# ITC Benefits Study

Executive Summary

**October, 2016**

Submitted to:
ITC Holdings Inc.

# I. Background

ITC Holdings Corporation (ITC) is the largest and first fully independent electric transmission company in the country. ITC owns and operates high-voltage transmission facilities in Michigan, Iowa, Minnesota, Illinois, Missouri, Kansas and Oklahoma, serving a combined peak load exceeding 26,000 megawatts along 15,600 circuit miles of transmission lines [1]. ITC operates its existing transmission network through four regulated subsidiaries – ITC Transmission (ITCT), Michigan Electric Transmission Company (METC), ITC Midwest (ITCMW) and ITC Great Plains and participates in two RTO market areas, MISO and SPP.

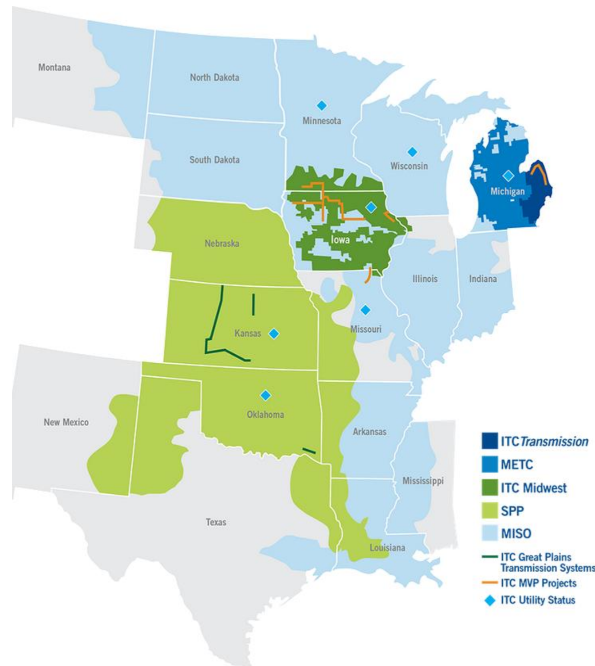



**Exhibit 1: ITC's geographic footprint**

The independent transmission company business model avoids the trade-off that can occur within a traditional, vertically-integrated, public utility company that owns transmission, generation and distribution. This single operational focus, in turn, enables the independent transmission company to: (i) remain neutral to the generator it will interconnect with, whether by fuel source or ownership; (ii) invest in transmission without competing investments in generation and/or distribution assets, and (iii) address without bias to other owned assets the necessary reliability and economic upgrades to the transmission system.

ITC Transmission, launched in 2003, serves southeast Michigan and the Thumb region. These regions were formerly served by DTE Electric.

Michigan Electric Transmission Company, LLC has been a wholly owned subsidiary of ITC Holdings since 2006. METC owns, operates, and maintains transmission lines in most of Michigan's Lower Peninsula.

ITC Midwest serves most of Iowa and portions of Minnesota, Illinois and Missouri. The subsidiary was created in 2007 when ITC acquired the transmission assets of Interstate Power and Light Company.

ITC Great Plains is a transmission-only utility operating in the Southwest Power Pool region since 2006. ITC Great Plains operates on a "greenfield" business model. The company currently owns transmission assets in Kansas and Oklahoma.

As a company, ITC has developed a unique business model, specializing in transmission investment, operations, and maintenance, which provides significant benefits to its customers and other stakeholders.

ITC requested that ICF quantify the actual benefits it has brought to each of its service areas since it assumed operations.

[1] ITC Holdings (2016). Accessed on September 23, 2016 at: http://www.itc-holdings.com/itc/about-us

# II. Approach

ICF used actual historical data on operations within the regions to calculate the actual benefits of ITC's operation. ICF determined that data would be available primarily for the operating years after 2007, therefore ICF performed the benefits assessment for the 2008 to 2014 operating period. Benefits for the period 2003 to 2007 have not been included in this study.

