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MISSOURI PUBLIC SERVICE COMMISSION

Case No. EA-2014-0207

DIRECT TESTIMONY OF

GARY MOLAND

ON BEHALF OF

GRAIN BELT EXPRESS CLEAN LINE LLC

March 26, 2014

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I. WITNESS INTRODUCTION AND PURPOSE OF TESTIMONY

Q. Please state your name, present position and business address.

A. My name is Gary Moland. I am the Director of Power Markets & Transmission Analysis at DNV GL (formerly GL Garrad Hassan). My business address is 9665 Chesapeake Drive, Suite 435, San Diego, CA 92123.

Q. Please describe your education and professional background.

A. I received a Bachelor of Science degree in nuclear engineering from the Georgia Institute of Technology and a Master of Science degree in mathematics and computer science from Emory University in Atlanta, Georgia.

I am currently employed by DNV GL, a global engineering consulting company headquartered in Norway. I have been employed by DNV GL since December 2010. I oversee analysis performed by DNV GL in regards to economic planning and simulation of U.S. energy markets. In this role, I manage consulting engagements that include economic benefit analysis for new transmission projects, congestion studies for generation projects both existing and under development, locational marginal price ("LMP") forecasting studies, curtailment risk studies for wind generators, and analysis of wind integration impacts and costs.

Prior to joining DNV GL, I spent 20 years working for Ventyx, the vendor of the PROMOD simulation software used by DNV GL and many utilities for economic planning studies. Ventyx employed me as a software developer for PROMOD, client support specialist for PROMOD users (primarily major utilities), manager of PROMOD technical development, manager of the PowerBase energy market database project, and vice president in the "Ventyx Advisors" consulting group. My full Curriculum Vitae is provided in **Schedule GM-1** to this testimony.

Q. Please describe your background in performing transmission economic analysis.

A. In my work as a consultant over the past ten years, I have performed numerous studies to assess the economic impact of new transmission projects, including several benefit studies that have formed the basis for testimony before state public service commissions and other regulatory agencies. Specific transmission projects I have studied include:

- Rock Island Clean Line high voltage direct current transmission project located in Iowa and Illinois;
- Axtell-Spearville-Comanche 345 kV, located in the Southwest Power Pool, Inc. ("SPP"), a regional transmission organization ("RTO");
- CREZ Scenario 2 transmission expansion, located in the Electric Reliability Council of Texas ("ERCOT"); and
- Atlantic Wind Connection offshore high voltage direct current transmission project, located in PJM.

In the course of conducting these studies, I designed and created future scenarios to assess the economic impacts of a proposed transmission project across a range of possible market conditions.

Q. What is the purpose of your direct testimony?

A. The purpose of my testimony is to describe the assumptions, methodology, and results of the analysis conducted by DNV GL to measure the economic and environmental impacts of the Grain Belt Express transmission project ("Grain Belt Express Project" or "Project") proposed by Grain Belt Express Clean Line LLC ("Grain Belt Express" or "Company"). The testimony will detail the economic and environmental benefits under four assumption scenarios or "futures" and will demonstrate that the Project will result in lower overall demand costs for energy in Missouri and throughout the region, lower energy production costs, and reduced overall emissions of pollutants.

II. ECONOMIC MARKET STUDY

A. Study Methodology, Scenarios and Data Assumptions

Q. Please summarize the economic study performed by DNV GL to analyze the impacts of constructing and operating the Grain Belt Express Project.

A. DNV GL used the PROMOD production cost modeling software package to perform simulations of future energy markets for a representative study year (2019) to assess the economic impact of the Grain Belt Express Project on system operations in Missouri. The year 2019 was chosen because it is the first full year the Project is scheduled to be in operation. PROMOD is proprietary modeling software, which incorporates extensive details in generating unit operating characteristics, transmission grid topology and constraints, and market system operations to support economic transmission planning. The simulations encompassed RTO energy markets and transmission grids throughout the eastern United States, including SPP, PJM Interconnection, LLC ("PJM"), Midcontinent Independent System Operator, Inc. ("MISO"), the New York Independent System Operator, the Ontario Independent Electricity System Operator, Entergy, and Tennessee Valley Authority, as well as most other utility systems in the eastern U.S. not currently participating in RTOs. In order to develop a robust view of impacts and benefits, simulations were performed across several possible future market scenarios both with and without the Grain Belt Express Project.

