Synergies in FEW in the Northern Great Plains: a North Dakota Perspective

NSF Food Energy Water Nexus Workshop
October 19–20
Rapid City, South Dakota

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Energy & Environmental Research Center (EERC)

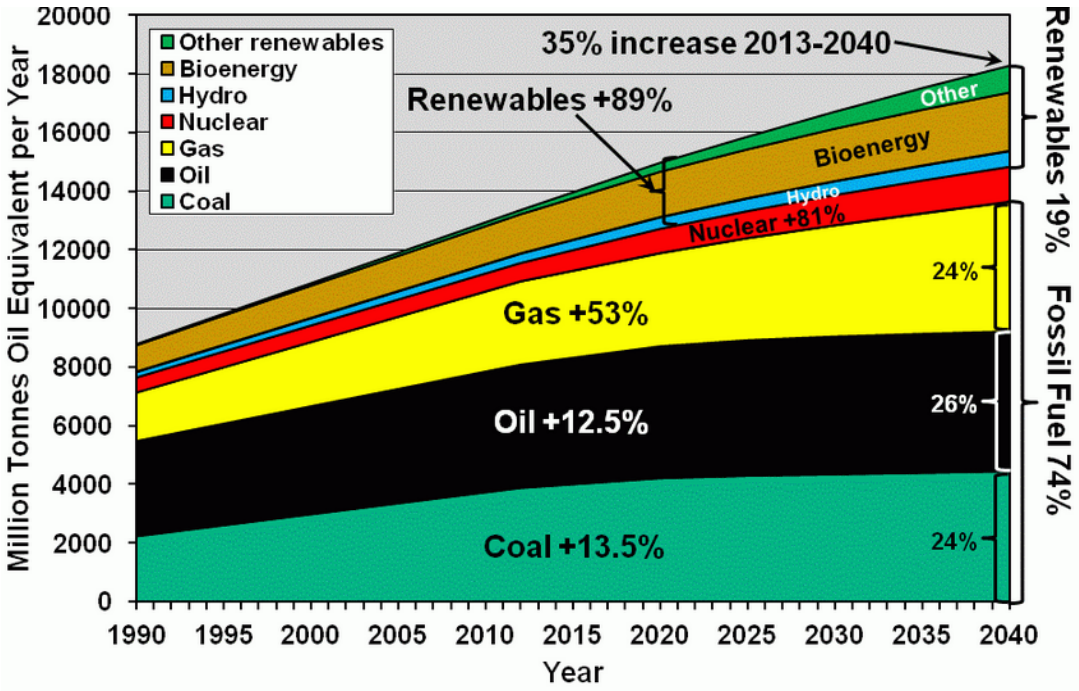
- Nonprofit branch of the University of North Dakota focused on energy and environmental solutions.
- More than 254,000 square feet of state-of-the-art laboratory, demonstration, and office space.

Presentation

- World and US energy picture and challenges
- Challenges to traditional energy production
- Regional synergies and the rise of Middle America
- Research and sustainable clean energy
- ND energy synergies

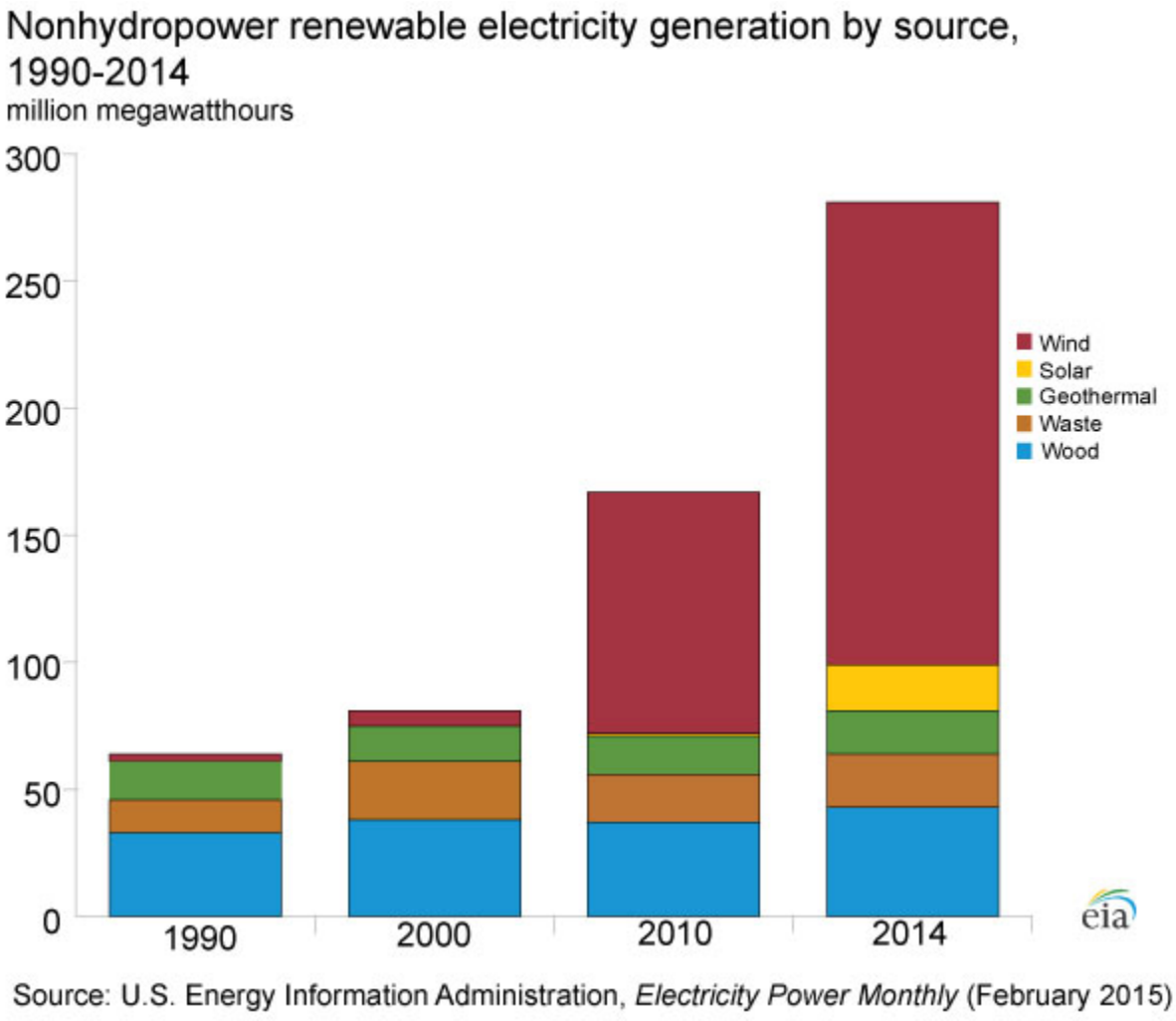
World Energy Consumption
(Liquid Transportation Fuels *and* Electricity)

- U.S. Energy Information Administration (EIA)
- 1990 – 2040 the world's energy types and growth
- Every form increase; largest increases in gas and renewables **but** . . .
- Fossil fuels still dominate



Also, U.S. Energy Information Administration, World Energy Outlook – New Policy Scenario, Percent Increase 2013 to 2040.