ICF quantified the benefits by comparing a case representing the status quo with ITC operating in its service territories (the ITC Case) to a case representing the potential system conditions if ITC had not taken over the service territories (the Non-ITC Case). Both cases included transmission projects that would likely have been built regardless of the service provider. Projects that could be attributed directly to ITC's management approach were included in only the ITC Case. Projects in the former category included generation and load interconnection projects, resource adequacy projects and reliability transmission projects. These projects were developed at the request or third party market participants or in order to meet reliability requirements, and would likely have been implemented even if a different service provider owned and operated the system. Therefore, these projects are included in both the ITC and Non-ITC cases.

However, projects such as the Michigan Thumb Loop, a MISO Multi Value Project (MVP) required significant effort from ITC to develop and construct the high voltage transmission lines to integrate wind resources into the regional generation mix. Such projects could reasonably be attributed to ITC's approach, and were therefore included in only the ITC Case.

The benefits were grouped into 3 categories:

- Market Efficiency Benefits
- Reliability Benefits
- Renewable Benefits

Exhibit 2 lists the transmission projects included in ITC and non-ITC cases. The list includes major transmission projects developed by ITC between 2008 and 2014.

### Exhibit 2 List of transmission projects included in ITC and non-ITC case

| Geographic Location by TO Member System | Project Name | Project Type | Expected ISD (Max) | To be modeled in ITC Case | To be modeled in Non-ITC Case |
|---|---|---|---|---|---|
| **MISO** | | | | | |
| ITCMW | Glenworth 161/69kV (Glenville Area) | Reliability Project | 30-08-2011 | Yes | Yes |
| | G612-Marshalltown-Boone 115kV to 161kV | Generator Interconnection | 31-12-2013 | Yes | Yes |
| ITCT | Adams-Spokane/Burns1-Jewel 120 kV Rebuild | Capacity / Resource Adequacy | 6/15/2012 | Yes | Yes |
| | Stephens - Erin 120 kV line #3 | Capacity / Resource Adequacy | 7/31/2007 | Yes | Yes |
| | Majestic 345/120 kV switching station | Capacity / Resource Adequacy | 12/31/2007 | Yes | Yes |
| | Coventry Station upgrade | Capacity / Resource Adequacy | 4/5/2008 | Yes | Yes |
| | Durant-Genoa 120 kV | Capacity / Resource Adequacy | 12/5/2009 | Yes | Yes |
| | Pontiac-Joslyn and Joslyn-Walton Equipment upgrade | Capacity / Resource Adequacy | 5/30/2007 | Yes | Yes |
| | Hines and Walton Station Equipment Replacement | Capacity / Resource Adequacy | 10/15/2007 | Yes | Yes |
| | B3N Interconnection | Capacity / Resource Adequacy | 4/5/2012 | Yes | Yes |
| | Wixom-Quaker 230 | Capacity / Resource Adequacy | 5/30/2007 | Yes | Yes |
| | Monroe-Wayne 345kV Sag Remediation | Capacity / Resource Adequacy | 01-06-2014 | Yes | Yes |