Q. Please describe the study methodology for evaluating the economic and environmental benefits of the Project.

A. The study methodology used to assess the economic benefits of the Grain Belt Express Project includes the following primary activities:

(1) Assumptions and scenario development: Study years and energy market scenarios are selected to provide several plausible futures under which to evaluate the economic and environmental benefits of the project. A scenario-based approach is critical to ensure that economic results are robust across a variety of future conditions. For each scenario, specific assumptions are developed for modeling inputs, such as future demand, future gas prices, new wind generation, and other key assumptions based on research and past modeling experience. Scenarios are constructed and tested to ensure that results reflect the intended data parameters.

(2) Base Case simulations: The first set of simulations is performed for the study year across multiple scenarios without the Grain Belt Express Project included. Extensive quality assurance checks are carried out on these Base Case results to validate data accuracy through a general comparison of results against historical operations.

(3) Grain Belt Express Project simulations: A second set of simulations is performed for the study year across multiple scenarios that include the Project along with the wind generation expected to supply energy delivered over the Project. An hourly energy profile for generation in western Kansas was provided by Grain Belt Express witness David Berry, Executive Vice President – Strategy and Finance of Clean Line Energy Partners LLC (the ultimate parent company of the Applicant in this case). I then modified this data to account for electrical losses at

the direct current converter stations and during transmission over the line. The added wind capacity is not interconnected into the existing transmission grid and can be delivered only via the Grain Belt Express Project. This benefit study is unique in that the economic feasibility of the Project and the new wind generation resources that will utilize it are directly intertwined, such that one cannot be reasonably modeled without the other. The Project serves no purpose without the new wind resources and the new wind resources would not be developed without the transmission access afforded by the Grain Belt Express Project. Quality assurance checks are carried out with a focus on the operation of the Project to ensure that the modeled line flow, electrical loss rates, and other results align with design parameters.

(4) Benefit Analysis: The Project simulations are compared to the corresponding Base Case for each scenario to assess the impact of the Project on system operations, costs, and emissions. The resulting economic and environmental benefits are wholly driven by new wind generation facilitated by the Grain Belt Express Project. This new wind generation offsets fuel and emission costs from conventional generation, and the low variable cost of the new wind generation also reduces LMPs in Missouri, lowering demand cost under RTO settlement processes.

Q. What are "LMPs"?

A. "LMP" stands for locational marginal pricing and represents the incremental cost of energy at a specific electrical bus (or collection of buses, often referred to as a "hub") at a given point in time. LMPs are calculated every five minutes by the system operators in Missouri, and these prices are used in financial settlements to determine the cost to buy and sell energy on the open wholesale market. LMPs include the cost of the next increment of energy needed to meet system-wide demand, the cost of transmission congestion impacts on a specific bus location, and the cost of electrical losses associated with a specific bus location.

Q. Does the study incorporate SPP's transition to its new "Integrated Marketplace" which began in March 2014?

A. Yes, the commitment and dispatch processes in the study simulations are set up to reflect the rules of the SPP Integrated Marketplace.

Q. Please describe the PROMOD software model used in the analysis.

A. PROMOD is an integrated electric generation and transmission market simulation tool. It performs hourly chronological commitment and dispatch of generating resources that minimizes system operating costs while simultaneously adhering to a variety of constraints, including maximum capacity of generation sources, transmission limits, fuel and environmental costs, operating reserve requirements, and customer demand. PROMOD can be used to forecast hourly energy prices (LMPs), unit generation, fuel consumption, emissions output, regional energy interchange, transmission flows, and congestion costs based on the input market conditions specified by the user.

