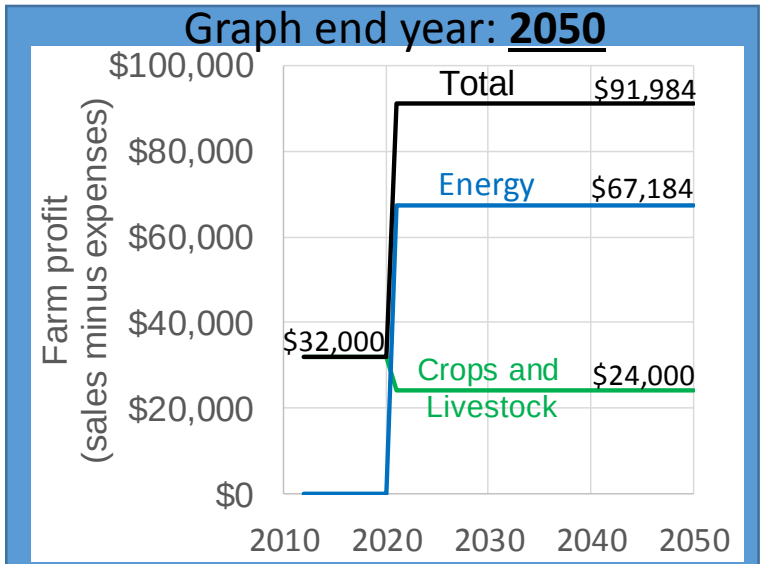


Kansas changes needed to support more locally profitable wind development

1. Special treatment of land owners/collectives who agree to water cutbacks for power sale rights.
   - Sell electricity to coops without KCC “utility” label
   - No generator size limit
   - Coops can sign PPAs* with landowners
   - Collectives are allowed.
   - Multiple meters under one contract.

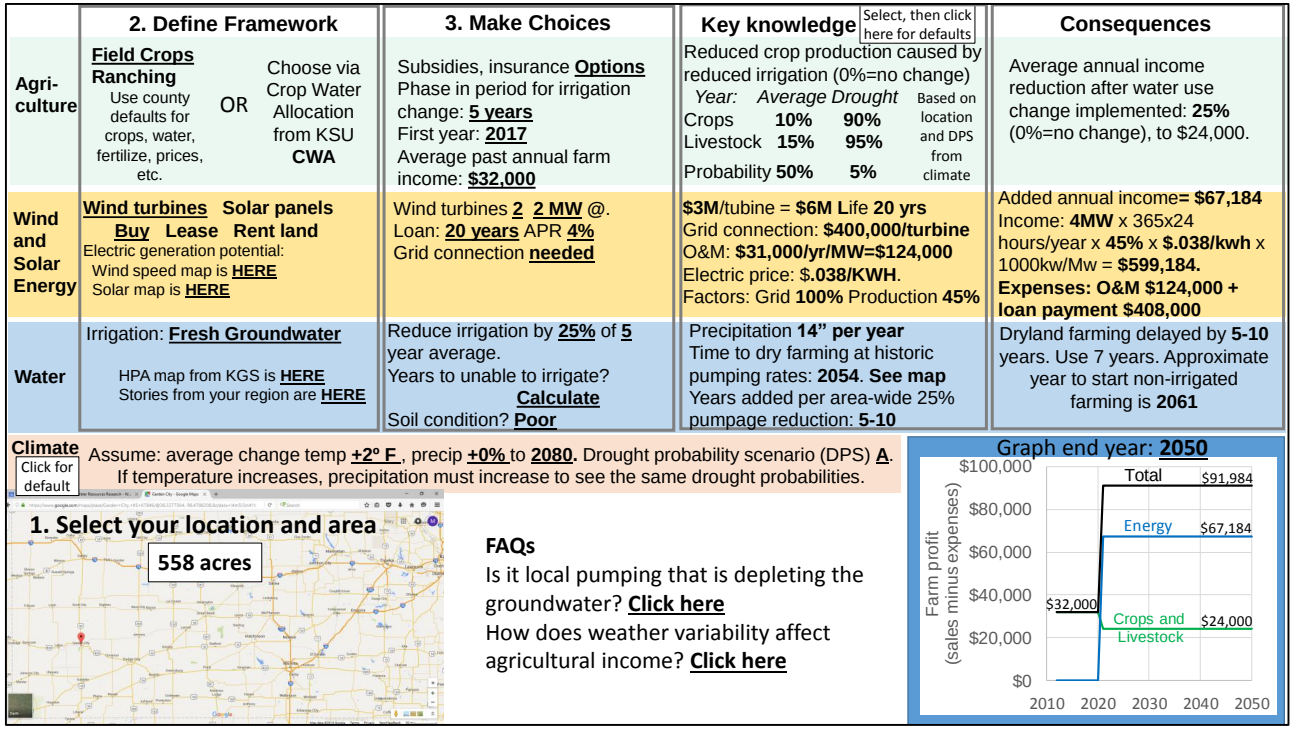
Necessary

Useful

2. Grid capacity:
   - Need lines and substations for MW-sized generators at landowner sites. Cost-share rules to pay for enhancements
   - Coop role bigger?

*PPA, Power Purchase Agreement: agreed sale price, typically for 20 yrs

Intended uses of the Food-Energy-Water Calculator



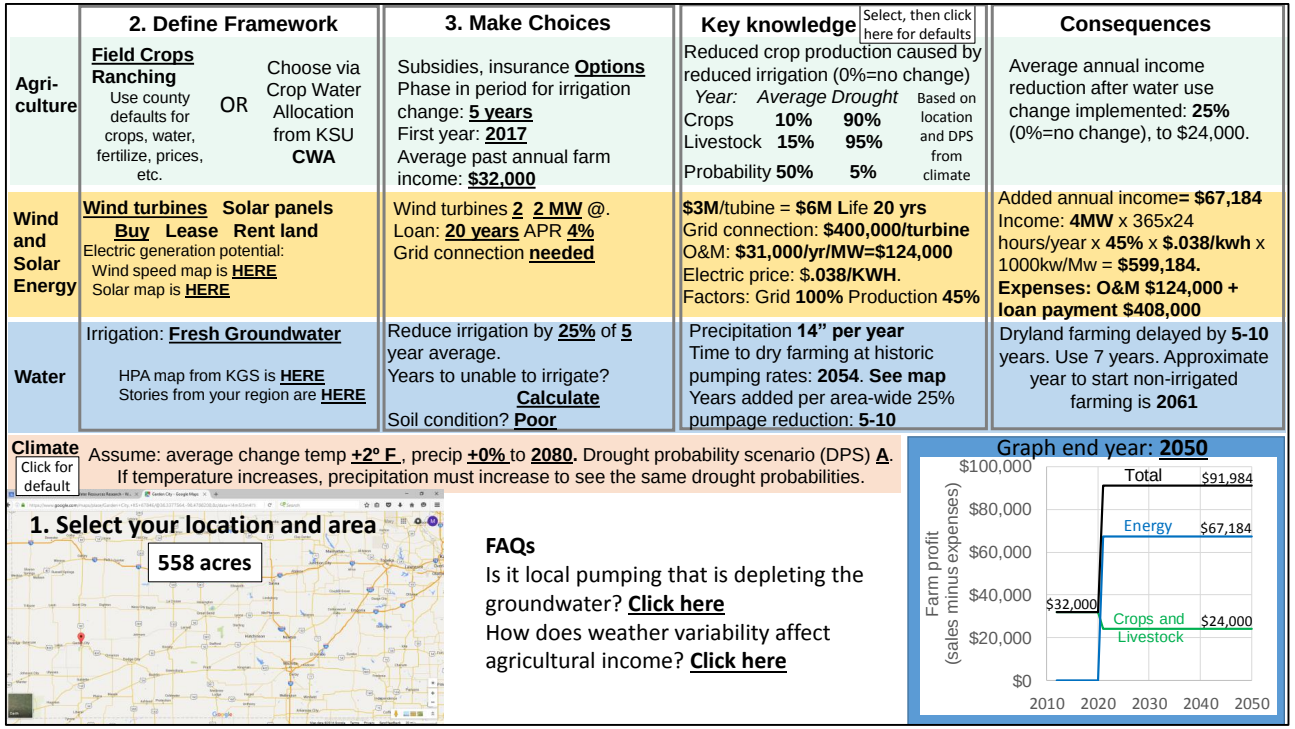
- Provides Kansas- and site-specific information to consider choices

