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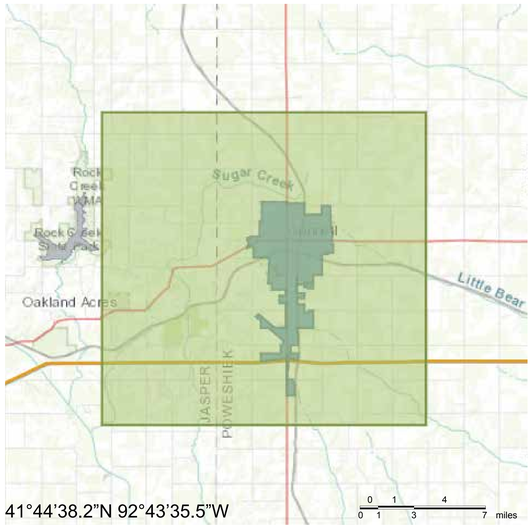


Agriculture and Energy in the Anthropocene: Alternative Futures for Grinnell, Iowa

Background

Located in the Tallgrass Prairie Region of the Great Plains, the landscape of Iowa is the most abundant source of grain and also one of the most highly altered in the United States. Rich deep soils have been drained, fenced, ordered into orthogonal fields; surface waters have been channelized and groundwater ordered through subsurface tiling.

The need for field access and farm to market roads have resulted in the densest road system in the country, a grid only interrupted by major river valleys, and steep topography. Providing the services needed to support people involved in agriculture have resulted in a settlement pattern with over 850 towns scattered throughout the state at regular intervals.

Objectives

As a city nested in an agricultural context, Grinnell is directly impacted by the environmental ramifications of changes in agricultural production. Of major concern are the impacts that current agricultural methods have on water quality, and on the increasing dependency by farmers for corn and soybean production: this results in low productivity, high water consumption, inefficient land use, and low yields.

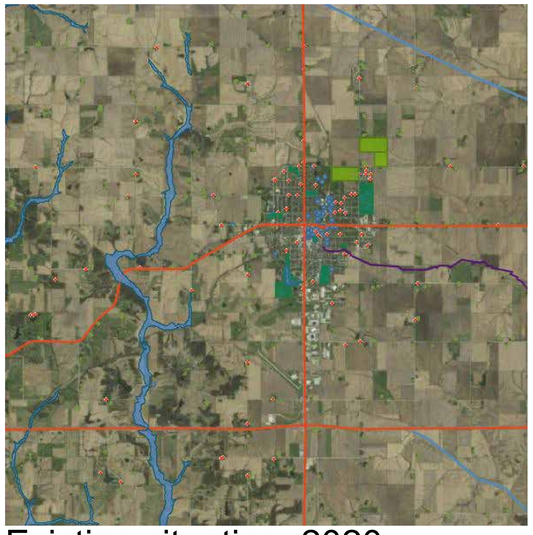
Through the lenses of agriculture and energy, the impacts of climate change in Iowa are modeled with local partners to describe, analyze, and experiment with strategies for future land use and lifestyles. Using geodesign methods, the process integrates current understandings of energy and agriculture systems based in science and technology with those emerging from social science and humanistic regarding rural life, values and decision making. Working with an integrated team of academics, off campus experts, and local stakeholders, the team coordinates discovery, communication, scenario building, and evaluation in a communicative planning process.

Five Major Requirements by 2050

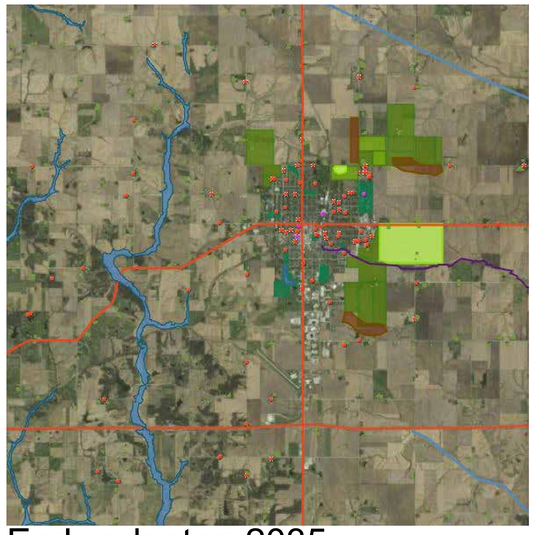
- Increase organic farming in the region by expanding the existing locations of organic farms.
- Improve life for low income communities.
- Improve soil quality in the areas of binary farming crops combining corn and soybean.
- Improve water quality.
- Attract young farmers to try alternative models of communities utilizing renewable sources of energy such as geothermal and solar.