Q. What future energy market scenarios were considered in the economic analysis?

A. The economic analysis of the Grain Belt Express Project considered four different future scenarios. A high-level description of each scenario is provided below, and detailed data assumptions for each scenario can be found in my **Schedule GM-2**. All scenarios included approved future transmission upgrades in SPP and MISO (including MISO's Multi-Value Projects) scheduled to be constructed by the 2019 study year. The study scenarios include:

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Business As Usual: Energy demand grows under a moderate economic recovery with no major changes to existing environmental policy, generating technologies, fuel commodity prices, or other key energy market assumptions. Expansion of renewable generation is driven by current state mandates with moderate retirement of coal generation driven by market economics and existing environmental rules.

Slow Growth: Continuation of depressed economic conditions characterized by slow demand growth, continued low fuel commodity prices, and minimal transmission/generation expansion. Addition of new renewable generation expansion is driven by current state mandates with moderate retirement of coal generation driven by existing environmental rules.

Robust Economy: Strong recovery in economic activity characterized by accelerated growth in electrical demand, higher fuel prices and emission allowances prices, and increased activity in new generation and transmission projects. Expansion of renewable generation is based on current state mandates with the moderate retirement of coal generation driven by existing environmental rules. This scenario includes the addition of proposed transmission projects including RITELine Company's Potomac Appalachian Transmission Highline ("PATH"), designed to move energy eastward into markets in Indiana and Ohio, then on to the major demand centers near the eastern coast.[1] Although these specific projects are not currently approved or under development, they are generally representative of the anticipated expansion of the transmission grid needed to support robust load growth assumptions and to provide representative value of such

[1] The PATH project was cancelled due to low load growth. It is reasonable to assume that the project will be renewed in a high load growth scenario.

expansions regardless of the specific likelihood of the construction of any such specific projects.

Green Economy: Expansion in environmental policy including carbon "cap and trade" legislation and a federal renewable portfolio standard. This scenario includes high demand growth and increases in fuel prices and emission allowance prices (including carbon). Expansion of renewable generation is significantly higher than current state mandates, with accelerated coal retirements driven by new emissions costs. This scenario includes the addition of proposed transmission projects including the RITELine and PATH transmission projects designed to move energy eastward into markets in Indiana and Ohio, then on to major demand centers near the eastern coast. Although these specific projects are not currently approved or under development, they are generally representative of the anticipated expansion of the transmission grid needed to support a green economy and to provide representative value of such expansions regardless of the specific likelihood of the construction of any such specific projects.

Q. What other data assumptions were used in the economic analysis?

A. In addition to the data assumptions presented in my Schedule GM-2 for each of the four study scenarios, DNV GL uses many other data assumptions in the study database. Along with the PROMOD simulation model, DNV GL licenses the "Simulation-Ready Data" product from Ventyx. This energy market database contains data for forecasted demand, forecasted fuel prices, detailed generating unit characteristics, transmission system configuration, and other information. DNV GL carries out validation activities to verify data accuracy and make enhancements in some areas such as modeling of wind generation and adding recently approved transmission projects. The Ventyx data is used as a starting point for system planners across North America and undergoes rigorous review by a wide variety of product users.

Q. What are the sources of operating and cost data on individual existing and planned generating units and transmission facilities that were used in the scenarios?

A. The bulk of the study data for generators, fuel, electrical demand, and market operating rules is provided by Ventyx, the same company that licenses the PROMOD simulation software. Ventyx compiles electrical system data from public sources and combines it with detailed market research and analysis to provide databases for use in energy market simulation models. Ventyx is a leading data vendor for North America, providing simulation databases to many utilities, transmission and generation planners, consulting organizations, and system operators (including MISO, SPP, PJM, ERCOT, and the California ISO). Ventyx provides data updates twice a year to keep databases current with regard to forecasted fuel prices, demand forecasts, and new generation projections. The Ventyx data is used as a starting point for system planners across North America and undergoes rigorous review by a wide variety of product users. Transmission assumptions are based on industry-approved transmission powerflow cases published by the North American Electric Reliability Corporation along with information on recently approved major transmission projects provided by transmission planning organizations, such as MISO and SPP.