Approximates future income for different choices

- Interested in considering turbine ownership??
  - Work with legislators, electric coops, IOUs, vendors and banks to figure out how to realize the opportunities.
  - To get started, see Windustry, or

http://windlibrary.org/exhibits/show/business-models/introduction OR
http://farmenergy.org/success-stories/wind-energy/new-crosswind-energy-project

Scientific Challenges for the Food-Energy-Water Income Calculator



- Accumulate data from web fast
- Define equations, including interactions
- Determine effects variability and uncertainty
- Design and build interactive app
  - Needs to be able to do a lot quickly

This is the first step

- We are interested in your thoughts.
- We hope for a continuing conversation.

Kansas: Feeding the World. Powering the Nation?

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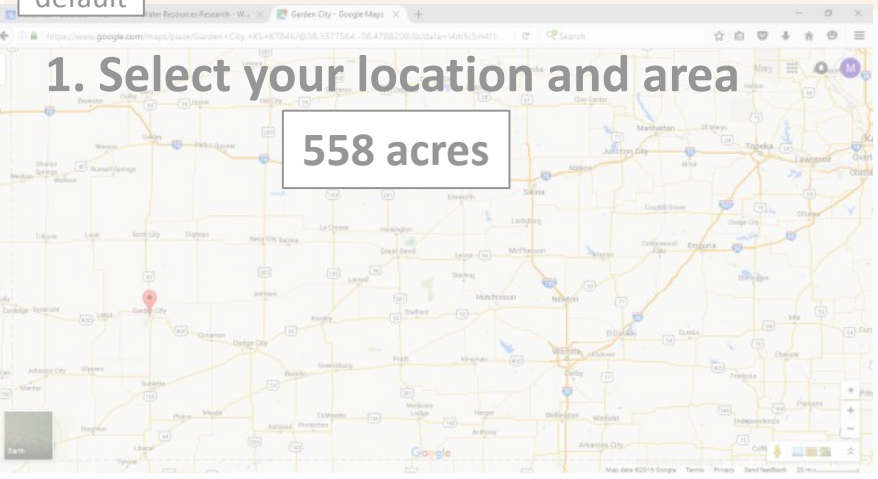

Questions?

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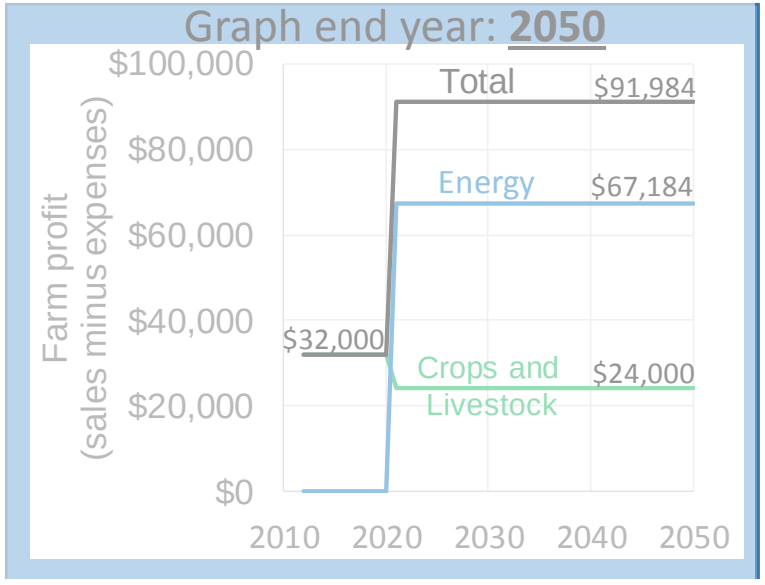
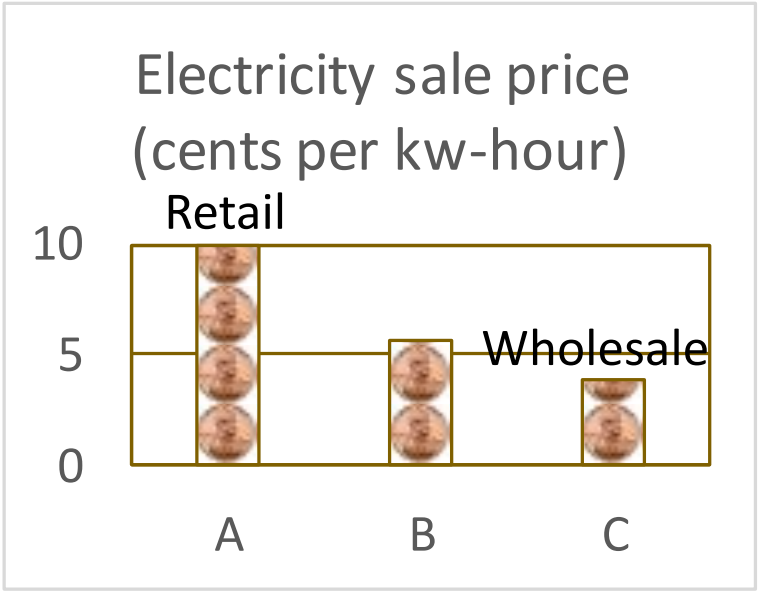


The following are slides for anticipated questions

Sales from owned turbines - Illustrated

A Net metering
B Parallel Generation
C Commercial scale



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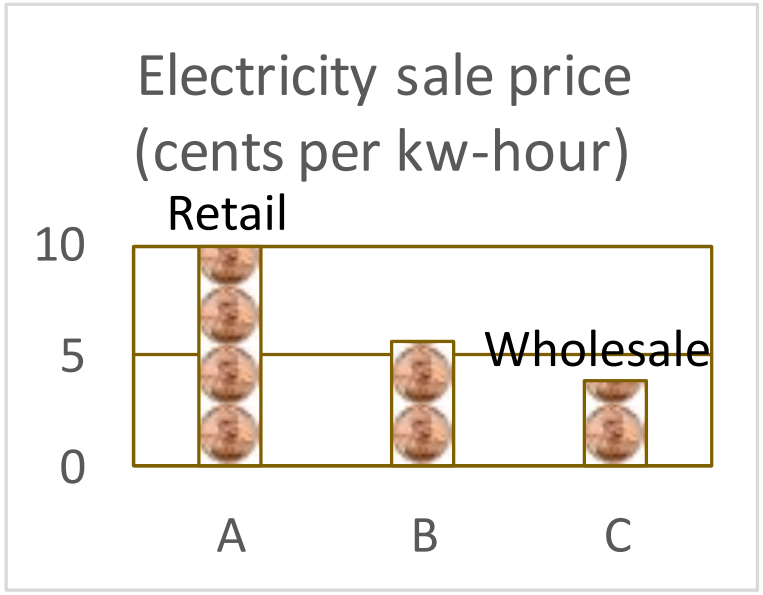