Growth of Renewable Electricity
(mostly wind and solar)



Source: U.S. Energy Information Administration, *Electricity Power Monthly* (February 2015)

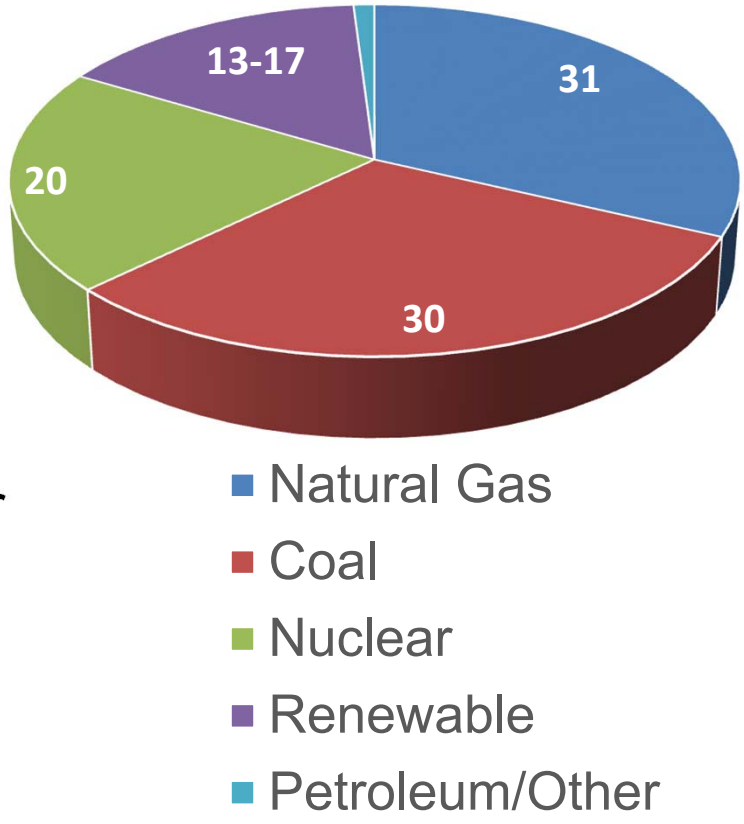
EPA

- EPA's New Source Performance Review, MATS, Clean Power Plan, and other regs
  - Create tremendous investment risk even on clean power options such as ultrasupercritical boilers with full emissions control
- EPA CPP: Cutting CO_2 from power plants by 32% by 2030 (as compared to 2005 levels).
  - State plans by 2016 with 2-year extensions
  - Implementation: 2022
  - State plans going forward even with uncertainty of political process; lawsuits. etc.
  - ND must cut back GHG emissions 45%.

Monday, August 3, 2015
President Obama released the final version of the Clean Power Plan (CPP)—an EPA program to cut carbon dioxide emissions from the nation's power plants.

U.S. Electricity Generation, 2015
(EIA, Electricity Monthly, February 2015)

- 2014 shows coal dominance
- 2014−2015 showed dramatic change
- Spring 2015: natural gas overtook coal as the top source of U.S. electric power generation for the first time ever
- Renewable (13-17%)
  - Hydro 8%
  - Wind 5 %
  - Biomass 2%
  - Solar-Geotherm-Other 2%



AP News July 2015-- Natural Gas Surpasses Coal as Biggest US Electricity Source
Jul 13, 2015, 12:56 PM ET
By TOM MURPHY AP Business Writer

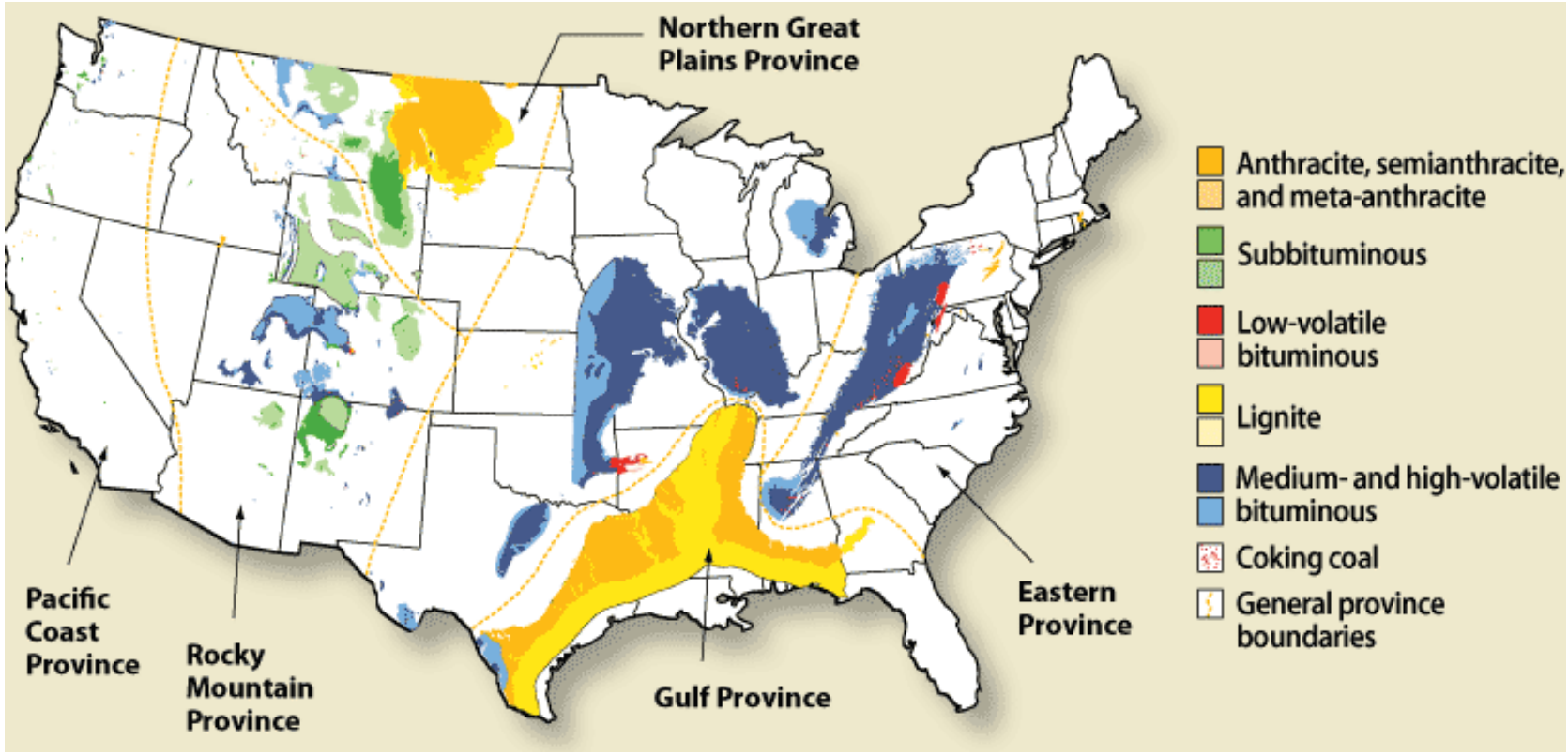
Where Is the Middle America Going with Energy? What Can be Learned?

- World coal use is growing.
- U.S. coal use is steadily losing ground to natural gas but not going away anytime soon (Power-Gen 2014).
- Politics could change things.
- In the meantime EERC is engaged in several projects that could “gel” for prudent and environmentally sensitive resource, energy, water, and agricultural development; all in the context of booming economic impacts.