Q. What metrics were developed in the economic analysis?

A. PROMOD simulations provide several key metrics that were used to assess the economic benefits of the Grain Belt Express Project and the new wind generation it supports. These metrics include:

- Demand Cost ($) – The hourly electrical demand (MWh) at each bus multiplied by the hourly LMP ($/MWh) at that bus summed over all Missouri buses for all hours. This represents the total cost to purchase energy to supply total Missouri annual demand under RTO settlement rules.
- Production Cost ($) – Total variable cost of generation to supply energy to meet annual demand including fuel costs, emission costs, variable operation and maintenance costs, and unit start up costs.
- LMP ($/MWh) – Incremental cost of energy averaged across all electrical load buses in Missouri.
- Emissions Production (tons) – Total volume of emissions produced by generation units for sulphur dioxide ("SO_2"), nitrogen oxide ("NO_x"), mercury, and carbon dioxide ("CO_2").

B. Results of the Economic Analysis

Q. What were the results of the economic analysis?

A. Schedule GM-2 shows the results of the economic analysis for each scenario in terms of demand costs, LMPs, and variable production costs. Schedule GM-2 also shows the emissions and water use reductions as calculated in the analysis. Scenarios run under each economic forecast showed positive economic impacts, including lower cost of production, lower demand and less pollution from generation.

Q. How were emissions reductions calculated?

The study database licensed from Ventyx includes emission production rates for NOx, SO_2, mercury, and CO_2 for each generator. The total number of tons produced for each of these effluents is calculated by PROMOD during the simulation of each scenario by multiplying the hourly output of each generator times the appropriate emissions production rate. Reductions in mercury were calculated after completion of the PROMOD runs by multiplying unit-specific production rates for mercury times the annual energy production for each coal plant modeled in the study. Reductions in water usage (evaporation) were estimated using general water consumption rates for each unit type (e.g., coal, combined cycle, combustion turbine) combined with annual generation results from the PROMOD simulations. Reduction of each of these emissions is a direct result from the reduced need for conventional, emissions-producing generation due to the addition of new wind resources facilitated by the Grain Belt Express Project.

Q. Please summarize the results of your studies of the Grain Belt Express Project and the interconnected wind generation.

A. (1) The Grain Belt Express Project reduces total demand costs in Missouri under each of the four future scenarios.

(2) The Grain Belt Express Project lowers LMPs ($/MWh) in Missouri in each of the future scenarios.

(3) The Grain Belt Express Project reduces total variable production costs in the eastern United States under each of the future scenarios.

(4) The Grain Belt Express Project reduces emissions of NOx, SOx, CO_2, and mercury, and reduces water usage in power generation, in the eastern United States under each of the future scenarios.

Q. Are your study results for 2019 representative of the impact of the Grain Belt Express Project and the new wind resources that will be connected to it in other future years?

A. Yes, the study benefits and impacts for the Grain Belt Express Project presented here are expected to be generally representative of results for other future years.

Q. Does this conclude your prepared direct testimony?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of the Application of Grain Belt Express Clean Line LLC for a Certificate of Convenience and Necessity Authorizing it to Construct, Own, Control, Manage, Operate and Maintain a High Voltage, Direct Current Transmission Line and an Associated Converter Station Providing an Interconnection on the Maywood 345 kV Transmission Line)	Case No. EA-2014-0207

AFFIDAVIT OF GARY MOLAND

STATE OF Georgia)
) ss
COUNTY OF Fulton)

Gary Moland, being first duly sworn on his oath, states:

1. My name is Gary Moland. I am the Director of Power Markets & Transmission Analysis at DNV GL (formerly GL Garrad Hassan).

2. Attached hereto and made a part hereof for all purposes is my Direct Testimony on behalf of Grain Belt Express Clean Line, LLC consisting of 12 pages, having been prepared in written form for introduction into evidence in the above-captioned docket.

3. I have knowledge of the matters set forth therein. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded, including any attachments thereto, are true and accurate to the best of my knowledge, information and belief.

Gary M. Moland
Gary Moland

Subscribed and sworn before me this 20th day of March 2014.