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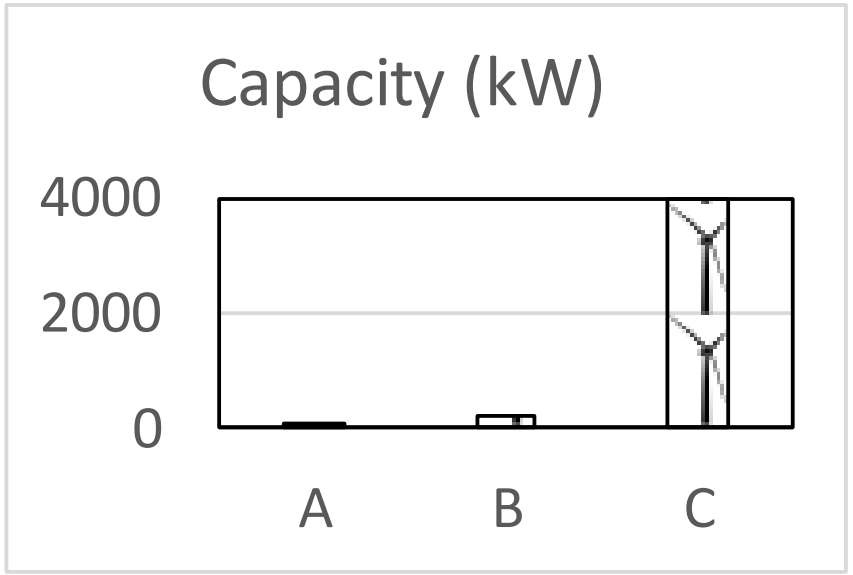

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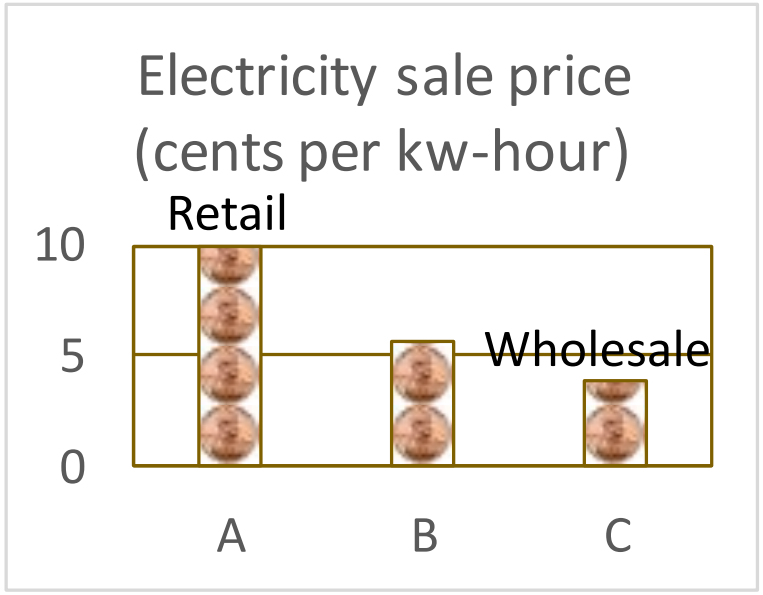

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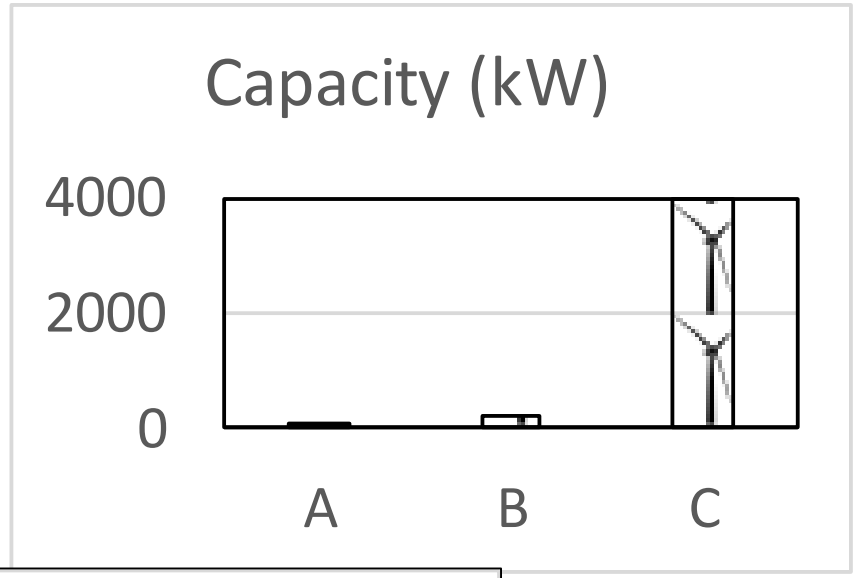
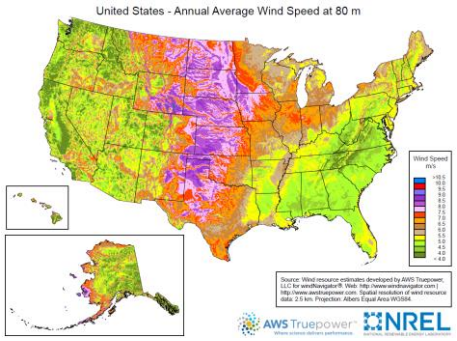
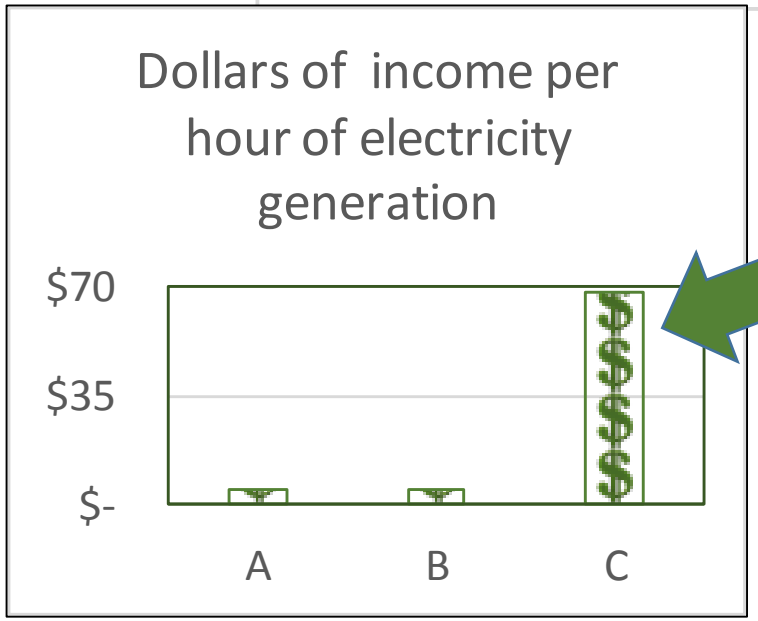