| Geographic Location by TO Member System | Project Name | Project Type | Expected ISD (Max) | To be modeled in ITC Case | To be modeled in Non-ITC Case |
|---|---|---|---|---|---|
| METC | Tittabawassee-Hemlock Semiconductor 138 kV line | Load Interconnection | 10/1/2007 | Yes | Yes |
| | Argenta-Verona 138kV SAG Limit | Capacity / Resource Adequacy | 12/4/2008 | Yes | Yes |
| | Twining - Almeda 138kV | Capacity / Resource Adequacy | 12/30/2011 | Yes | Yes |
| | Almeda - Saginaw River 138kV | Capacity / Resource Adequacy | 11/24/2010 | Yes | Yes |
| | Campbell - Black River 138kV | Capacity / Resource Adequacy | 10/15/2010 | Yes | Yes |
| | Tippy - Chase 138kV | Capacity / Resource Adequacy | 3/8/2013 | Yes | Yes |
| | Algoma - Croton | Capacity / Resource Adequacy | 1/14/2011 | Yes | Yes |
| | Felch Road - Croton | Capacity / Resource Adequacy | 2/26/2010 | Yes | Yes |
| | Argenta-Palisades 345kV ckt. 1 & 2 | Capacity / Resource Adequacy | 6/3/2010 | Yes | Yes |
| | Leoni-Beecher 138 kV | Capacity / Resource Adequacy | 5/5/2009 | Yes | Yes |
| | Livingston - Vanderbilt 138 kV Rebuild | Capacity / Resource Adequacy | 10/31/2012 | Yes | Yes |
| | Cottage Grove-East Tawas 138 kV Rebuild | Capacity / Resource Adequacy | 10/4/2013 | Yes | Yes |
| | Croton-Nineteen Mile 138 kV Rebuild | Capacity / Resource Adaquacy | 11/7/2014 | Yes | Yes |
| | Vestaburg 138 kV line upgrade | Capacity / Resource Adaquacy | 6/1/2012 | Yes | Yes |
| | Bullock - Summerton 138 kV line upgrade | Capacity / Resource Adaquacy | 10/31/2012 | Yes | Yes |
| | Canal Jct. - Delhi 138 kV Sag Remediation | Capacity / Resource Adaquacy | 6/11/2013 | Yes | Yes |
| | Karn-Garfield 138kV Sag Remediation | Capacity / Resource Adaquacy | 5/30/2014 | Yes | Yes |
| | Brickyard Jct. - Felch Road 138 kV | Capacity / Resource Adaquacy | 3/10/2010 | Yes | Yes |
| | American Bumper - David 138 ckt # 1 | Capacity / Resource Adaquacy | 6/1/2007 | Yes | Yes |
| | Keystone - Clearwater - Stover 138 kV line Phase 1 | Capacity / Resource Adaquacy | 12/12/2008 | Yes | Yes |
| | Simpson - Batavia 138 kV line | Capacity / Resource Adaquacy | 6/1/2012 | Yes | Yes |
| | 4 Mile-Englishville 138 kV Sag Clearance | Capacity / Resource Adaquacy | 12/18/2008 | Yes | Yes |
| | Midland | Load Interconnection | 12/31/2009 | Yes | Yes |
| | Tallmadge - Wealthy Street 138 kV line #2 | Capacity / Resource Adaquacy | 12/23/2008 | Yes | Yes |
| **MISO** | | | | | |
| ITCT | Michigan Thumb Loop (Phase-1): Baur-Rapson 345 kV Line | MVP | 1/9/2013 | Yes | No |
| | Michigan Thumb Loop (Phase-II): Fitz-Greenwood 345 kV Line | MVP | 1/5/2014 | Yes | No |
| METC | Canal Jct - Island Rd 138kV | Reliability/Hardening/infrastructure Replacement | 2/10/2011 | Yes | No |
| | Iosco - East Tawas 138kV | Reliability/Hardening/infrastructure Replacement | 6/29/2011 | Yes | No |
| | Cobb Swamp Rebuild | Reliability/Hardening/infrastructure Replacement | 9/30/2010 | Yes | No |
| | Alcona - Mio 138kV | Capacity / Resource Adaquacy | 6/15/2012 | Yes | No |
| | Twining - Alcona 138kV Rebuild | Reliability/Hardening/infrastructure Replacement | 6/29/2014 | Yes | No |
| ITCMW | Emery-Lime Crk 161kV, Ckt 2 | | 6/1/2007 | Yes | Yes |
| | Hazleton - Salem 345 kV line with a 2nd Salem 345/161 kV 448 MVA transformer. | | 5/1/2013 | Yes | No |
| | Quad Cities-Rock Creek-Salem 345 kV line | Reliability/Hardening/infrastructure Replacement | 6/1/2010 | Yes | Yes |
| | Rock Creek 345/161 kV transformer | Reliability/Hardening/infrastructure Replacement | 6/1/2010 | Yes | Yes |
| | Heron Lake-Lakefield 161kV line rebuild | Reliability/Hardening/infrastructure Replacement | 4/17/2014 | Yes | No |
| | Arnold-Vinton-Dysart-Washburn 161kV Reconductor | Reliability/Hardening/infrastructure Replacement | 12/31/2009 | Yes | No |
| | Beaver Channel-Albany 161kV Uprate | Reliability/Hardening/infrastructure Replacement | 4/1/2013 | Yes | Yes |
| | Bertram-PCI 161kV Uprate | Reliability/Hardening/infrastructure Replacement | 12/31/2013 | Yes | Yes |