Notary Public

My commission expires: Nov 1, 2014

V. RAGHUNATHA REDDY VEMUSU
NOTARY PUBLIC
Exp. Nov 1, 2014
FULTON COUNTY, GA

81926337V-1

Gary Moland

Director of Power Markets & Transmission Analysis
DNV GL

Mr. Moland is an experienced consultant to the energy industry specializing in economic market analysis, energy price forecasting, congestion risk, wind curtailment risk, and integration of renewable generation. Mr. Moland's expertise includes comprehensive knowledge of study methods and technical approach to assessing wind curtailment risk, wind integration costs, economic impacts of new transmission, generation asset valuation, congestion risk, and other key areas. He has extensive project management experience and has led major consulting engagements including working in a team environment and responding to stakeholder and committee oversight in performance of studies. Mr. Moland has deep technical knowledge of simulation-based modeling of power systems and analytical methods for quantifying the economic impacts of future changes in energy markets. He has a strong track record in successfully managing a consulting group, including leading sales and marketing activities, budget development, staff mentoring, setting business strategy, and interfacing with executive management. He has participated as a panelist and speaker at industry-leading conferences and has published articles and provided interviews for energy-related publications.

Career History

GL Garrad Hassan/ DNV GL

Director of Power Markets & Transmission Analysis, December 2010 - present

Responsible for starting up a new service area within GL Garrad Hassan to provide services for economic market studies including congestion and curtailment risk assessment for renewable development projects. Wide latitude to pursue strategic studies in new industry markets to broaden the company's client base and penetrate new industry segments. Duties include

- Management of staff and oversight of all departmental consulting engagements
- Development of business plan, including strategic direction to meet revenue growth targets
- Annual budget development for revenue projections and staffing requirements
- Business development activities including writing proposals and technical sales support
- Establish and foster strong client relationships
- Provide expertise to support other service offerings within GL Garrad Hassan
- Expand industry presence through conference speaking engagements and publications

Ventyx

Vice President, 2007 - 2010

- Business Development – Managed all consulting business development activities for renewable companies, transmission development companies, and ISOs including proposal development, providing technical expertise on sales, maintaining strategic action plans for key clients, overseeing marketing activities, attending and speaking at conferences.

- Project Oversight – Held periodic reviews of all active projects, provided technical and project management direction as needed to ensure a successful engagement. Participated in key project calls, reviewed deliverables, wrote and edited final reports, and followed up with clients after project completion.
- Staff Development – Provide staff mentoring and internal training to ensure that consulting staff skills continue to develop and work quality is maintained at a high level. Responsible for hiring new staff as needed to meet project work load.

Principle Consultant, 2003-2007

- Nodal Market Team Leader – directed staff and participated in sales for nodal market studies.
- Project Manager – Led major project engagements including
    - Wind site congestion and curtailment analysis for over 20 separate project sites
    - Oversaw all Ventyx project work on EWITS and Nebraska wind integration studies funded by NREL (http://www.nrel.gov/wind/systemsintegration/ewits.html) (http://www.nrel.gov/wind/pdfs/47285.pdf)
    - Studied economic benefits of developing the transmission expansion "X" plan in SPP to support public filing by ITC for regulatory approval.
    - Studied ERCOT CREZ expansion to provide quantitative benefits for CREZ Scenario 2 in support of PUC testimony filed by a major wind developer
    - NPPD participation in SPP/MISO – this study was a key factor in NPPD's decision to join the SPP market.
    - Led the Ventyx Cost Benefit Study to assess SPP's move toward adding a day-ahead market with expanded ancillary services and financial Transmission rights (http://www.spp.org/publications/SPP%20Report%20April%20v8.pdf)

PowerBase™ Product Manager (2000 – 2003)

- Product Manager – Provided business plan, staffing levels, cost & revenue forecast, and strategic vision for the PowerBase data product for upper management.
- Market Data – Oversaw the development of simulation-ready data for North American energy markets delivered in the PowerBase database to over 40 clients. This included developing processes for migrating data from Platts database products as well as identifying other data sources and data research activities. Also included the incorporation of detailed powerflow data for full transmission system representation and the development of flowgates and contingencies for modeling congestion.
- Business Analyst – Acted as a business analyst to guide technical product development of new relational database and new user interface. Provided functional specifications, test plans and screen layouts to technical staff for implementation.

PROMOD™ Technical Manager (1997 – 2000)

- Product Version Control – Oversaw all code changes, testing, QA process, and version releases for the PROMOD product. Heavily involved in scoping and design of new program features including Hourly Monte Carlo dispatch under simple transmission, Marketwise convergence Monte Carlo feature, significant user interface enhancements, and many other program upgrades.