X 0.45 Production Factor =

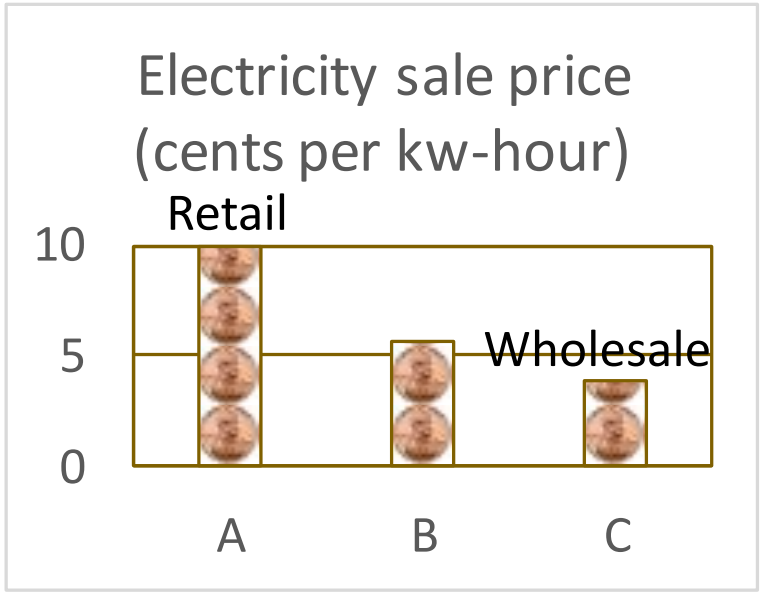




Explains “One turbine has changed my life”

Sales from owned turbines - Illustrated

A Net metering
B Parallel Generation
C Commercial scale



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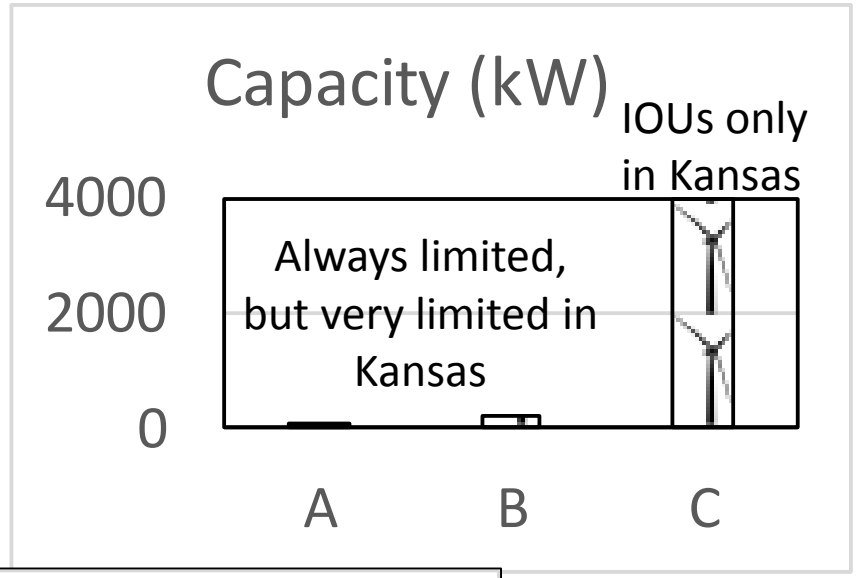
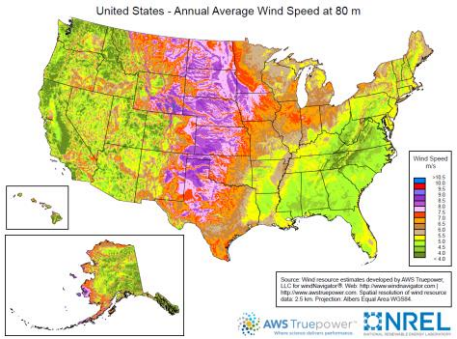
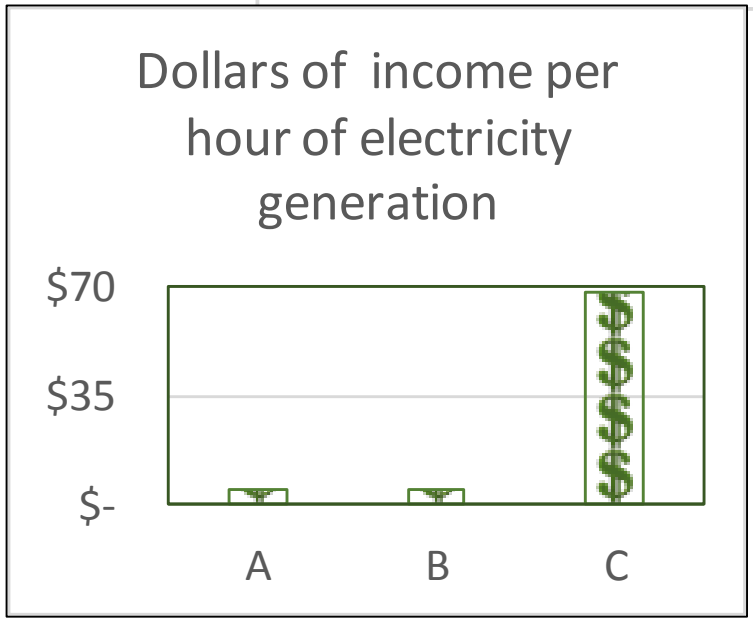


IOU: Investor Operated Utility, like Westar. KCC defines what is an IOU and thus who can own large wind generators in Kansas

X 0.45 Production Factor =

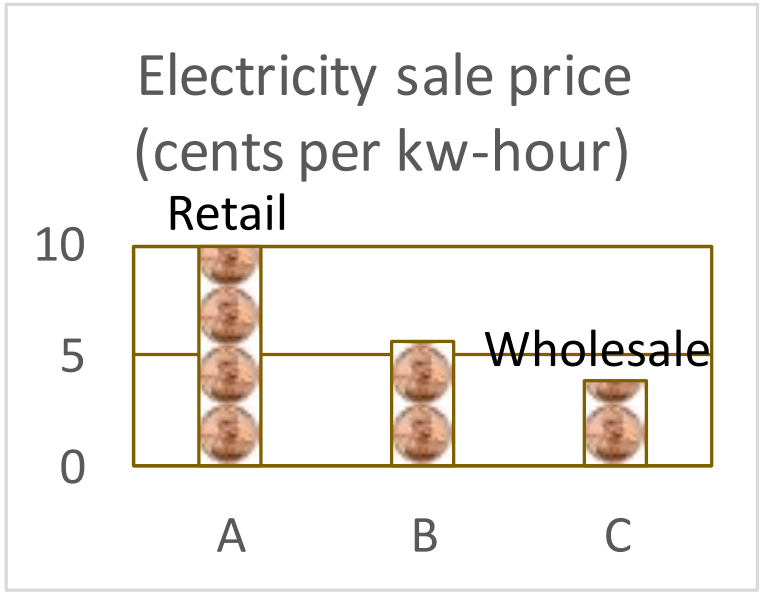




There are also restrictions relating to timing and percent of utility peak demand.

