EERC | UND UNIVERSITY OF NORTH DAKOTA

ECONOMIC IMPACT

NORTH DAKOTA CARBON CAPTURE AND ENHANCED OIL RECOVERY

STUDY OVERVIEW

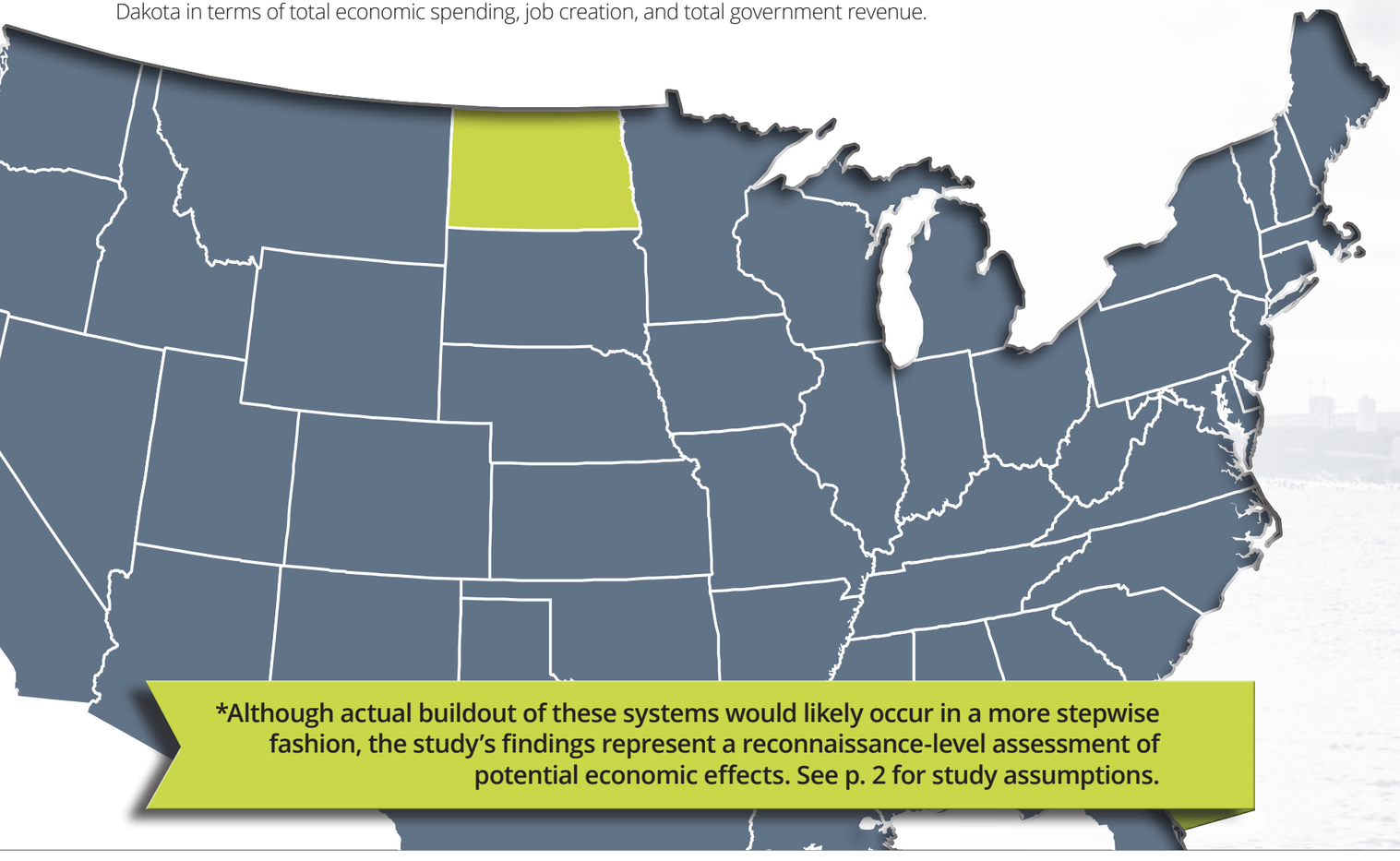
Carbon capture and North Dakota CO_2 enhanced oil recovery (EOR)

technologies require significant investment to implement as a means of reducing CO_2 emissions and increasing oil production in North Dakota.

Implementation could positively affect regional economies and state and local revenue by creating jobs and increasing revenue to the state.