- Staff Development – Directed programming staff on implementation of new program features based on feedback from clients and sales staff. Mentored staff to enhance knowledge of production costing algorithms and coding techniques.

PROMOD™ Support (1990 – 1997)

- Provided technical programming support and direct client support for PROMOD users

Professional Experience

Selected key consulting engagements led by Mr. Moland include:

- *Eastern Wind Integration & Transmission Study* (EWITS, 2009) - Mr. Moland was the project manager for Ventyx, a key study partner responsible for developing the detailed modeling methods for capturing the operational impacts of hourly wind forecast error, hourly spinning/regulating reserve requirements, and other factors. EWITS was the first wind integration study in North America using detailed hourly wind profiles developed on a two kilometer grid, and provides an important benchmark for study methodologies in capturing wind integration costs and impacts. Link to study web site: http://www.nrel.gov/wind/systemsintegration/ewits.html

- *Nebraska State-Wide Wind Integrations Study* - (2009) - Mr. Moland was the overall project manager for the economic modeling work for this important regional wind integration study assessing up to 40% wind penetration within the Southwest Power Pool. Scenarios included assessing the impacts of SPP high voltage transmission expansion to transport wind to load areas. Link to study report: http://www.nrel.gov/docs/fy10osti/47285.pdf

- *Cost Benefit Analysis for Nebraska Utility's Participation in SPP & MISO Market (2008)* –Mr. Moland was the Ventyx project manager for a detailed cost/benefit analysis to support a Nebraska utility's decision to join the Midwest ISO or Southwest Power Pool energy market. PROMOD IV full transmission logic and the Simulation Ready Data were utilized to quantify the operational costs/benefits of MISO's centralized dispatch, MAPP balancing authority dispatch, and SPP EIS market dispatch. Other market design features were analyzed including ancillary services, MISO marginal loss impacts, and transmission congestion rights. Scenarios were developed to assess the impact of other Nebraska utilities joining MISO and whether the benefits of each option were dependent on the decisions of others. An initial view of FTR values for pathways from the client's generators to load hub was also provided to support the MISO participation option. The analysis from this study was used to support the client's decision to join the SPP market.

- *Atlantic Wind Connection Economic Feasibility Study (2010)* – Mr. Moland was the project manager for Ventyx's participation in an analysis of the economic and operational benefits associated with the construction of an offshore HVDC looped transmission backbone to facilitate 6000 MW of off shore wind development off the Atlantic coast of the US. The project included detailed modeling of the transmission design including assessing impacts of electrical losses and comparing a multi-terminal loop with radial connections for delivering wind to shore.

- *Southeastern U.S. Offshore Wind Integration Study (2011)* – Mr. Moland performed a study analyzing production cost and transmission congestion to assess the impacts of 8.5 GW of new offshore wind along the coast of North & South Carolina and Georgia. This public study was performed as part of a DOE grant to the Southern Alliance for Clean Energy. The study utilized databases from the Eastern Wind Integration and Transmission Study (EWITS) to look at a future 20% wind energy scenario for the year 2024. Study results included the fuel and emissions cost savings from offset thermal energy and the impact of energy prices in the Southeastern U.S. Key study scenarios included comparison of independent radial connections for offshore wind versus a looped offshore transmission network that allowed the wind energy to move north and south to reach a preferred landing point. Final report and supporting documents can be found at https://sites.google.com/site/sobreip/home/completed-reports.