Sales from owned turbines - Illustrated

A Net metering
B Parallel Generation
C Commercial scale



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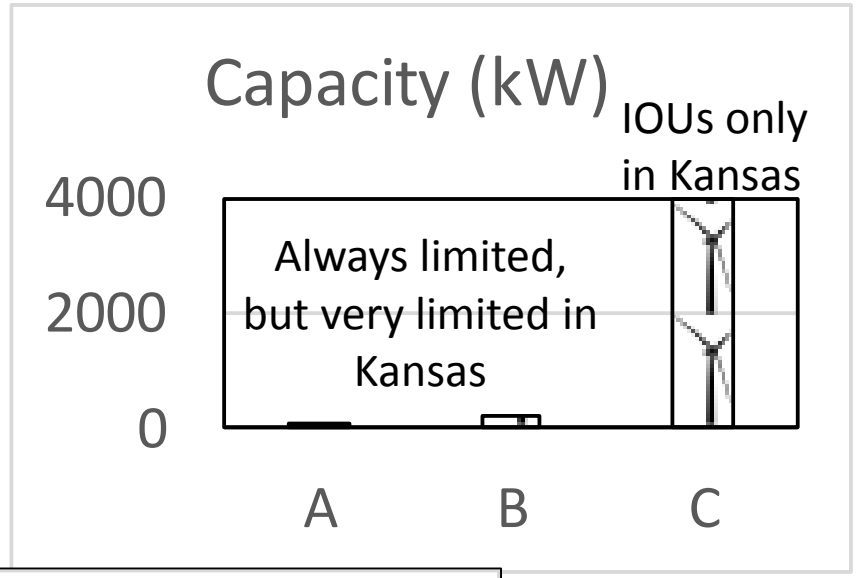

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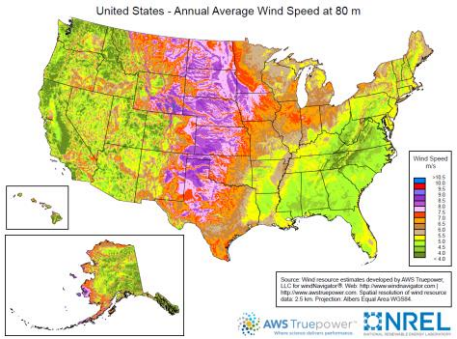
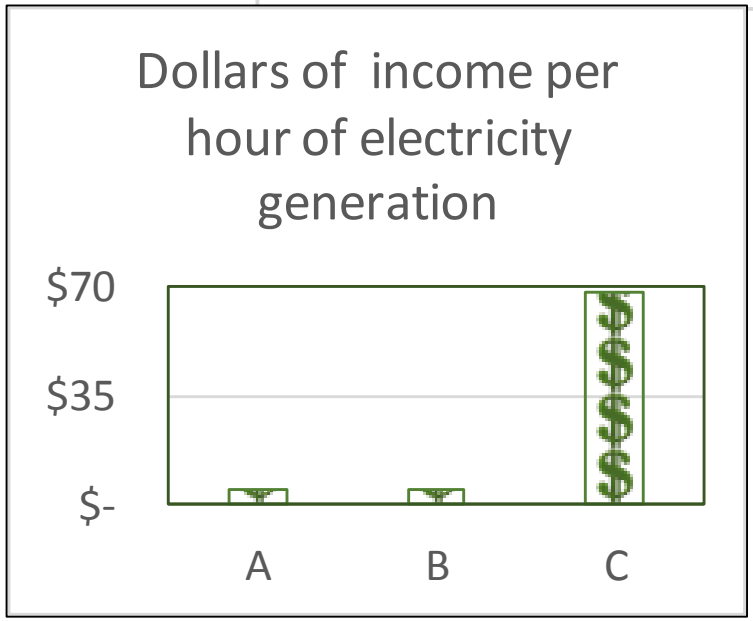




Additional factors: Restrictions relating to timing and percent of utility peak demand.

In all cases, Kansas restrictions mean less money for private land owners than in many other states.

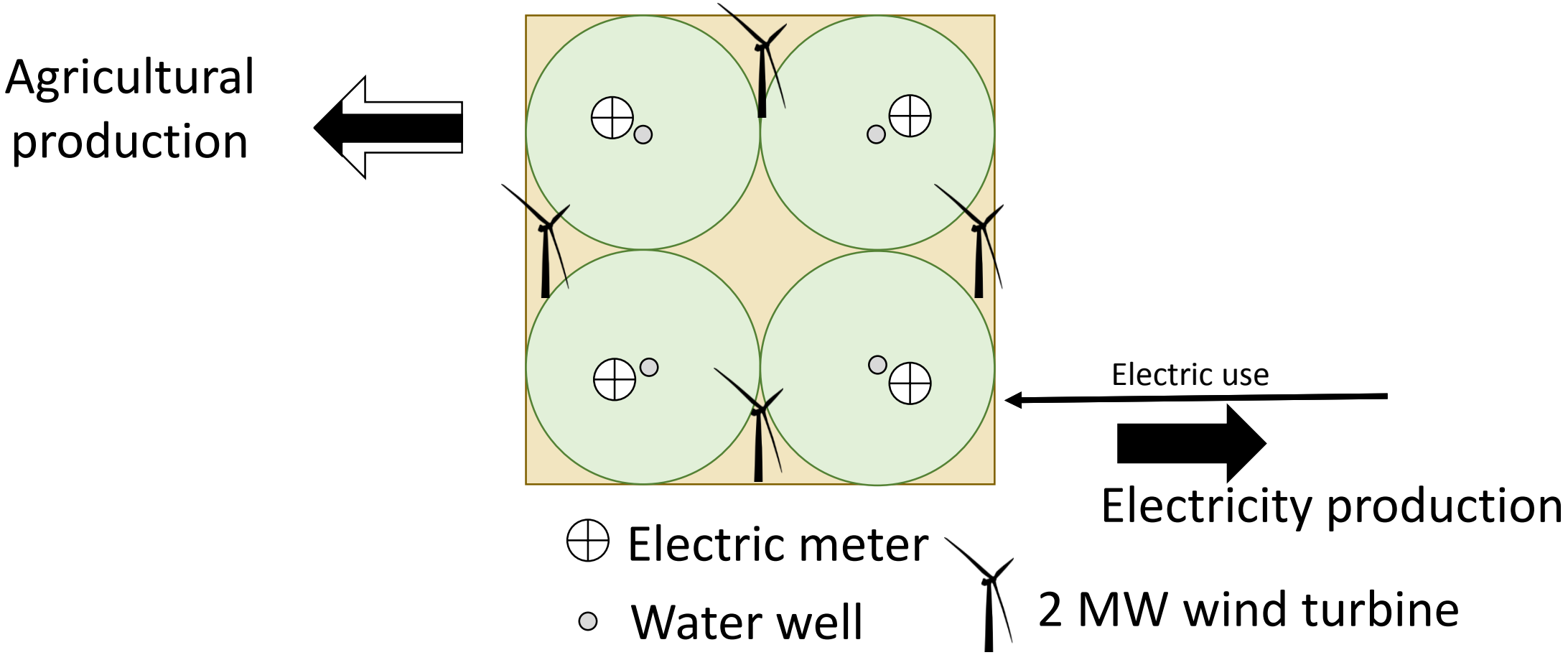
Farm Net Income Cartoon

Wind Energy Ownership

More complicated arrangement

Farm net income = 3 + 6

From agriculture and turbine



Kansas changes needed to support more locally profitable wind development

1. Special treatment of land owners/collectives who agree to water cutbacks for power sale rights.
   - Sell electricity to coops without KCC “utility” label
   - No generator size limit
   - Coops can sign PPAs* with landowners
   - Collectives are allowed.
   - Multiple meters under one contract.

