Fuel Stream Diversity

The University of Iowa's Balanced Approach to Zero Coal and Beyond

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Agenda

- University of Iowa Background
- Utility System Information
- University of Iowa Fuels Philosophy
- Individual Fuels – Pros and Cons
- Wrap Up
- Pop Quiz - chance to win a gift card!

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University of Iowa

- Comprehensive research university.
- Home to one of the nation's largest academic medical centers.
- 30,000 students. 14,000 employees.
- Over 2200 acres of campus.

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How much energy does the UI consume compared to my house?

- UI annual energy use is equal to:
  - 4,200 homes
  - 42,000 homes
  - 420,000 homes
  - 1,000,000 homes

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How much energy does the UI consume compared to my house?

- UI annual energy use is equal to:
  - 4,200 homes
  - **42,000 average Midwest homes**
  - 420,000 homes
  - 1,000,000 homes

* EIA.GOV RECS survey data table CE1.3 Midwest households

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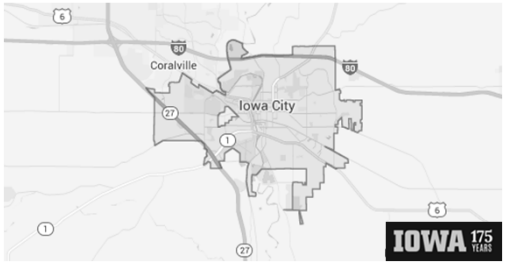
Annual energy use at UI is:



The same energy use as all of the homes in Iowa City

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UI Utilities System

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Steam for Various Uses

Building Cooling via 42F water

Electricity from Grid

Drinking Water

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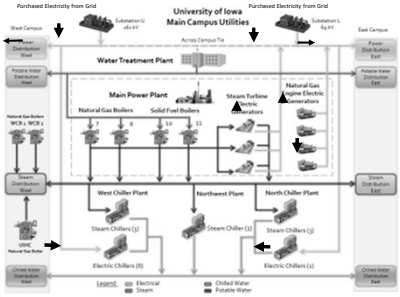
Iowa's Combined Heat & Power Overview

Energy in primary fuel converted to steam

Steam passed thru turbines to make electricity

Steam leaves turbines and goes out to heat buildings

Steam also runs chiller plants to cool bldgs



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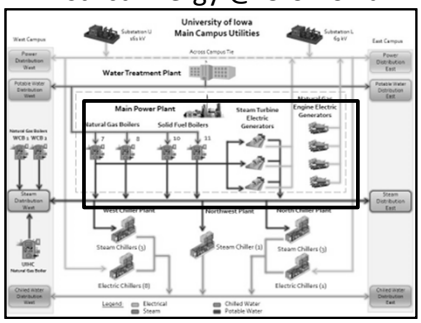
District Energy @ U of Iowa



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UI Main Power Plant

- Combined Heat & Power facility with 755,000 lb/hour (1500 gpm) steam capacity at 500 PSI
  - 3 Natural Gas boilers
  - 2 Solid Fuel boilers
    - One of which can burn gas
  - Remote auxiliary gas boilers
- Electric generation capacity from steam = 29MW
  - Typically co-gen ⅓ total demand, with ability to generate more if economical
  - Additional 8MW from natural gas generators
- Total Campus Peak Demand 70 MW
- Fuel budget ~$14M

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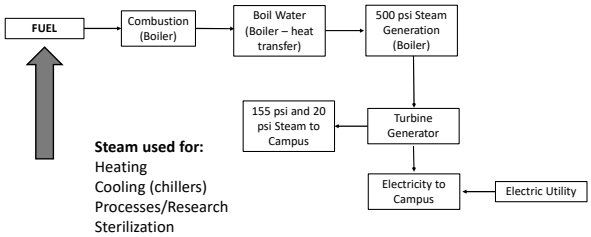
Simplified Flow Diagram



Steam used for:
Heating
Cooling (chillers)
Processes/Research
Sterilization

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Iowa Winter

Brrrrr….We Need to Make Some Heat !!