The Energy & Environmental Research Center (EERC) in partnership with North Dakota State University (NDSU) performed a study to evaluate the potential economic impact to North Dakota of implementation of carbon capture and CO_2 EOR. The study provides:

- A cost estimate for implementing carbon capture and CO_2 EOR on North Dakota's existing coal-fired power plant units and conventional oil fields.*
- An estimate of the overall economic impact of carbon capture, utilization, and storage (CCUS) on North Dakota in terms of total economic spending, job creation, and total government revenue.



*Although actual buildout of these systems would likely occur in a more stepwise fashion, the study's findings represent a reconnaissance-level assessment of potential economic effects. See p. 2 for study assumptions.

THE ECONOMIC BENEFITS OF CCUS

The EERC studied the costs and benefits associated with CO_2 capture from each power station unit in North Dakota greater than 100 MW in size, pipeline transport of the CO_2, and EOR. The study assumed that 90% of the CO_2 currently produced at each power plant would be captured and incidentally stored either via EOR or directly stored via geologic sequestration.

An economic impact model was developed to estimate the overall impact of CCUS technologies on North Dakota's economy. The costs to build capture and EOR infrastructure will be substantial, which results in significant job creation during the construction and operation phases. The results of the economic impact analysis showed that temporary jobs are created during the construction period for the capture facilities and permanent jobs result from capture of the CO_2 and its use in oil fields. Overall oil production in North Dakota increases as a result of EOR activities.

The increase in the number of jobs would have a substantial positive effect on state and local tax revenue.