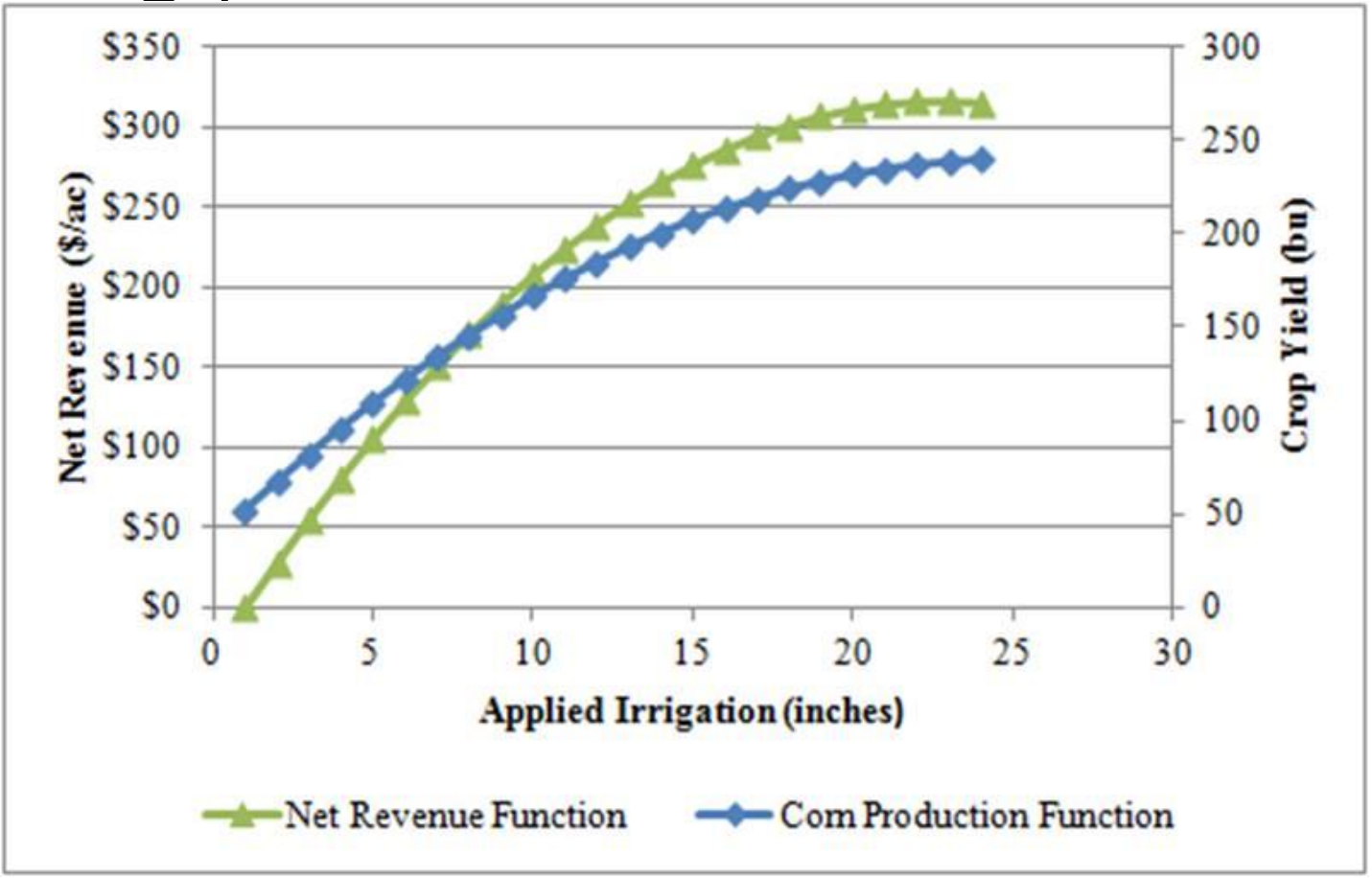
Necessary

Useful

2. Grid capacity:
   - Need lines and substations for MW-sized generators at landowner sites. Cost-share rules to pay for enhancements
   - Coop role bigger?

*PPA, Power Purchase Agreement: agreed sale price, typically for 20 yrs

Relate irrigation to ag production and income



For long forecasts include aquifer projections from KGS groundwater models

Calculate income from electrical generation

2 2MW wind turbines

Added annual income**= $67,184**

vs ~$12,000 for land lease

Income:

4MW x 365x24 hours/year x

45% x Production factor

$.038/kwh x Price for electricity

1000kw/Mw =

$599,184 **Total**

Expenses:

O&M $124,000 +

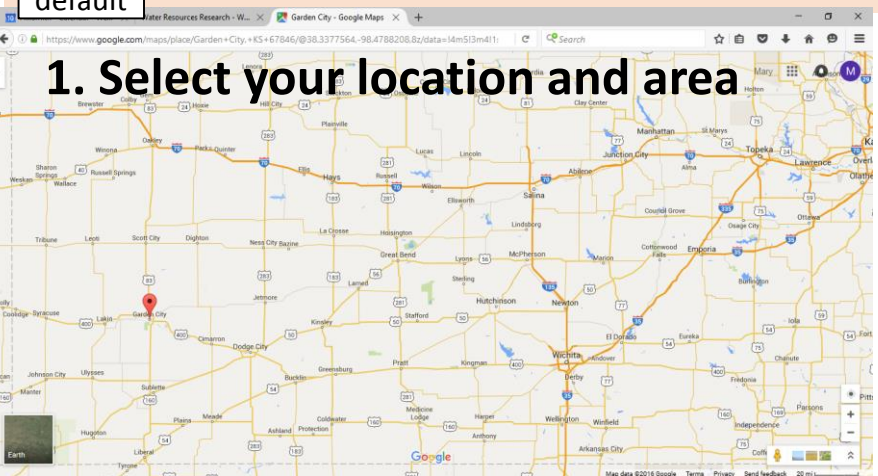
loan payment $408,000 Total

	2. Define Framework	3. Make Choices	Key knowledge Select, then click here for defaults	Consequences
Agri-culture				
Wind and Solar Energy				
Water				