Regional Synergies

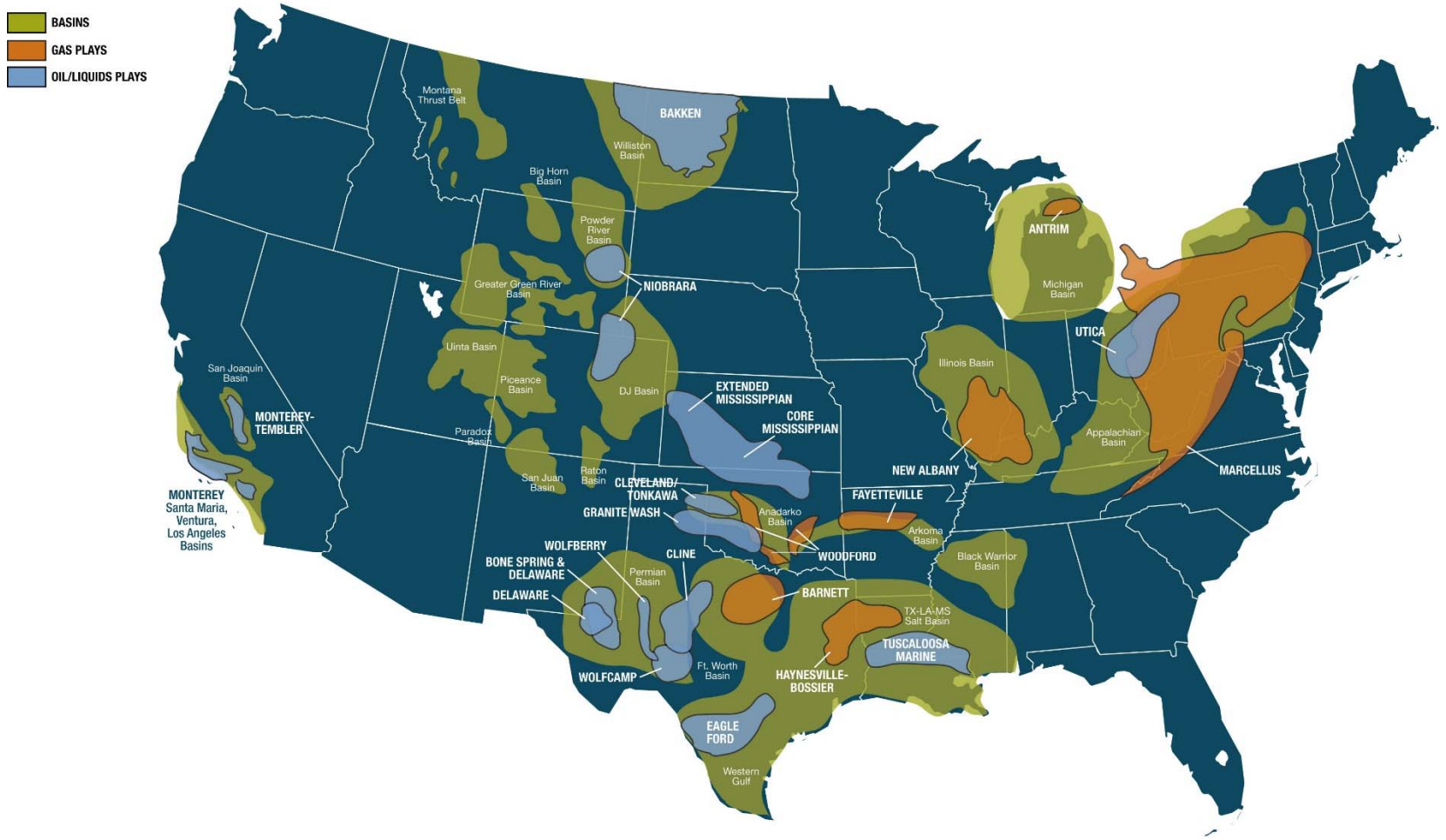
- **Energy resources**
  - Wind
  - Developing solar
  - Hydro
  - Coal – lignite
  - Oil, natural gas, and gas liquids
  - Biomass
- **Agriculture/Food Production – ND alone leads nation in over a dozen crops**
- **Technology innovation via ND and regional universities/colleges**
- **Biggest challenge: lack of heavy manufacturing infrastructure and systems**
- **People**

Coal Resources

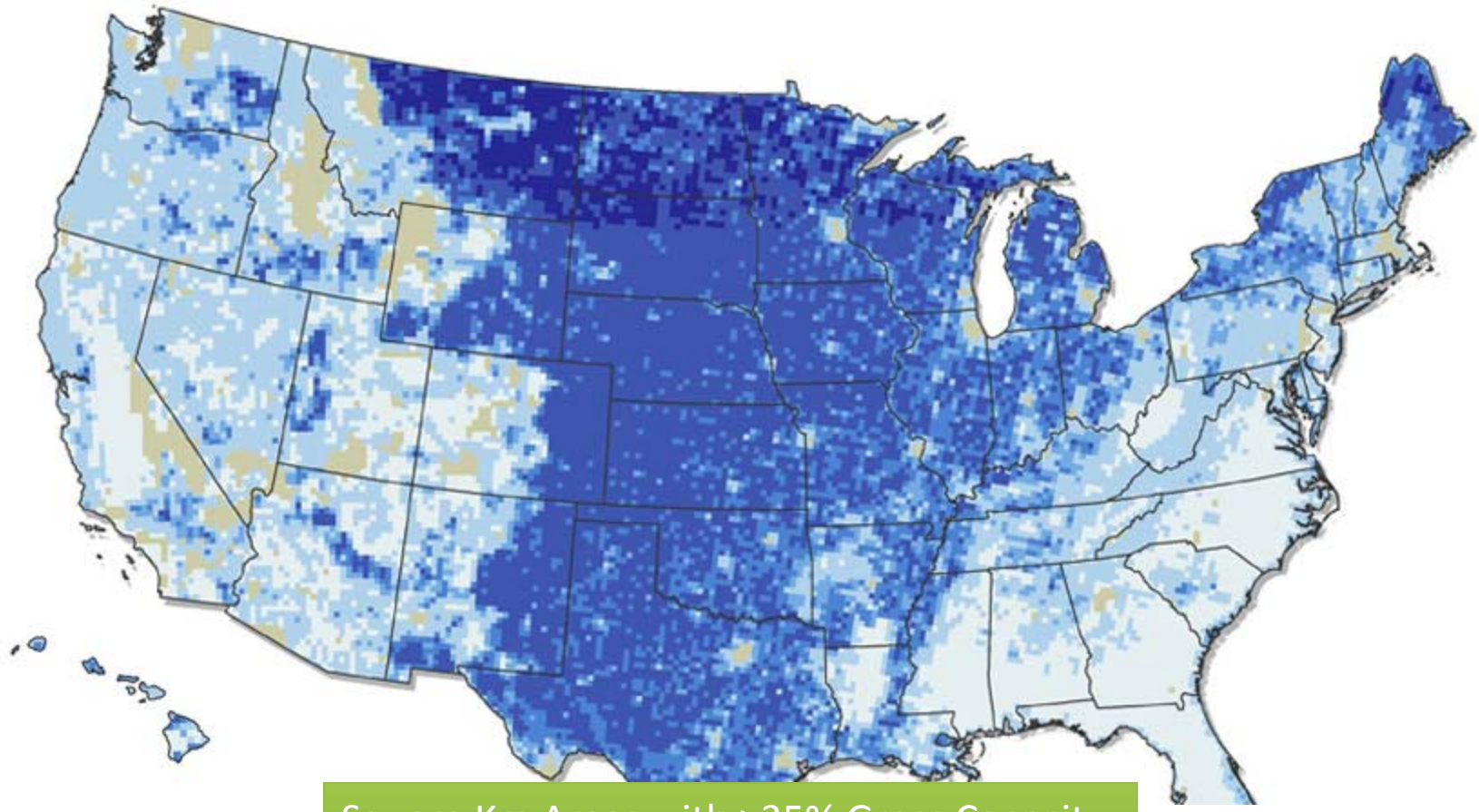


Source: EIA

Oil and Gas Resources



US Wind Resources



Square Km Areas with >35% Gross Capacity Factor at 110-Meter Hub Height, NREL 2015