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Iowa Summer

Yikes….We Need to Cool Off!!

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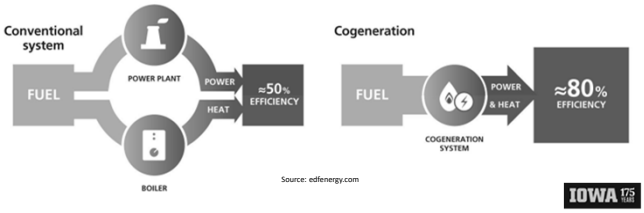
Cogeneration – Efficient Use of Fuel

Definition of *cogeneration*: the production of electricity using waste heat (as in steam) from an industrial process or the use of steam from electric power generation as a source of heat



Source: edfenergy.com

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Fuels Selection

- Not “one-size-fits-all.”
- Every energy district will have its own priorities.
- UI seeks to balance a number of interests in its fuel selection and off-coal planning.
- UI community places priority on renewable fuels, while understanding it can’t jeopardize reliability and resiliency.

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UI Fuels Philosophy

- UI is committed to a multi-fuel strategy for energy security
  - Switching to 100% natural gas is not considered a viable option
- Biomass functions as hedge against natural gas supply interruptions, pricing volatility
- For UI, replacing coal makes the most significant environmental impact. Goal of zero-coal by 2025
  - Transition must be conducted economically
- Reliability and Resiliency of the Utility system will not be compromised.

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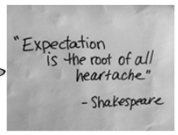
Reliability


Economics


Sustainability


Available Technology



Stakeholder Expectations

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UI Renewable Energy Strategy

- Two solid fuel Boilers #10 and #11, will convert from coal to renewable fuels. (Boiler 10 transition is complete).
- Three fuels will replace coal: oat hulls, Convergen renewable fuel pellets and miscanthus grass.

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UI Renewable Energy Strategy

- Generally, wind and solar are left to electric utility companies – EPA Green Power Partnership
- Solar and wind do not necessarily help UI replace coal. Electricity only accounts for roughly 25% of campus energy use.

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EPA Green Power Partnership

- Mid American Energy electrical supply to UI Main Campus is 88.5 % renewable (wind).
- Alliant Energy electrical supply to UI Oakdale Campus is 43.8% renewable (wind and solar).
- Current EPA GPP Rankings (as of July 28, 2022)
  - #2 --Top 30 College & University List of the largest green power users
  - #52 – EPA Top 100 Green Power Companies
  - Formerly #24 --Top 30 College & University On-Site Green Generation List – main turbine currently down for extended overhaul

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Iowa recognized by EPA as top green power user

By FACILITIES MANAGEMENT | 2022.02.03 | 07:38 AM

The University of Iowa, which recently became a U.S. Environmental Protection Agency (EPA) Green Power Partner, is recognized on several of the **EPA's Top Green Power Partner Lists.**

About EPA's Green Power Partnership

The Green Power Partnership is a voluntary program that helps increase green power use among U.S. organizations to advance the American market for green power and development of those sources as a way to reduce air pollution and other environmental impacts associated with electricity use. For additional information, please visit www.epa.gov/greenpower.

"This list of the largest users of green power across the nation is proof that good business practices can also benefit the environment," said James Critchfield, Program Manager of EPA's Green Power Partnership. "EPA applauds the leading organizations in the Green Power Partnership's Top Partner Rankings for their notable commitment to expanding their use of green power and protecting the environment."