Climate

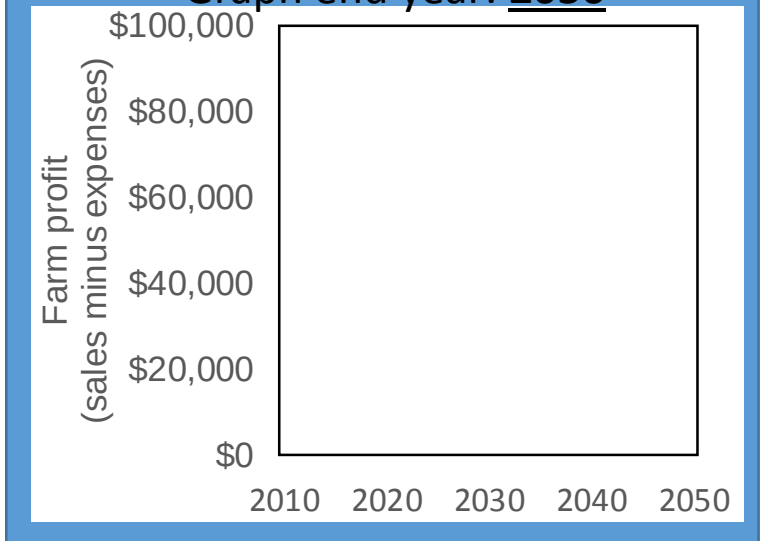
Click for default

1. Select your location and area



FAQs

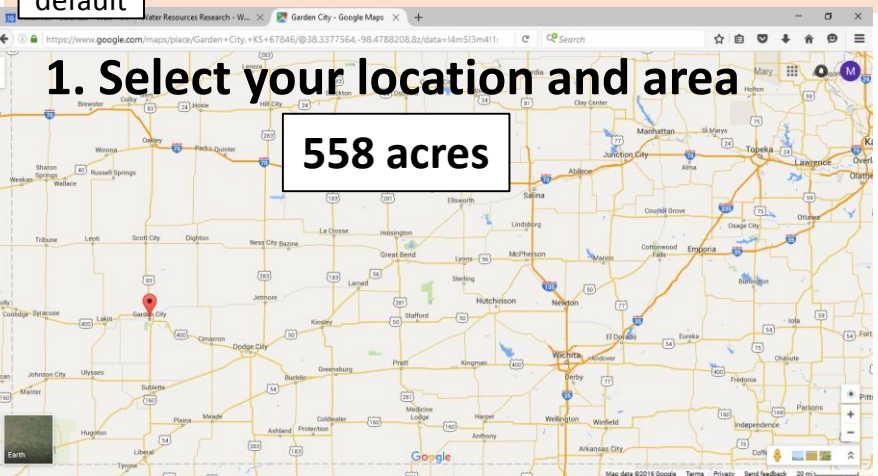
Graph end year: **2050**



	2. Define Framework	3. Make Choices	Key knowledge (Select, then click here for defaults)	Consequences
Agri-culture	**Field Crops** **Ranching** Use county defaults for crops, water, fertilize, prices, etc. OR Choose via Crop Water Allocation from KSU **CWA**			
Wind and Solar Energy	**Wind turbines** **Solar panels** **Buy** **Lease** **Rent land** Electric generation potential: Wind speed map is **HERE** Solar map is **HERE**			
Water	Irrigation: **Fresh Groundwater** HPA map from KGS is **HERE** Stories from your region are **HERE**			

Climate

Click for default

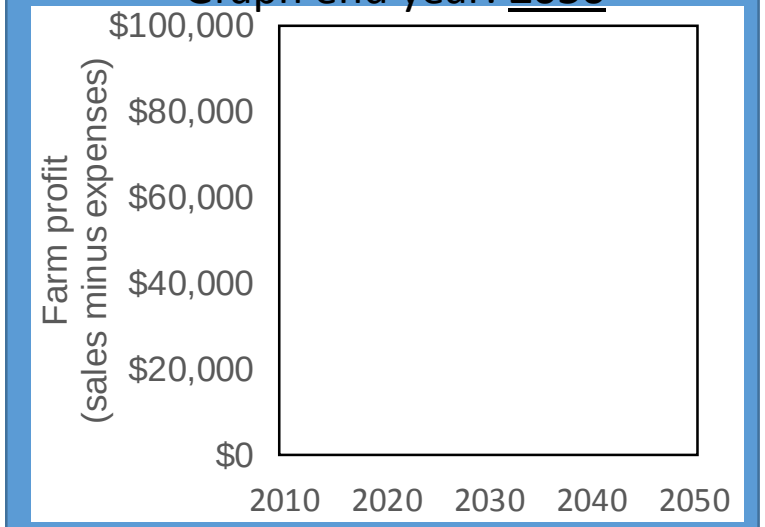


FAQs

Is it local pumping that is depleting the groundwater? **Click here**

How does weather variability affect agricultural income? **Click here**

Graph end year: **2050**



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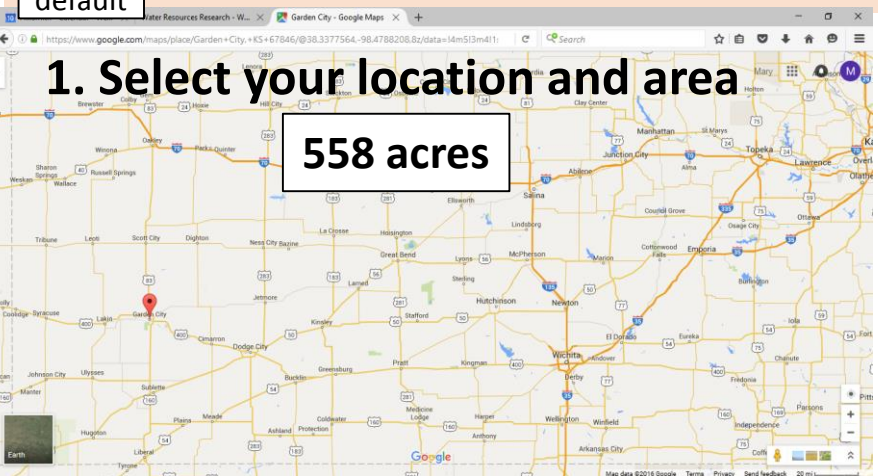
Agri-culture	**Field Crops** **Ranching** Use county defaults for crops, water, fertilize, prices, etc. OR Choose via Crop Water Allocation from KSU **CWA**	Subsidies, insurance **Options** Phase in period for irrigation change: **5 years** First year: **2017** Average past annual farm income: **$32,000**		
Wind and Solar Energy	**Wind turbines** **Solar panels** **Buy** **Lease** **Rent land** Electric generation potential: Wind speed map is **HERE** Solar map is **HERE**	Wind turbines **2** **2 MW** @. Loan: **20 years** APR **4%** Grid connection **needed**		
Water	Irrigation: **Fresh Groundwater** HPA map from KGS is **HERE** Stories from your region are **HERE**	Reduce irrigation by **25%** of **5** year average. Years to unable to irrigate? **Calculate** Soil condition? **Poor**		

Climate

Click for default



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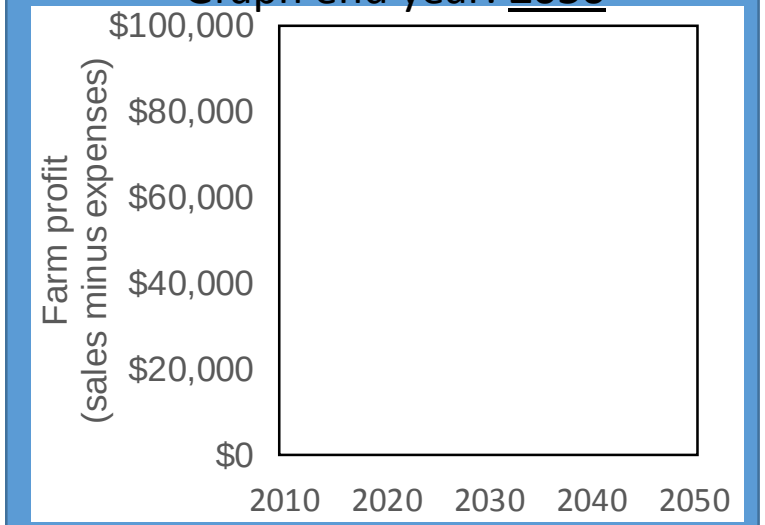