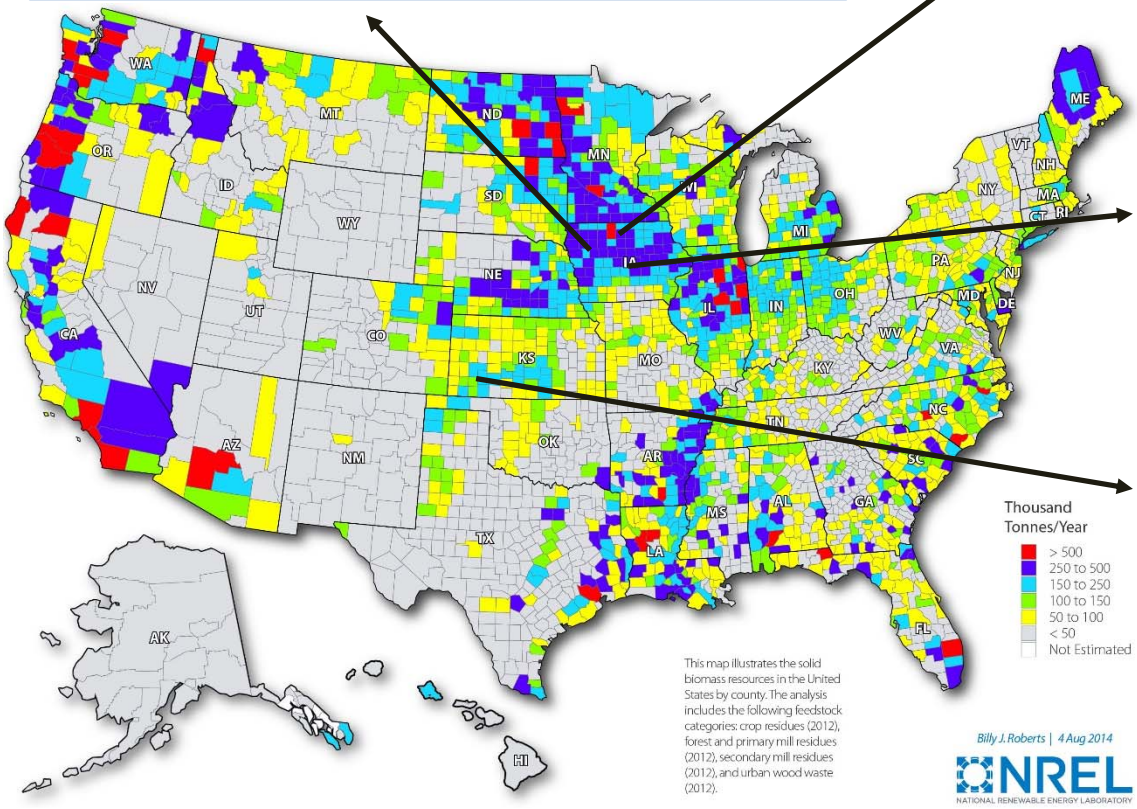
Solid Biomass Sources by County

Quad County Corn Adding Cellulosic Ethanol—3.75 MGPY, Galva, Iowa
Operational Date: June 2014
Feedstock: Corn kernel Fiber

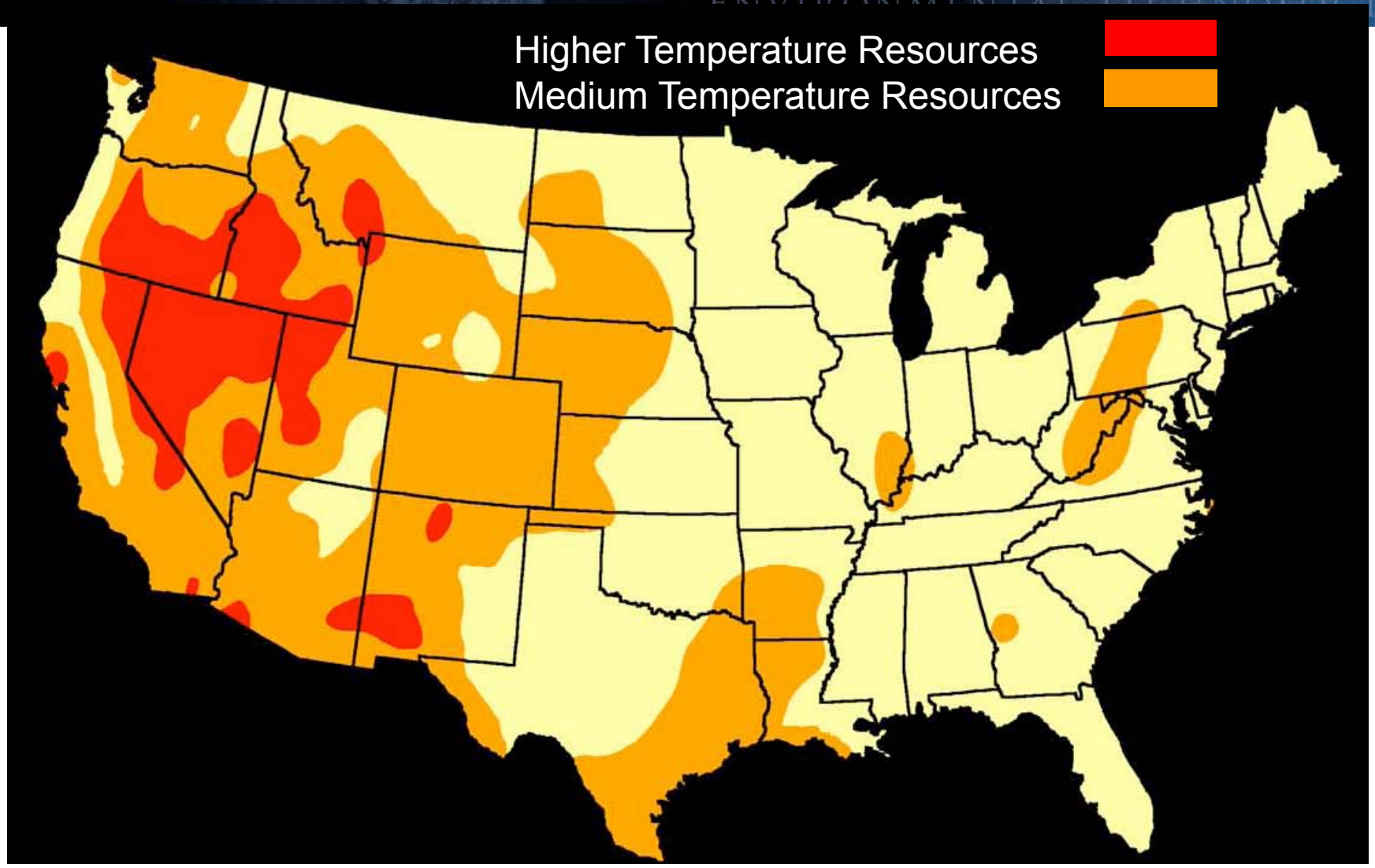
POET-DSM Project Liberty—25 MGPY, Emmetsburg, Iowa
Operational Date: June 2014
Feedstock: Corn cobs, leaves, husk and stalks

DuPont—30 MGPY, Nevada, Iowa
Operational Date: Q4 2014
Feedstock: Corn Stover

Abengoa—25 MGPY, 21MW biopower, Hugoton, Kansas
Operational Date: Q2 2014
Feedstock: Corn stover, wheat straw, milo stubble and prairie grasses