Main Assumptions and Innovations

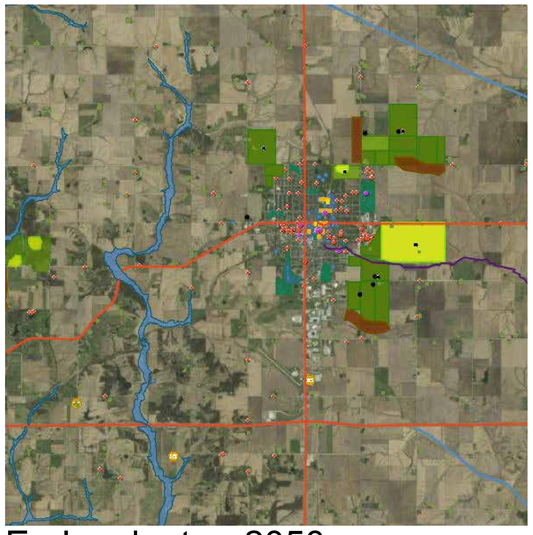
- Geothermal installations for public buildings and agricultural businesses
- Harvesting solar energy by installing solar roofs, designing and implementing solar roads and parking lots
- Expanding organic farming by building organic farms coalition
- Using agroforestry to prevent the drift from non-organic farms
- Testing algorithmic farming to increase the variety of planted crops



Existing situation: 2020



Early adopter: 2035

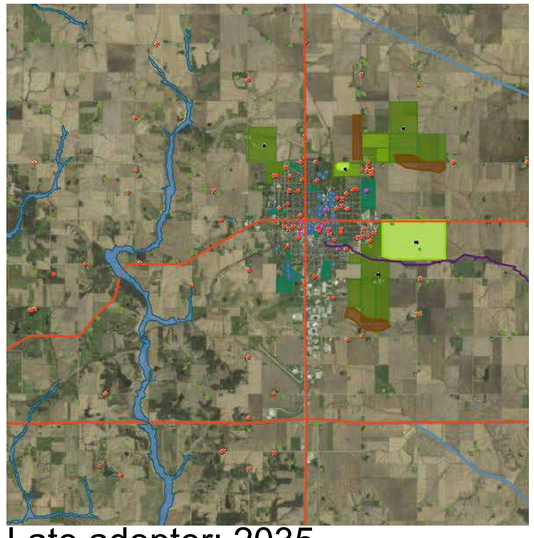


Early adopter: 2050

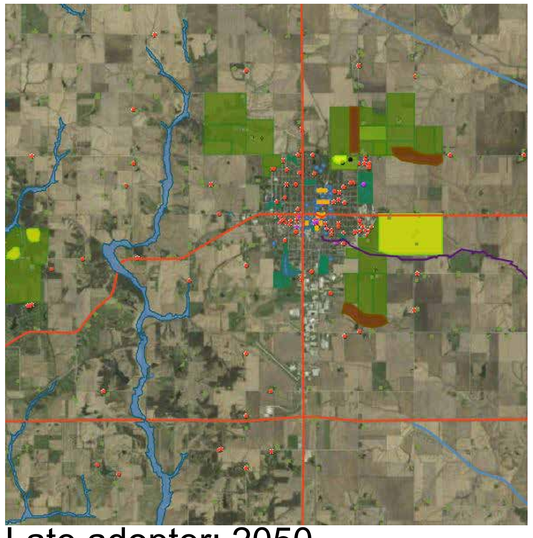
Grinnell

Grinnell is a small college town in Poweshiek County in Iowa, United States, located along the route of the future Rock Island railroad between the Mississippi and Missouri Rivers, and between Des Moines (the capital city of Iowa), and Iowa City. It is situated at the top of three major watersheds: the Iowa, the Skunk, and the English Rivers. The soils, native flora, and hydrological characteristics of the Grinnell area are diverse and representative of the region's geological and landform history including the relatively level Wisconsin till plain located to the northwest, the gently rolling Iowan Surface to the north and east, and the ancient, more deeply dissected Southern Iowa Drift Plain to the south.

It has a population of 9,218 as of 2010 census. The city was founded in 1854; in 1860 it had a population of 392 inhabitants. Recent growth of the populations shows low percentages of growth; 5.5% in 1980, 0.4% in 1990, 2.3% in 2000, 1.2% in 2010. A progressive city of Grinnell with its Grinnell College is aware of the consequences of climate change and concentrates on sustainability study programs and environmental protection initiatives.