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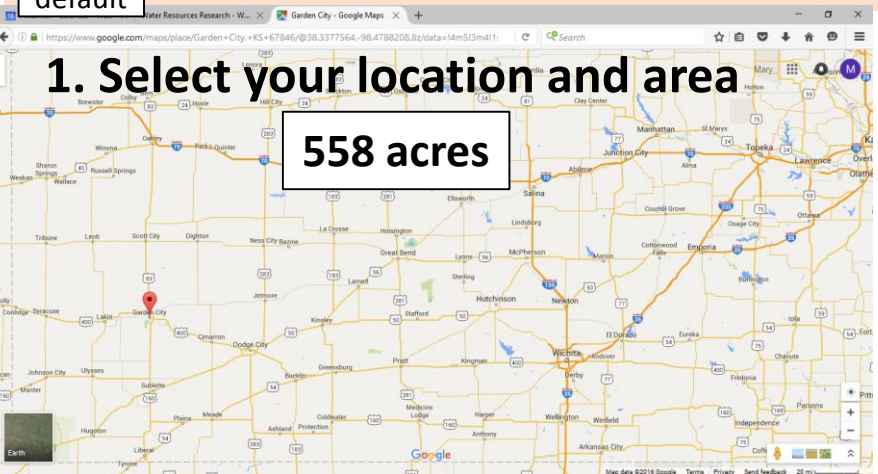
Water	Irrigation: **Fresh Groundwater** HPA map from KGS is **HERE** Stories from your region are **HERE**	Reduce irrigation by **25%** of **5** year average. Years to unable to irrigate? **Calculate** Soil condition? **Poor**	Precipitation **14" per year** Time to dry farming at historic pumping rates: **2054**. **See map** Years added per area-wide 25% pumpage reduction: **5-10**	

Climate Click for default

Assume: average change temp **+2º F** , precip **+0%** to **2080.** Drought probability scenario (DPS) **A**.
If temperature increases, precipitation must increase to see the same drought probabilities.



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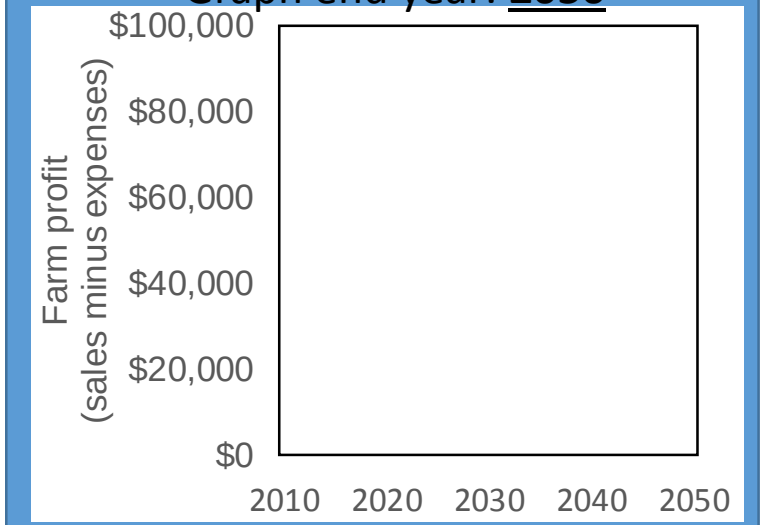

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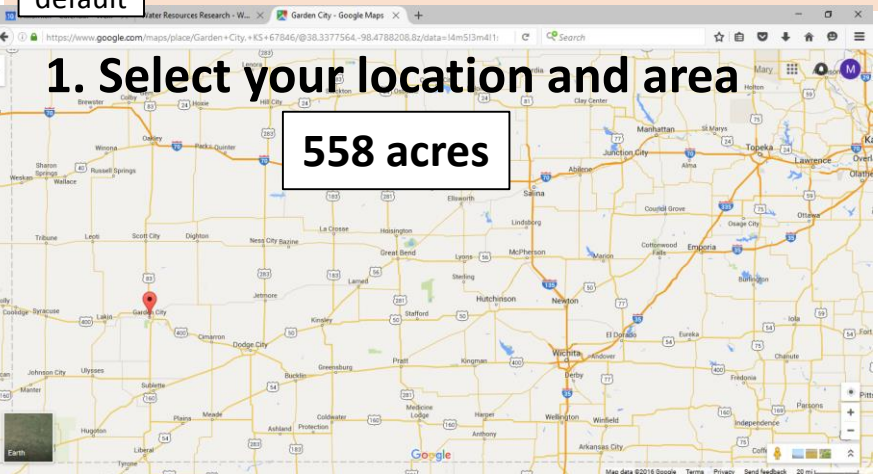
Climate Click for default

Assume: average change temp **+2º F** , precip **+0%** to **2080.** Drought probability scenario (DPS) **A**.
If temperature increases, precipitation must increase to see the same drought probabilities.



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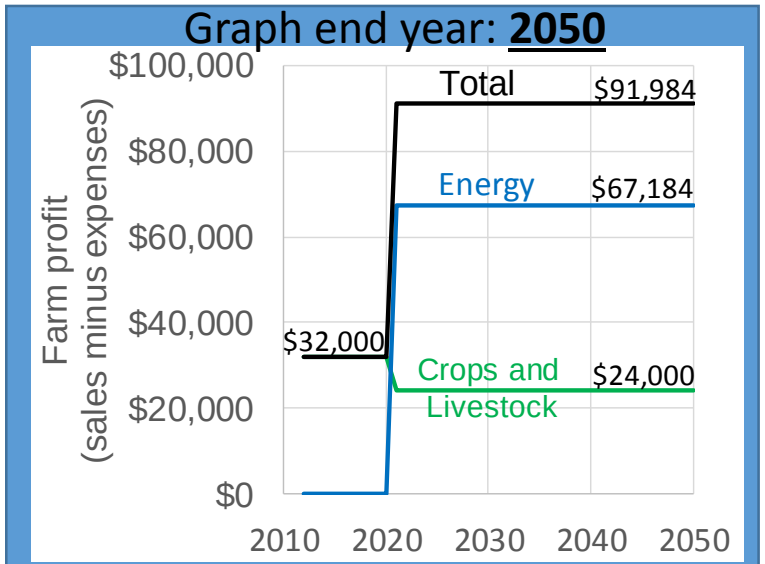


Farm Net Income Cartoon

Wind Energy Land lease agreement

No investment by the land owner

Farm net income = 3 + 0.5

From agriculture and land lease

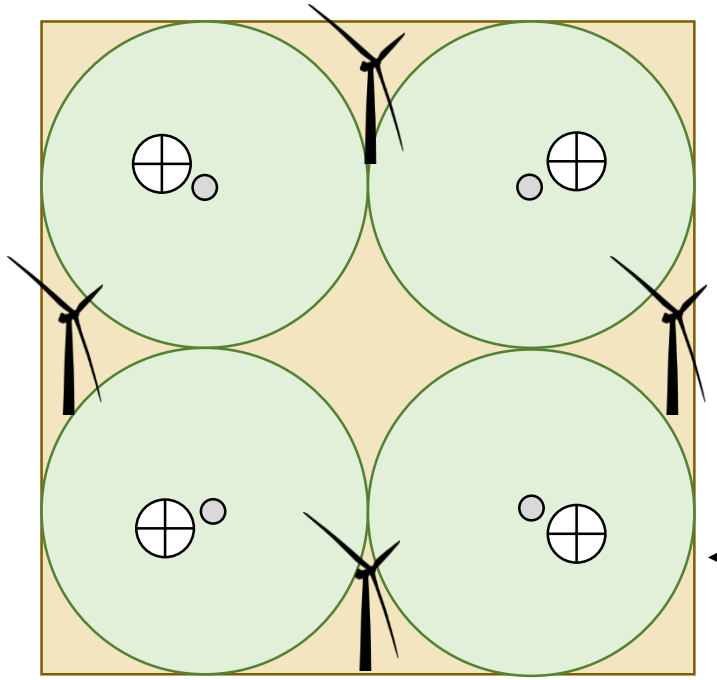
Electricity

Investor Owned Utilities

(IOUs, like Westar)

and Coops (like Sunflower)

Agricultural production



Trans-mission

IOU or Coop

Distribution

Electricity production

⊕ Electric meter

○ Water well

2 MW wind turbine