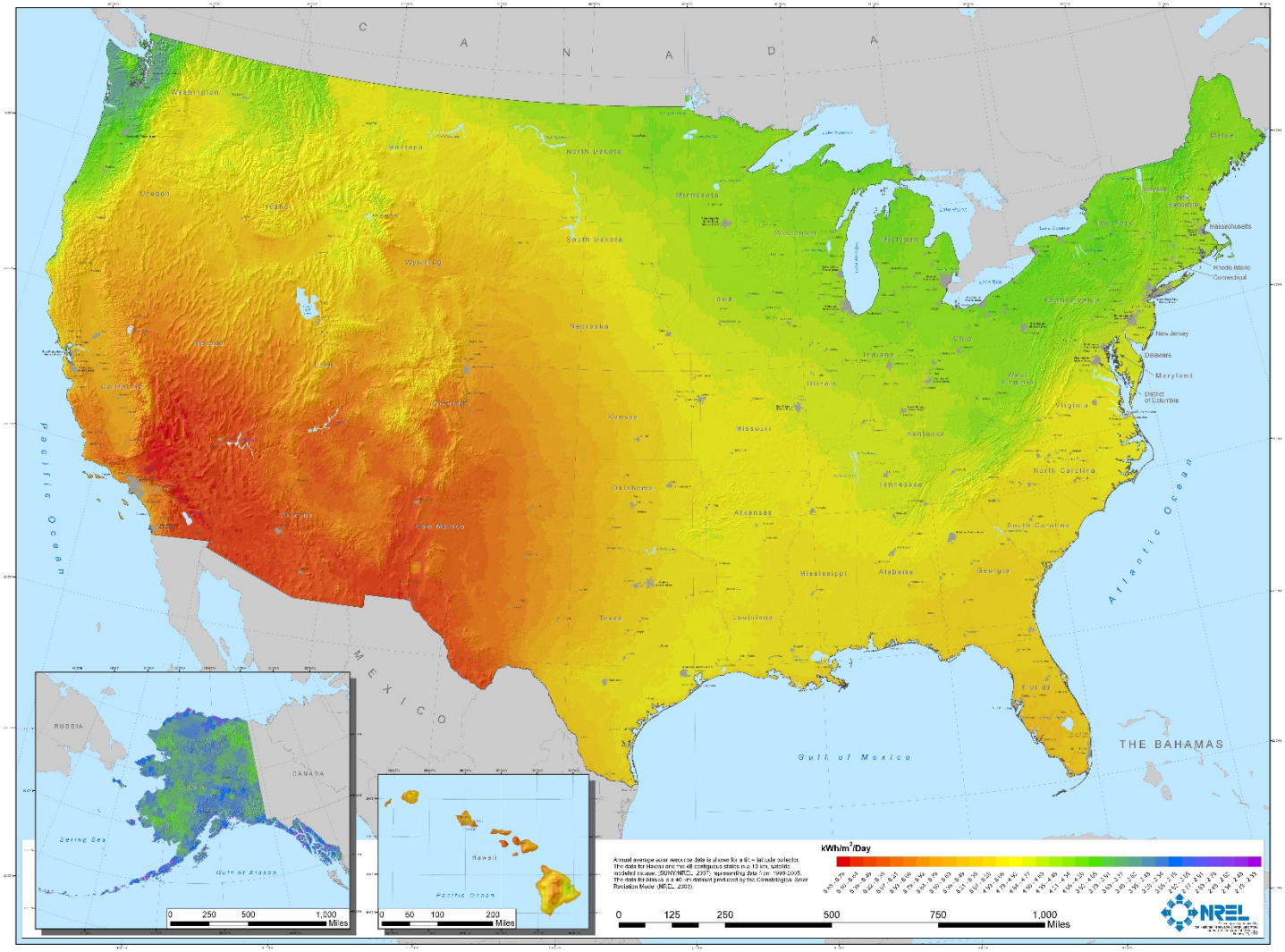


Geothermal Resources



Solar Resources

(Photovoltaic, NREL)



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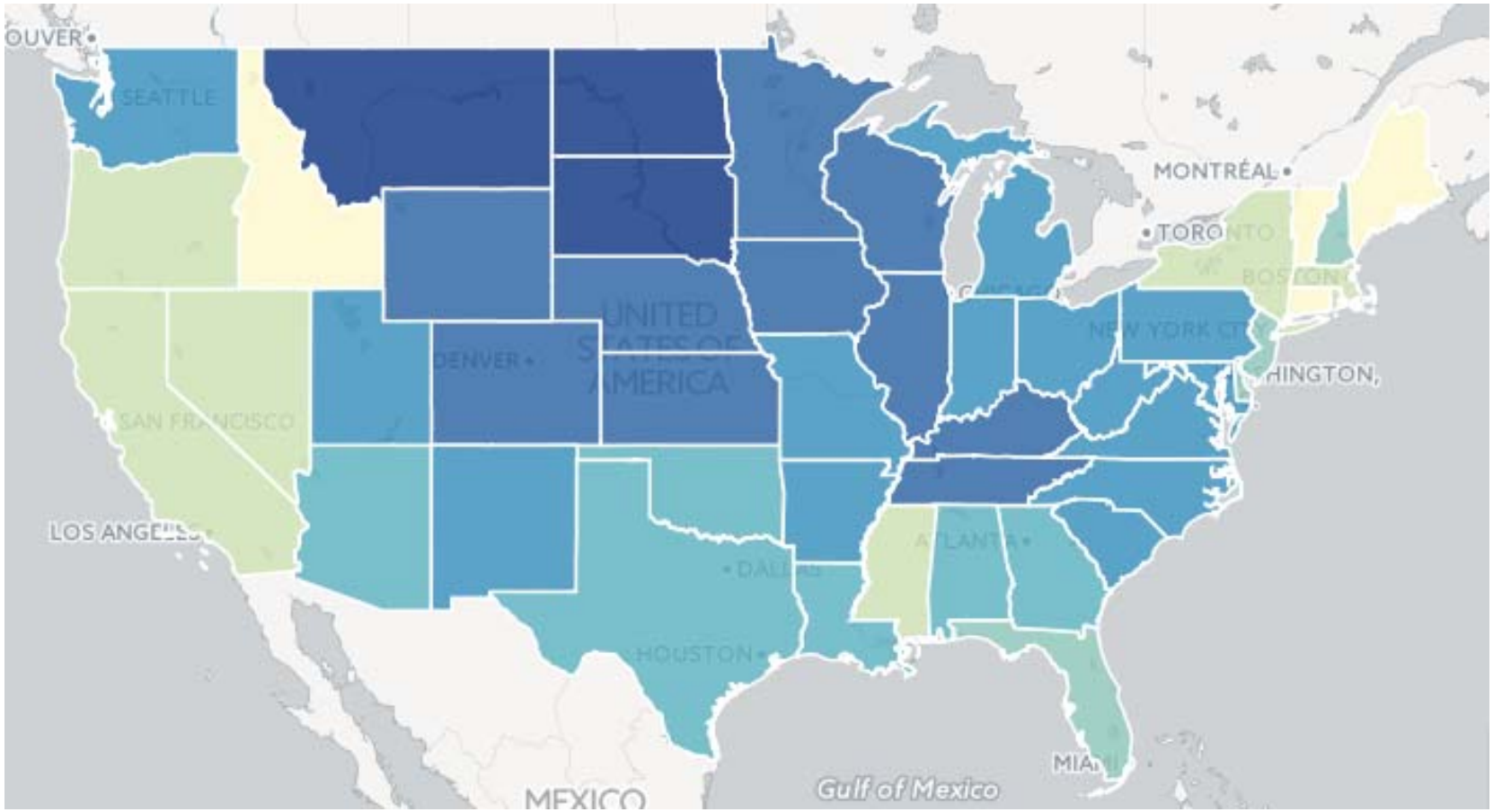
EPA CPP

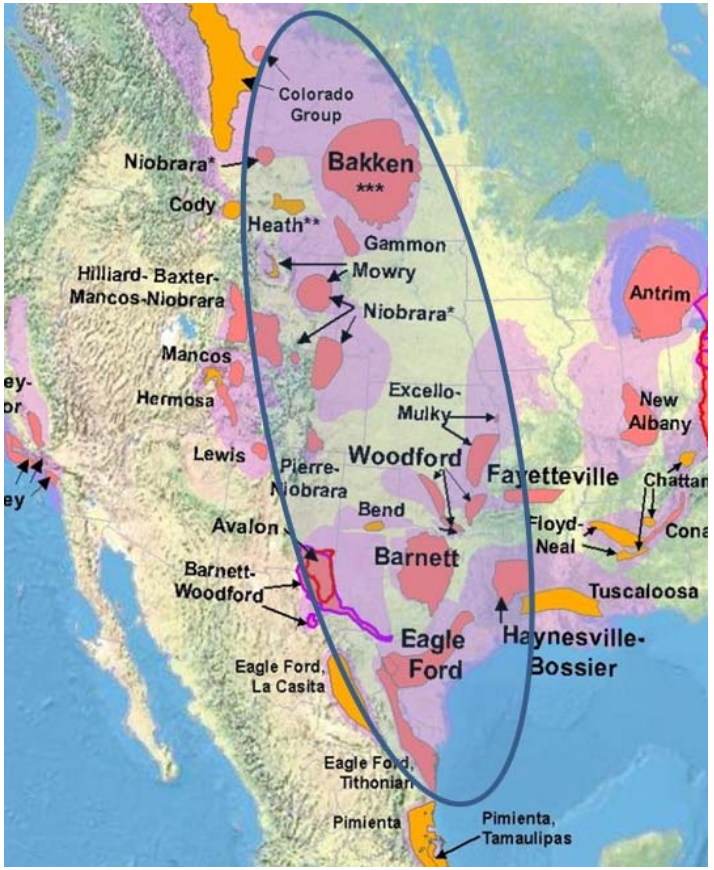

SEATTLE
MONTRÉAL
TORONTO
DENVER
SAN FRANCISCO
LOS ANGELES
HOUSTON
MEXICO
Gulf of Mexico

People: Middle U.S. Workforce

(Ingenuity, Grit, Work Ethic)