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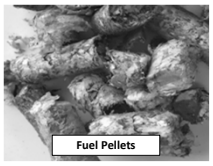
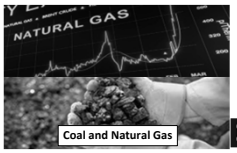
Current Fuels at UI


Fuel Pellets


Oat Hulls


Miscanthus Grass



Coal and Natural Gas

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Coal

Pros:
- Energy dense
- Relatively economical to ship (barge, rail)
- Material handling - easy to convey
- Historically economical
- Proven technologies

Cons:
- Environmental Impact
  - -Mining
  - -Emissions
  - -Ash disposal
- Expensive emission controls required
- Recent price volatility

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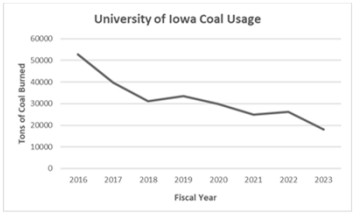
Coal – Next Steps

Goal: Zero coal by 2025



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Natural Gas

Pros:

- Can be relatively cheap
- Low maintenance boilers/infrastructure
- Reliable supply
- Inexpensive transport
- Can be pre-purchased when price is low

Cons:

- Extreme pricing volatility
- Not renewable
- Environmental impacts of extraction

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Natural Gas – Next Steps

Using natural gas helps the UI maintain reliability while replacing coal with biomass. Natural gas also allows our operations team to use existing assets and infrastructure.

UI has not pursued a strategy of switching to 100% natural gas to get off of coal, but instead focuses on development of a diverse energy portfolio focused on renewables.

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Engineered Fuel Pellets

- Convergen Energy (CE) produces renewable engineered fuel pellets under the U.S. EPA Alternative Fuels Program. These fuel pellets are classified by U.S. EPA as non-hazardous, non-waste materials and are obtained from manufacturers and are comprised primarily of fiber/paper material (60 to70%) and clean plastics (30 to 40%).

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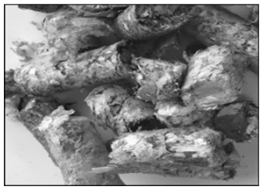
Engineered Fuel Pellets

Non-recyclable feedstock materials include:

- Non-Woven polyethylene fabrics
- Paper
- Label Matrix
- Non-Chlorinated Plastics
- Flexible Packaging & Films
- Release Liner
- Nylon
- Miscanthus grass
- Oat Hulls



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Engineered Fuel Pellets

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Engineered Fuel Pellets

- CE's engineered fuel pellets are designed to provide a fuel that is low ash, low moisture, and high energy and works well in many solid fuel type boiler systems.
- The pellet is low in emissions compared to many other solid fuels. Compared to coal, CE fuel is low in CO, lower in NOx, lower in Sulfur, and lower in Mercury (Hg).

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Engineered Fuel Pellets

- Low ash, low moisture, high Btu fuel for solid fuel boilers.
- Are an approved EPA alternative fuel and are classified as "non-hazardous, non-waste".
- Work efficiently in many existing industrial, commercial, municipal, utility, and institutional solid fuel boilers. **– Low capital costs to implement**
- Have lower emissions compared to many traditional solid fuels.
- Can meet the Industrial Boiler MACT and Utility MATS regulations with a minimum of capital and operating costs.
- Can provide better economics than coal or natural gas in many cases.

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Engineered Fuel Pellets - Renewable Determination

The EPA no longer makes rulings on whether a fuel is "renewable."

EPA Green Power Partnership accepts the pellet fuel in its percent-renewable calculations.

UI bases its determination on:
1) The criteria for renewable fuels in states that have a renewable portfolio standard.
2) Calculations on renewable fuels used by the EU.

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Why Engineered Fuel Pellets?

Pros:

- Renewable solid fuel
- The consistent pricing of CE fuel provides the University with an excellent hedge against commodity fuels including coal and natural gas
- Allows us to burn oat hulls – Circulating Fluidized Bed (CFB) Boiler
- Allows us to convey and combust miscanthus in the boilers
- Can customize the "recipe"
- Low capital investment, drop-in coal replacement.
- Better emissions than coal (60% improvement in CO2 emmissions)
- Divert material from landfills (waste and cost reduction for industrial partners)
- Cost competitive $/BTU

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Why Engineered Fuel Pellets?