Late adopter: 2035



Late adopter: 2050

Early adopter scenario

By 2035, the main focus is on expanding organic farming; 17 additional farms are joining the local subsidized program building an organic farms coalition. This will consequently improve the quality of the soil in this area and lead to the improvements in water quality. It will also attract young farmers, millennials with ideas for building alternative types of communities. Algorithmic farming will be applied as a test study on two bigger farms. Due to the wind and the consequences of drift, three agroforests will be planted at the beginning of 2020. The first results of these forests are expected to come to an effect by 2035.

The existing geothermal infrastructure/installations will be expanded by additional 21 residential geothermal installations (in red on the map), 7 geothermal public installations (purple) and 6 geothermal installations for the agricultural businesses (black). Algorithmic farming will be expanded to 4 farms. The agroforest will keep on growing, but no new planting has been envisioned. Harvesting solar energy will be achieved by installing 6 solar roads, solar parking lots, and 8 solar roofs. Three farmers will test the efficiency of a plug-flow digester.

Late adopter scenario

The main focus of this scenario is on building the infrastructure for organic farming and expanding the existing geothermal installations. Due to changing conditions in solar roofs getting cheaper and more accessible, this scenario envisions 8 solar roofs by the end of 2035. The geothermal installations are still central to this scenario with additional 11 residential installations (red), 7 public (purple) and 5 installed on farms. Three of the farms are testing algorithmic farming and three agroforests have been planted in 2020/21

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Organic farming is successful. Additional organic farms have been implemented. All together we experience a flourishing organic farming business with additional 25 organic farms. Geothermal installations are successful too and expanded by 21 residential installations (red), 7 public installations (purple) and 8 agricultural installations (black). Four organic farms implement algorithmic farming and the 3 planned agroforests are in full expansion and growth. Solar roofs are successful and 17 farmers install solar roofs. The 6 solar roads are still producing enough energy to keep them viable and maintain them.

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Exploring Innovations in Agriculture

Agroforesty

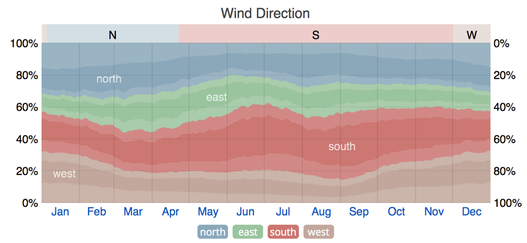
Agroforestry is a technique that uses trees or forest around farm to protect the crops and increased biodiversity.
The wind average in Grinnell is 10.3 miles per hour and it can be increased to 12.7 miles per hour in early April. Strong wind in Grinnell can be very challenging to the organic farmers. They have to deal with some of their crops that contaminated by chemical materials from plane spraying crops.
Thus, Agroforestry can be very benefit to help the farmers protecting their crops and they do not have to wait for another 3 years to be able to sell their crops as organic.

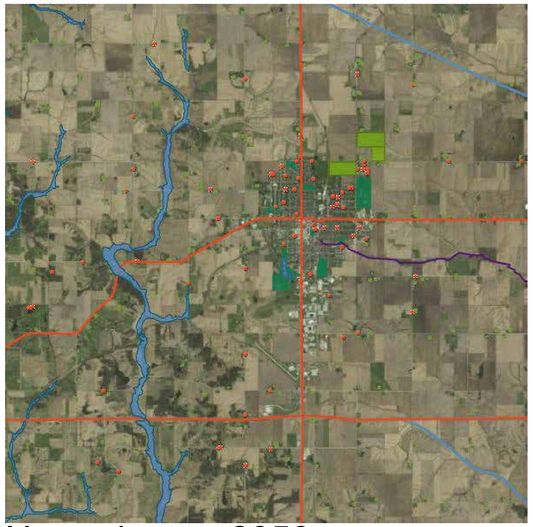
Wind Directions

Average wind direction in a year:

- April - December: Mainly from the south (42%)
- December - January: Mainly from the west (32%)
- It is concluded that the general direction of the wind is most often coming from the South West.

It would be advantageous for Grinnell to install agroforestry from the southern and western borders of there farmland.





Non-adopter: 2050

Non-adopter scenario

Loosing farms: Iowa lost 24,600 farms from 1982 to 1997, with 10,000 farms disappearing during the 1980s Farm Crisis. Since then, the state has lost another 8,000 farms according to the 2012 U.S. Agriculture Census.

Water quality: Intense binary farming rotation (corn and soybean) is the primary contributor to contamination of waterways in the state. In addition to washing away healthy and vital soil coagulates, run-off from this type of operation also adds chemical and manure run-off into Iowa's waterways.

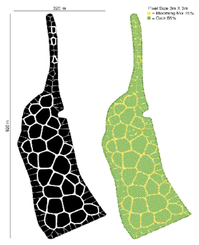
Soil quality: Soil is especially important in regulating runoff of storm water and in supporting trees, shrubs, lawns and gardens. Urban activities, such as construction grading, often result in erosion, sedimentation and soil compaction. Certain farming techniques reduce soil quality which may lead to lower farm yields, reduced productivity and less income from selling farm produce.