- **"The U.S. is developing a new geography of power, and its focus is the vast energy and commodities corridor extending from the western Gulf to the northern tip of the continent. . . ."** –Joel Kotkin
- Growth in population
- Growth in economics
- Growth in youth retention
- Growth in immigrants from eastern and western populous of the U.S.

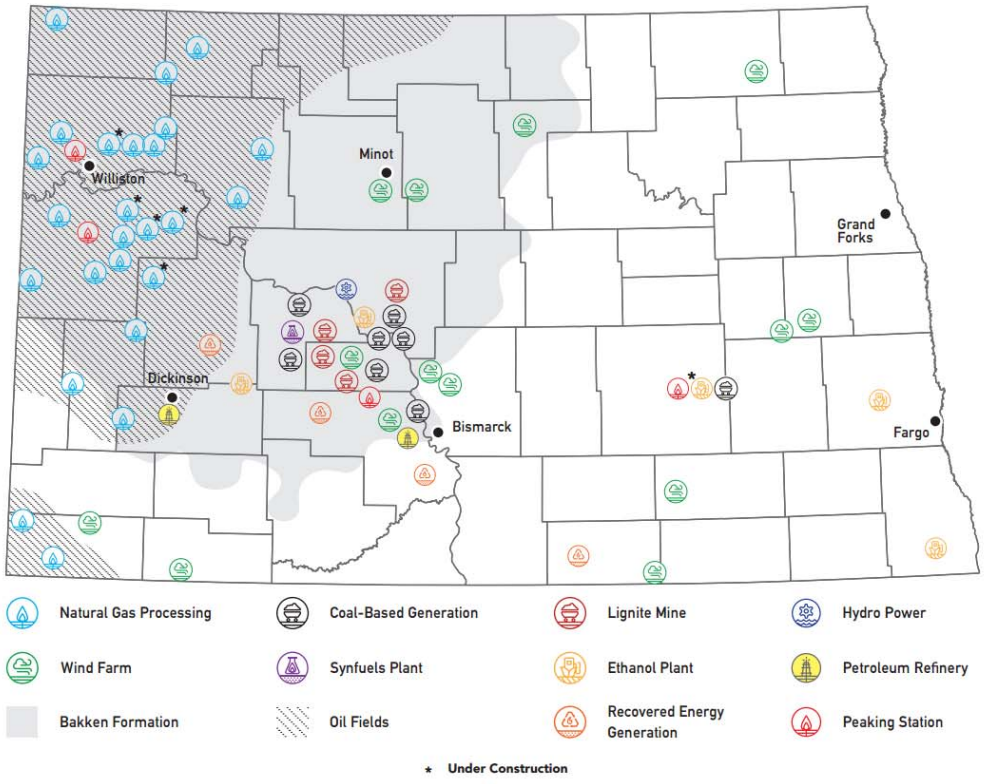
** Odd indicator -- Growth in miles driven and gasoline-diesel-ethanol consumed.



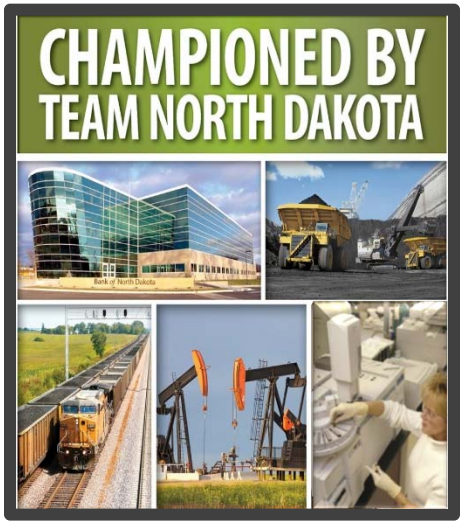
Joel Kotkin's New Geography of Power

ND Synergies—Up to Challenge

Energy Sites of North Dakota



Map courtesy of BSC National Energy Center of Excellence



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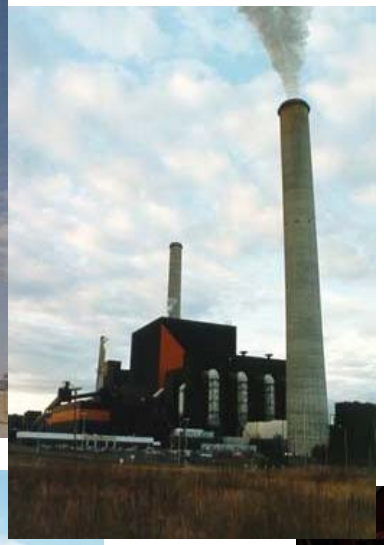
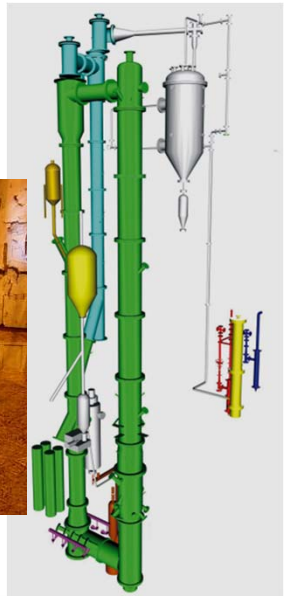
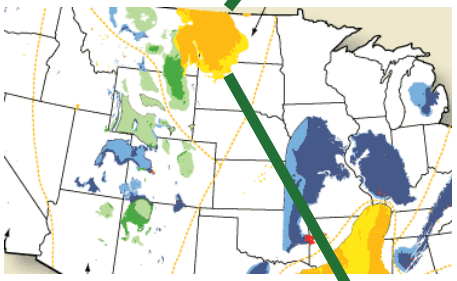
Increasing Renewable with Fossil