Academic History

M.S., Mathematics and Computer Science, Emory University, Atlanta, 1992

B.S., Nuclear Engineering, Georgia Institute of Technology, Atlanta, 1984

Published Articles

Public Utility Fortnightly – May 2008 – "Windpower's Warning"
http://www.fortnightly.com/pubs/05012008_PowerMeasurements.pdf

Data Assumptions for Study Scenarios

2019 Assumptions	Business as Usual	Robust Economy	Slow Growth	Green Economy
Nat Gas Prices (Henry Hub Spot, $/MMBTU)	Medium: $4.74	High: Medium + $3	Low: Medium - $3	High: Medium + $3
Forced Coal Retirements (GW)	Medium: MISO - 13.5, PJM - 15.8	Low: MISO - 9.0, PJM - 11.1	Low: MISO - 9.0, PJM - 11.1	High: MISO - 21.8, PJM - 18.4
Carbon Pricing	No	No	No	Yes: $50/ton
NOx, SOx ($/ton)	Medium: NOx – 40.59, SOx - 0	Medium: NOx – 40.59, SOx - 0	Low: Medium -25%	High: Medium +25%
Load Growth	Medium: 1.4% peak, 1.7% energy	High: 2.1% peak, 2.5% energy	Low: 0.7% peak, 0.8% energy	High: 2.1% peak, 2.5% energy
Wind (Eastern US)	60.8 GW	60.8 GW	60.8 GW	111.6 GW
Transmission expansion	Approved Projects	Approved Projects + RITELine, PATH	Approved Projects	Approved Projects + RITELine, PATH

Full Economic Benefit Results for Grain Belt Express

Demand Cost **($M)** **2019**

		Business as Usual	Slow Growth	Robust Economy	Green Economy
Without Grain Belt	Missouri	2,965	2,063	4,872	8,362
With Grain Belt	Missouri	2,943	2,052	4,807	8,328
Savings	Missouri	22	11	65	34

Locational Marginal Price ($/MWh) **2019**

			Business as Usual	Slow Growth	Robust Economy	Green Economy
Without Grain Belt	LMP OnPeak Avg	Missouri	38.99	26.94	63.73	99.43
Without Grain Belt	LMP OffPeak Avg	Missouri	28.77	21.07	37.93	78.12
Without Grain Belt	LMP Average	Missouri	33.64	23.87	50.24	88.27
With Grain Belt	LMP OnPeak Avg	Missouri	38.65	26.80	62.92	98.91
With Grain Belt	LMP OffPeak Avg	Missouri	28.62	20.97	37.35	77.93
With Grain Belt	LMP Average	Missouri	33.40	23.75	49.55	87.92
LMP Change	LMP OnPeak Delta	Missouri	-0.33	-0.14	-0.81	-0.52
LMP Change	LMP OffPeak Delta	Missouri	-0.15	-0.10	-0.58	-0.18
LMP Change	LMP Average Delta	Missouri	-0.24	-0.12	-0.69	-0.34

Variable Production Cost (Eastern US) **($M)** **2019**

	Business as Usual	Slow Growth	Robust Economy	Green Economy
Without Grain Belt	75,906	52,959	100,798	150,015
With Grain Belt	75,331	52,572	99,931	148,780
Savings	574	387	867	1,236

Emissions and Water Use Reduction Results for Grain Belt Express

Emissions (Eastern US) 2019

		Business as Usual	Slow Growth	Robust Economy	Green Economy
Without Grain Belt	NOx (tons)	902,580	596,858	1,084,855	615,122
Without Grain Belt	SOx (tons)	2,196,005	971,702	2,618,321	1,426,626
Without Grain Belt	CO2 (tons)	1,541,471,608	1,171,768,238	1,768,831,993	1,140,810,137
Without Grain Belt	Hg (lbs)	28,091	13,352	32,614	18,238
Without Grain Belt	Water (MGal)	424,612	502,802	457,766	478,173
With Grain Belt	NOx (tons)	895,469	588,908	1,080,168	609,014
With Grain Belt	SOx (tons)	2,176,216	955,125	2,608,824	1,405,774
With Grain Belt	CO2 (tons)	1,531,458,478	1,160,202,768	1,761,300,314	1,130,027,471
With Grain Belt	Hg (lbs)	27,955	13,235	32,545	18,095
With Grain Belt	Water (MGal)	420,331	500,018	452,873	474,222
Reduction	NOx (tons)	7,111	7,950	4,687	6,109
Reduction	SOx (tons)	19,788	16,578	9,497	20,852
Reduction	CO2 (tons)	10,013,130	11,565,469	7,531,679	10,782,667
Reduction	Hg (lbs)	135	117	69	143
Reduction	Water (MGal)	4,281	2,783	4,893	3,952