Shrinking rural populations. Iowa also faces the issue of shrinking population, and shrinking rural populations in particular. U.S. Census Bureau data shows that more than 60 percent of cities in Iowa lost population since 2010.

Algorithmic farming

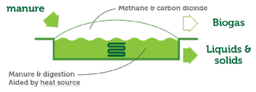
Algorithmic Farming is a new way of doing mixed crop farming. One thing that make it different from the traditional way is the use of technology to estimate the model of the mixed crops. Different technologies that help the farmers to do this technique are GPS and a design software that uses algorithm to determine the most effective layout of a mixed crop farm.

The benefits of this technique are time saving and having the most effective pattern of mixed plants and crops. Farmers can have an array of patterns for multiple biomass productions, creating a number of land-use solutions.This technique helps the organic farmers to continue being organic while also increasing the productivity. Also, by implementing Algorithmic Farming in Grinnell, it supports the idea of being a Smart-Farm town.



A plug-flow digester

A plug-flow digester is used to digest manure from animals and food waste, and can be collected with minimal contamination and delivered to a collection point. The gas from digestion produces electricity to power the farm. We envision the growth of renewable energy in Grinnell agriculture will be through the advancement of Plug Flow Digesters and other power reducing innovations.



https://www.rcmdigesters.com/rcm-technology/plug-flow/

Solar roads and parking coverage

Solar Roads -- a modular system of specially engineered solar panels that can be walked and driven upon.

- Made of specifically formulated tempered glass
- LED lights provide warning flashes during heavy traffic

Solar Parking -- adapting existing parking lots into sustainable energy producing assets with solar panel coverage

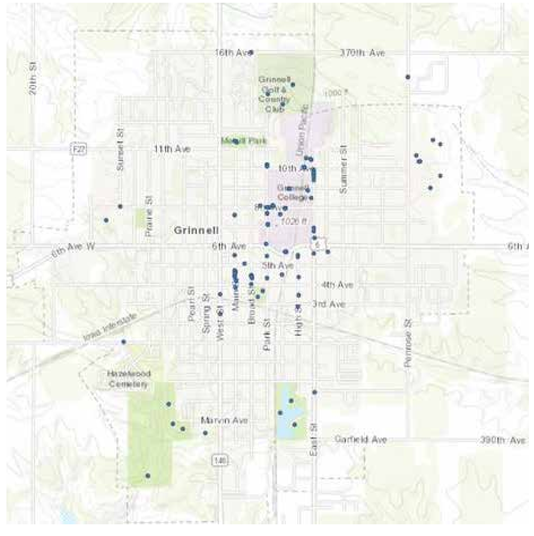
Geothermal power

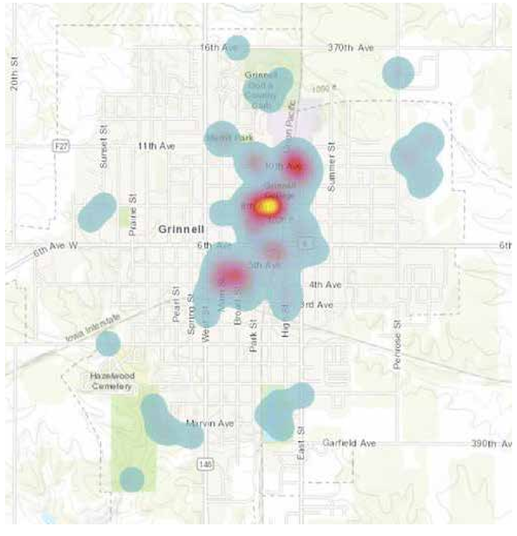
Uses an underground pipe system called an earth loop and traditional HVAC systems to heat and cool building.

- A typical home single family home of 2000 square feet, with a heating load of 60,000 BTU and a cooling load of 60,000 BTU will cost on average between $20,000 to $25,000 to install a new system.
- Price increases as square footage increases
- Return on investment in 2-10 years depending on load

Evocative Places in Grinnell

Evocative places are places that evoke images, memories and emotions. We are interested in understanding these intangible, emotional landscapes in the cities and how can they be visualized on a map. We involved over 60 students from the College of Grinnell. We asked them to map places at which they can relax and recharge, describing these places with three words and select words that best describe the emotions felt at these places. The image on the left shows the 180 places self-selected by the participating students. The image on the right shows the heat-map with high concentrations of evocative places in yellow and purple and low concentrations of evocative places in light blue.





Participating team credits

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