Cons:

- Combustion of plastic – public perception
  - -UI College of Chemistry collaboration
- Reliant on factory production
- Slight variability in available feedstocks
- Volumetric constraints – conveying and combustion
- Long term Outdoor storage – weathering
- Chlorine content – HCl emission control

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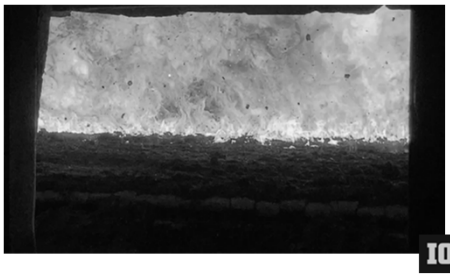
Engineered Fuel Pellets

(click to view video)



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Engineered Fuel Pellets – Next Steps

- With partners, develop a local renewable energy pelletizing facility in Iowa to turn non-recyclable material into renewable pellets, keeping material out of the landfill.
- Continue to improve the processes to utilize miscanthus in renewable pellets.
- Continue experiments with torrified fuels.
  - Torrefaction has potential to increase available feedstocks, and decrease cost of emission controls

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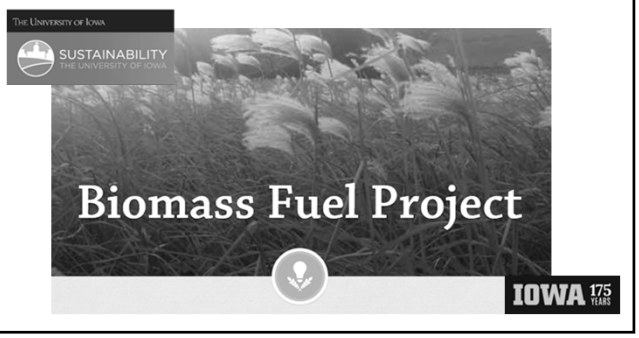

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Biomass Fuels

- Naturally, the utilization of biomass fuels works more efficiently where the energy source and the end user of the energy produced are physically close.

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Oat Hulls -- Industrial By-Product

- UI has been burning oat hulls for energy since 2003
- Public-private collaboration created a new market for previously-discarded materials
- Sourced from Quaker Oats in Cedar Rapids, IA
- 30,000 to 40,000 tpy
- Displaces roughly 1000 truckloads of coal/year

sustainability.uiowa.edu/initiatives/biomass-fuel-project/

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Why Oat Hulls?

Pros:

- Renewable solid fuel
- Consistent pricing provides the University with an excellent hedge against commodity fuels including coal and natural gas
- Energy dense
- Displaces coal with better emissions
- Local source – shipping / diesel fuel

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Why Oat Hulls?

Cons:

- Specialized trailers for transport
- Must be pneumatically conveyed into boiler or pelletized
- Factory schedule – supply interruptions
- Sizeable storage required

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Quaker Oat Hulls – Next Steps

- Maintain collaborative relationship with Quaker Oats to secure stable supply
- Evaluate increase in on-site and off-site storage
- Potential feedstock for local pellet plant

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Miscanthus Grass

- Miscanthus x giganteus (MxG)
  - Partnership with AggrowTech LLC and Iowa State University Agronomy .
  - Approximately 1100 acres planted since 2015

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Why Miscanthus?