Up to

$3.0 Billion/yr

Injected into North Dakota's Economy Annually, Resulting in

As much as a

$300 Million

Annual Increase in Taxes Collected by the State

As many as

15,000

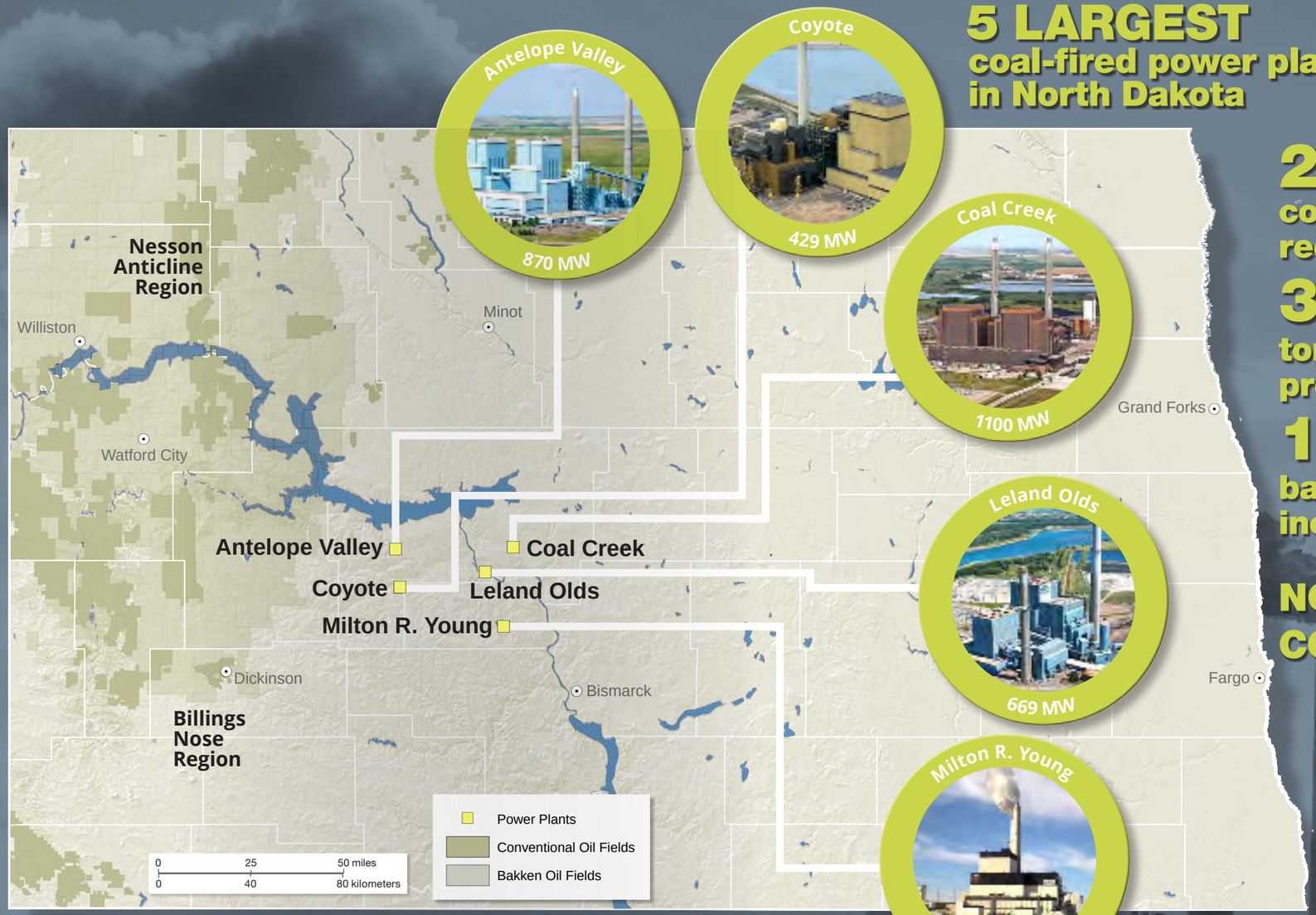
Long-Term Jobs

STUDY OVERVIEW

Study Assumptions:

- 90% carbon capture from the five largest plants in North Dakota.
- CO_2 production beyond oilfield demand stored geologically.
- $65/barrel oil

Conventional oil fields represent
1 billion barrels
of potential additional oil recovery.



5 LARGEST
coal-fired power plants in North Dakota

201
conventional oil fields requiring
358,000,000
tons of CO_2 to produce up to
1,000,000,000
barrels of incremental oil

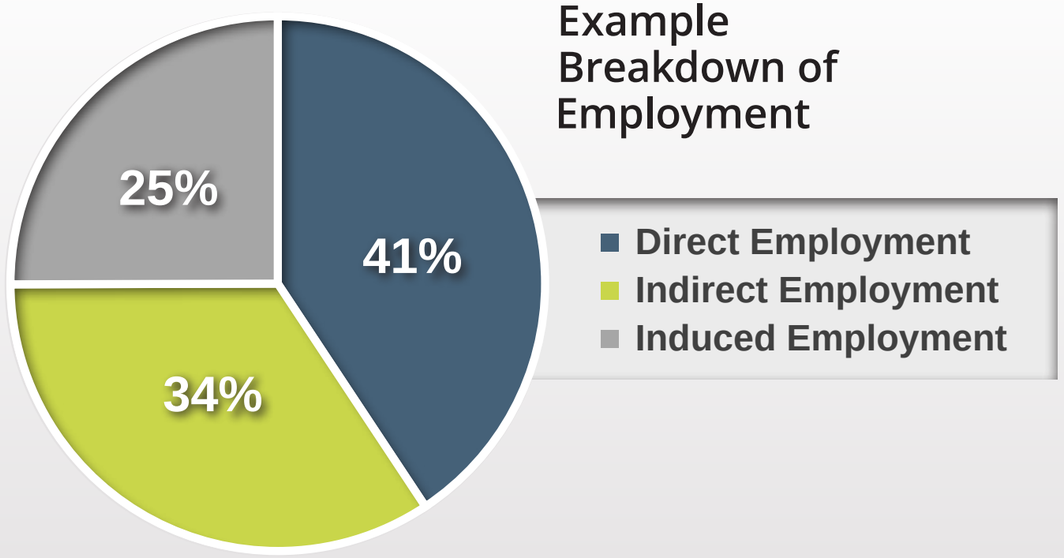
NO Bakken
CO_2 EOR considered

UNDERSTANDING ECONOMIC IMPACT ANALYSIS

When a new project is developed in the state, jobs are created in three ways:

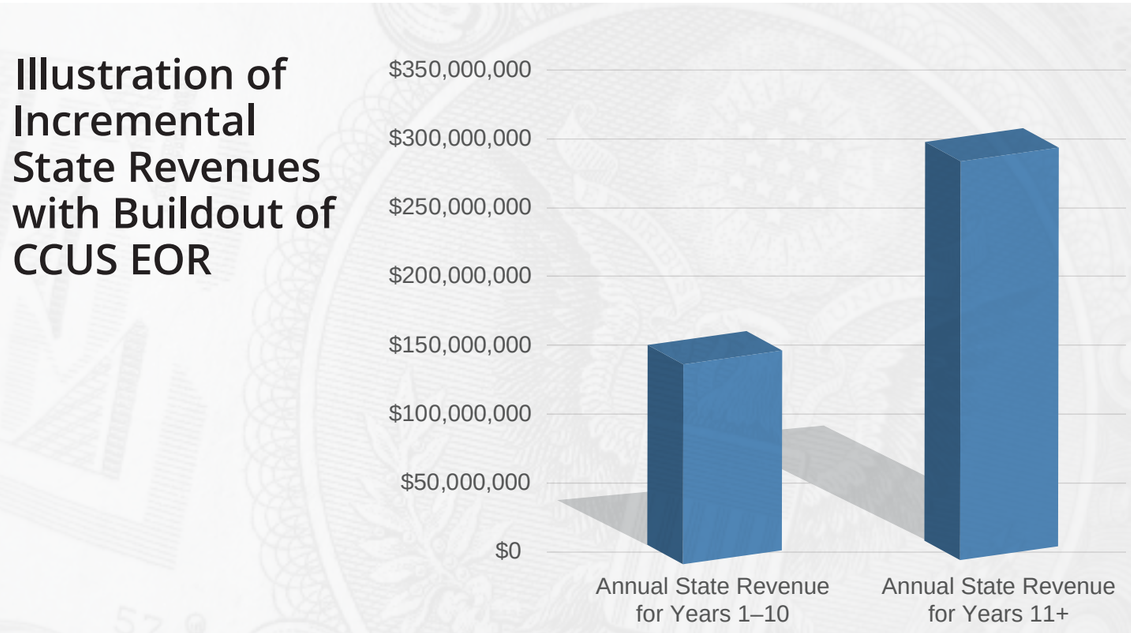
- **Direct Effects**—jobs created by employees directly working on the new project
  - Example: construction worker pouring foundations for a carbon capture facility.
- **Indirect Effects**—jobs created at companies that support the construction efforts
  - Example: a welder at a machine shop producing components for the carbon capture facility.
- **Induced Effects**—jobs created at businesses that support the local workforce
  - Example: restaurant worker serving lunch to construction crew.

The EERC used a model called IMPLAN (Impact Analysis and Planning) to estimate these effects based on the estimated cost of the implementation of carbon capture and storage facilities.



TAXES AND GOVERNMENT REVENUE

1. **COAL CONVERSION TAX**: Taxes are assessed when coal is converted to electricity. In this study, a slight reduction in coal conversion tax is estimated because a portion of the electricity produced is used to operate the carbon capture system and is not exported to the grid.
2. **PROPERTY TAX**. An exemption was considered to owners of the pipelines and related equipment for property taxes for 10 years. The state reimburses counties for this loss in payments for 10 years as payments in lieu of property taxes.
3. **PAYMENTS IN LIEU OF PROPERTY TAXES**. Property tax payments are made by the state to the various subdivisions for a period of years (usually 10 years), thereby providing a tax break to the property/facility owner but allowing the local governments to receive revenue. When the exemption period is over, the estimated property tax becomes the responsibility of the property/facility owner.
4. **OIL AND GAS SEVERANCE TAXES**: Entities receive an exemption in taxes paid to the state for 10 years for incremental oil from the use of CO_2 EOR that would not have been extracted without this use of CO_2. Both the gross production and extraction tax are estimated in this study and are being included in the government revenues. The tax rates and exemption period follow the North Dakota Century Code.
5. **STATE AND NET FEDERAL ROYALTIES**: State and net federal royalties have been estimated for the incremental oil produced in the study.



Acknowledgments

The EERC would like to thank the U.S. Department of Energy and the Lignite Energy Council through the North Dakota Industrial Commission for funding this work. The EERC would also like to thank Dean Bangsund at NDSU for contributing toward the economic impact analysis.

Notes on the Bakken:

This study evaluated the near-term potential for EOR in conventional oil fields in North Dakota, but the Bakken petroleum system in the Williston Basin provides a significant opportunity for future CO_2 EOR efforts. The Bakken is a world-class unconventional tight oil play with oil-in-place estimates in the hundreds of billions of barrels. Despite the enormous resource, recovery factors are typically low, ranging from 4% to 10%. With such low primary recovery factors and such a large resource, small improvements in productivity could increase North Dakota's technically recoverable oil by billions of barrels. From 2012 to 2018, the EERC conducted a series of laboratory experiments, modeling studies, and field-based injection tests focused on determining the potential to use CO_2 for EOR in the Bakken. While additional pilot-scale field tests are needed to develop cost-effective EOR design and operational schemes and commercial-scale deployment of EOR in the Bakken is likely 5 to 10 years from fruition, research results suggest up to 16 billion barrels of incremental oil could be produced from the injection of 1.5 billion tonnes of CO_2.

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