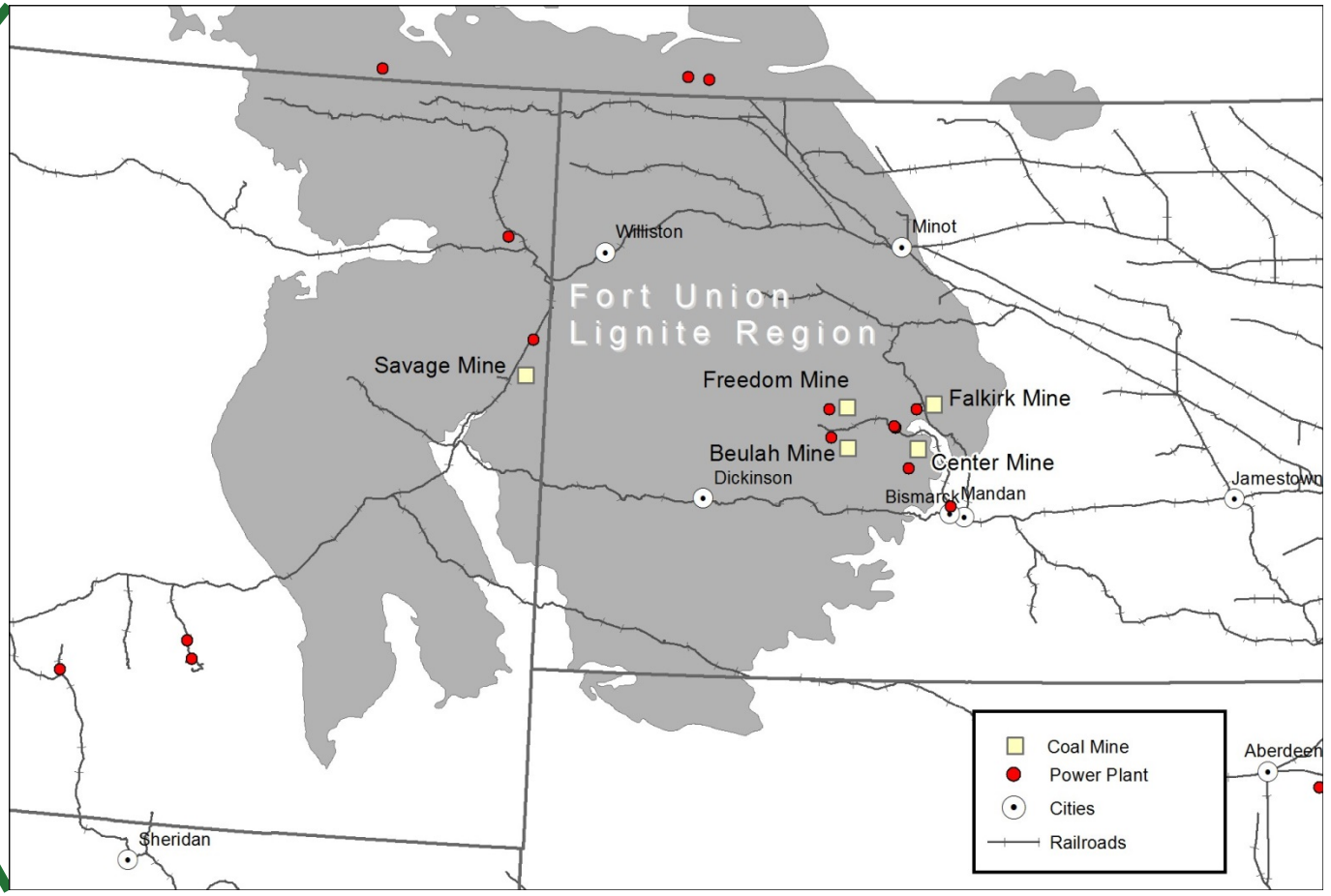
2000 → 2050





North Dakota Lignites





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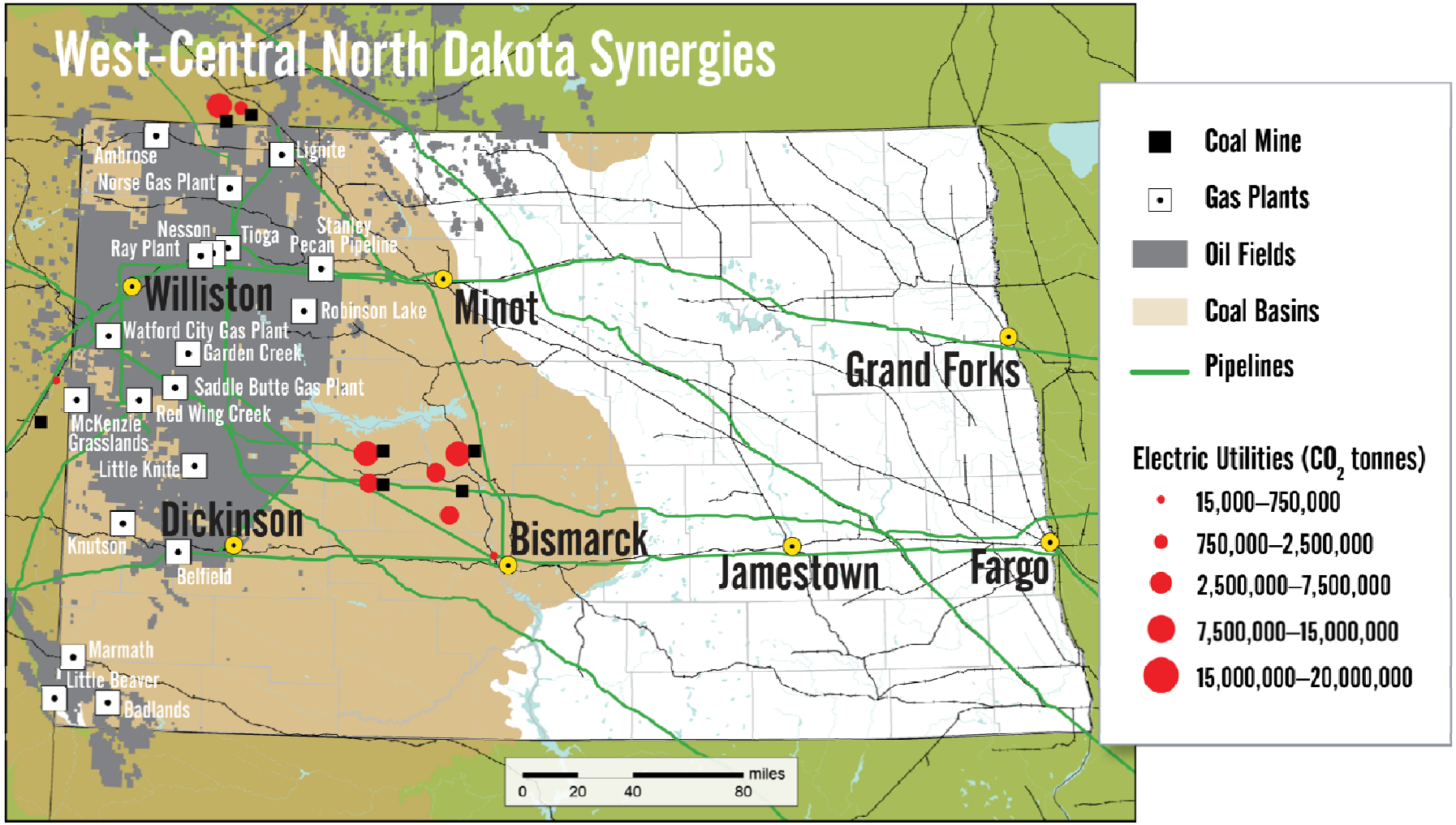
ND Bakken Oil Fields
(Including the Bakken)