Pros:

- Iowa conducive to agriculture
- Perennial crop, no ongoing establishment costs
- Efficient to harvest
- Grows on marginal land (low CSR)
  ~15% of land within Iowa fields not profitable in corn
- High seasonal growth rate (energy dense)
- Keeps fuel spend in local economy
- Provides long-term, stable income to Iowa's growers.
- Environmental benefits

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Miscanthus – Environmental Benefits

- Currently UI is sequestering approximately 245 tons of carbon annually.
- We are quantifying nitrogen and phosphate uptake from the soil. Current research shows energy crops performing more effectively at nitrate reduction than most current conservation practices -- 70-80% effective nitrogen removal compared to 30% for cover crops.
  (pg 36 https://www.nutrientstrategy.iastate.edu/sites/default/files/documents/NRSfull-130529.pdf)
- Erosion control and Water quality

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Why Miscanthus?

Cons:

- Land price tied to price of corn
- Expensive to ship unless densified
- Harvest cost currently tied to price of diesel
- Requires some form of processing for energy use
- Birds
- Storage – seasonal harvest

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Miscanthus Harvest

- Miscanthus is a very efficient crop to harvest.
- It naturally dries in the field, reducing harvest and logistic costs per ton, when compared to high moisture crops.
- We have developed a process to harvest during poor weather conditions that would typically limit harvest times for traditional crops.
- Our current farms have allowed us to improve the harvest process over time.

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Miscanthus Harvest

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Harvest Drum Designs

John Deere

CLAAS

				
Drum type	MaxFlow	MaxFlow	MaxFlow	Ringos drum
No. of knives per drum	29	28	36	40
LOC	5 - 31 mm	4 - 22 mm	3 - 17 mm	2.5 - 15 mm

Crone

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117 MMBtu per year

- How many acres of Miscanthus would you need to provide energy for the average midwest home for one year?
  - Less than 1 acre
  - 10 acres
  - 100 acres
  - 1000 acres

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117 MMBtu per year

- How many acres of Miscanthus would you need to provide energy for the average midwest home for one year?
  - **Less than 1 acre**
  - 10 acres
  - 100 acres
  - 1000 acres
  - **0.75 acres**

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Miscanthus Program Additional Notes

- While we await new local pellet plant, some of the product is being used to support emerging markets in animal bedding, erosion control, and other retail miscanthus-based products.
- This bridge has further allowed us to better understand the production and supply dynamics as we move our project forward.
- We are not currently using product as a feedstock for biogas digesters, but there is opportunity for successful projects in this realm.

Torrified Miscanthus Pellets

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Today Show Clip

https://www.today.com/video/biden-is-latest-candidate-to-meet-iowa-farmer-leading-the-charge-on-climate-change-73992773539

UI Student Documentary

Link:

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Miscanthus – Next Steps

- Development of local pellet plant. Currently miscanthus can make up 10% of the engineered fuel pellet (with the rest comprised of non-recyclable paper, pulp and plastic products). We are testing ways to increase percentage.
- Increase bulk density to reduce cost of storage and trucking
- Continue improving harvest efficiency and logistics

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Miscanthus Program:
We Thank Our Partners and Supporters

AGgrow TECH | Iowa State University Department of Agronomy | DNR | FSA Farm Service Agency | CONVERGEN | Tippie College of Business | USDA | Iowa Department of Agriculture and Land Stewardship | Facilities Management | The University of Iowa College of Engineering | The University of Iowa Sustainability | IOWA 175 YEARS

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UI Fuels – Into the Future

- Continue on path to zero coal
- Reduce natural gas usage
- Implement programs that promote efficient use of fuel
- Local pellet plant, continue fuel pellet innovation
- Implement electrification where economics permit
- Negotiate long-term supply agreements to ensure stability
- Continue partnering with academic and industry experts
- Minimize costs and risks for Iowa taxpayers

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In Closing

- Improve UI's energy resiliency through multi-fuel strategy
- Sustainability is more than just fuel choices – requires an efficient use of fuel. UI champions energy conservation programs, efficiency focus, and combined heat and power infrastructure.
- Maximize economic benefit for local economy
- Pop Quiz – Chance to win a gift card!

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Thank You!
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The University of Iowa's
Balanced Approach to
Zero Coal
Fuel Stream Diversity
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