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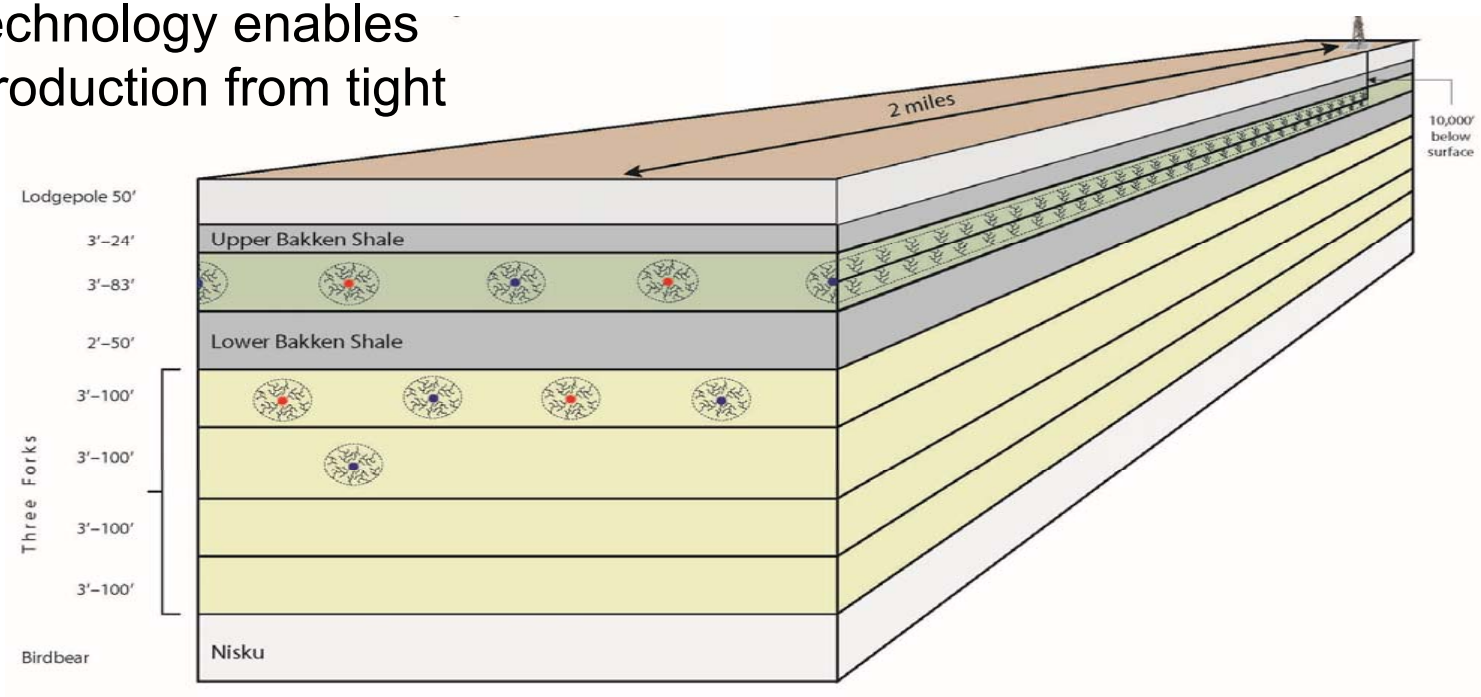
Bakken and Three Forks Production

- **Production (January 2015)**
  - Over 9000 wells in North Dakota.
  - Over 1.1 Mbbl/day of oil (2nd in U.S.)
  - Over 1.5 Bcf/day of gas (23 plants)
  - Horizontal wells and hydraulic fracturing technology enables prolific oil production from tight rocks.



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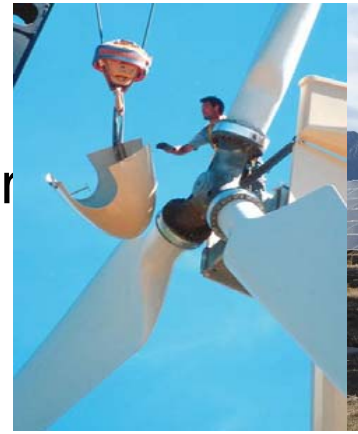
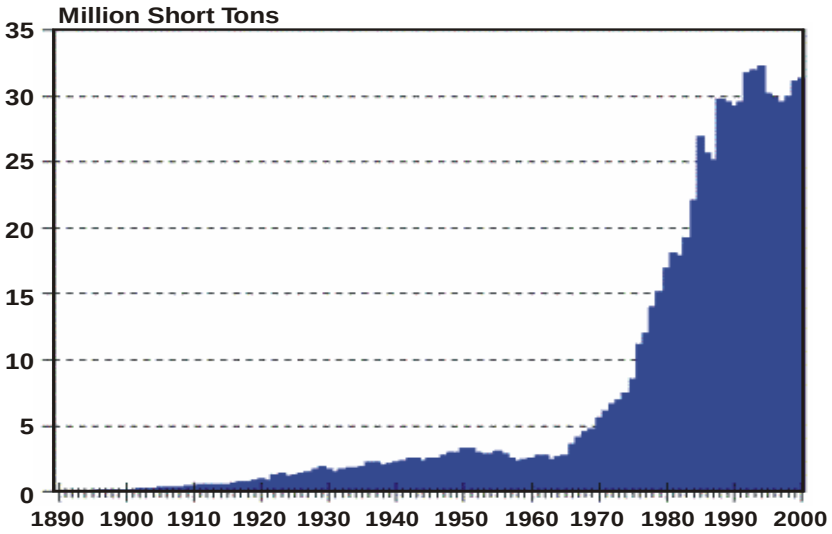
ND Renewables

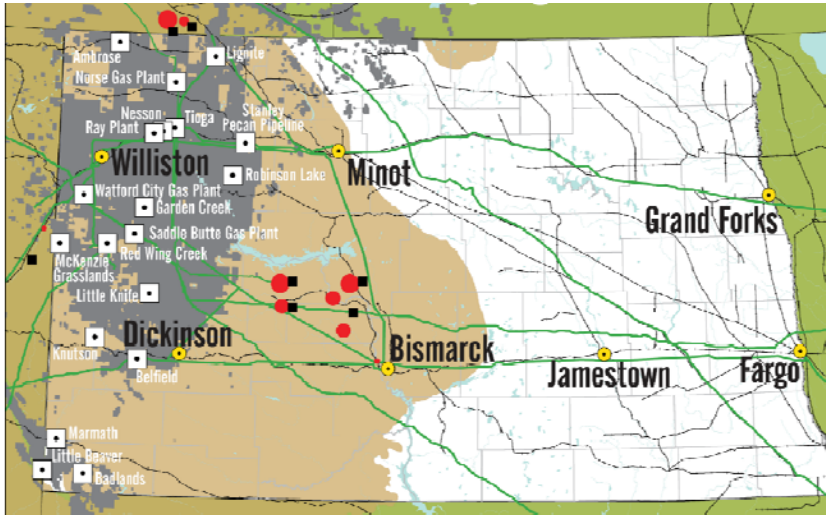
- **Solar:** Reasonable resource for small PV
- **Wind:** 1,884 MW of wind energy capacity, 1,050 wind turbines with design/planning for nearly 3000 MWs.
- **Hydro:** 580 MW Garrison Dam
- **Biomass:** residues and energy crops
  - ND leads the U.S. in flaxseed, canola, durum wheat, edible beans and peas, spring wheat, lentils, sunflowers, barley and oats (residues?)
  - High energy crop potential (camelina, pennycress, switch grass, and others)
- **Biofuels:** 5 ethanol plants, 1 biodiesel-ready plant



Water

- Western ND
  - Lake Sakakawea reservoir brought coal power industry in mid 1960's.
  - Surplus for ag & energy
- ND Water Commission derives funding from energy production
- State-wide water projects
  - Eastern NDmdeep saline aquifer remediation, municipal water remediation, western source pipelines, and sustainable water.
- Middle ND: Prairie pot-holes fly way preservation





What Can Happen with FEW in the Northern Great Plains

- Next-generation low-C energy development.
- Sustained low-cost coal & ag resources use.
- Electricity to fulfill the need for 1000s of MWs of ***new*** power needs.
- CO_2 stored and utilized for new enhanced oil recovery (EOR) markets.
- 2–3.2 Bt of CO_2 yields 4–7 Bbbl of EOR oil.
- Energy crops for Northern Great Plains ag industry.
- New food-ag-energy-water technologies & innovations to fuel research/industry corridors.
- Establish region as the “tip of the spear” and an international model for sustainable FEW.

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Polygen and Advanced Energy Systems

- **Polygen**eration: A facility or plant that produces multiple energy forms and products, as opposed to just electricity.
- Advanced energy systems: new lower C, higher efficiency systems for power and products.
- Utilizing coal, biomass, natural gas, and water sustainably.

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An Example of Synergy

- $250,000 matching award from a state (ND) research program (with Accelergy Corp.)
- New catalyst technology for renewable, low-toxicity, biodegradable biolubricants, waxes, transformer fluids, solvents, and drilling fluids.
  - Technology development and university research
  - Agricultural industry feedstock
  - Oil and gas production use
  - Potential for manufacturing “green” or low-carbon biologically derived products for the chemical industry

EERC Parr autoclaves for catalytic conversion of crop oils

Thank You!

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