| Geographic Location by TO Member System | Project Name | Project Type | Expected ISD (Max) | To be modeled in ITC Case | To be modeled in Non-ITC Case |
|---|---|---|---|---|---|
| | Ottumwa-Briddgeport North 161kV Uprate | Reliability/Hardening/infrastructure Replacement | 12/31/2013 | Yes | Yes |
| | Ottumwa-Wapello #2 161kV Uprate | Reliability/Hardening/infrastructure Replacement | 12/30/2014 | Yes | Yes |
| SPP | | | | | |
| ITCGP | HUGO - VALLIANT 345KV CKT 1 | Transmission Service | 6/08/2012 | Yes | Yes |
| | HUGO 345/138KV TRANSFORMER CKT 1 | Transmission Service | 6/30/2012 | Yes | Yes |
| | Line - Hugo - Sunnyside 345 kV | Transmission Service | 6/18/2012 | Yes | Yes |
| | POST ROCK - SPEARVILLE 345KV CKT 1 | Balanced Portfolio | 6/18/2012 | Yes | No |
| | POST ROCK 345/230KV TRANSFORMER CKT 1 | Balanced Portfolio | 12/15/2012 | Yes | No |
| | AXTELL - POST ROCK 345KV CKT 1 (ITC GP) | Balanced Portfolio | 6/08/2012 | Yes | No |

# III. Market Efficiency Benefits

Market efficiency benefits are achieved when transmission system improvements allow operator to use generation resources more efficiently. Transmission system additions and upgrades can increase line and interface capacity, reduce constraints, improve the ability to operate in the event of planned or unplanned outages, and allow system operators to better use relatively cheaper generation that would otherwise be constrained or curtailed due to congestion. This results in benefits from reduced production cost of power, reduced system congestion, and lower losses.

To calculate these benefits ICF simulated the operation of the MISO and SPP markets using the GE-MAPS production cost software.GE-MAPS is a highly detailed model that chronologically calculates hour-by-hour production costs while recognizing the constraints on the dispatch of generation imposed by the transmission system. GE MAPS uses a detailed electrical model of the entire transmission network, along with generation shift factors determined from a solved alternating current (AC) load flow, to calculate the real power flows for each generation dispatch. The outputs of GE MAPS includes hourly locational marginal prices for all generator and load busses, hourly forecast of congestion across transmission lines and interfaces and associated congestion cost, system-wide congestion cost, and hourly dispatch of generation units. Therefore ICF's analysis was consistent with the current nodal operation of the MISO and SPP markets.

ICF developed assumptions on fuel prices, peak and energy demand, emission allowance prices, transmission topology, generation and other market information based on historical parameters for the ITC Case and the Non-ITC Case. Using these assumptions, ICF modeled the Eastern Interconnect with a focus on MISO and SPP. ICF simulated the operation of the MISO and SPP markets for both the ITC Case and the Non-ITC Case. Because the transmission projects attributed to ITC were developed at the start of 2010, ICF simulated market operations for 5 explicit run years – 2010 through 2014. By comparing system operations and production costs for the two cases in these 5 years, ICF quantified the economic benefits of ITC's projects.

Exhibit 3 summarizes the market efficiency benefits for MISO and SPP in nominal dollars based on the reduction in Adjusted Production Cost (APC) in the ITC Case relative to the Non-ITC Case. The APC is the production cost adjusted for imports and exports. Market efficiency benefits vary annually as new transmission projects or transmission upgrades are implemented. Variations are also due to changes in natural gas prices and demand. Over the 5-year period the ITC transmission projects provide total economic benefits of $643MM and $71MM in 2015$ (present value using a nominal discount rate of 6.8%) for MISO and SPP respectively.

Between 2010 and 2014 ITC's transmission projects saved ITC's customers and neighboring customers $714 million in 2015$ (present value using a nominal discount rate of 6.8%) in reduced energy production costs. Of this amount $172 million were direct savings to ITC Midwest customers and $111 million were direct savings to ITC Michigan customers.

**Exhibit 3 Annual adjusted production cost savings for MISO and SPP ($ MM) (nominal)**


Source: ICF

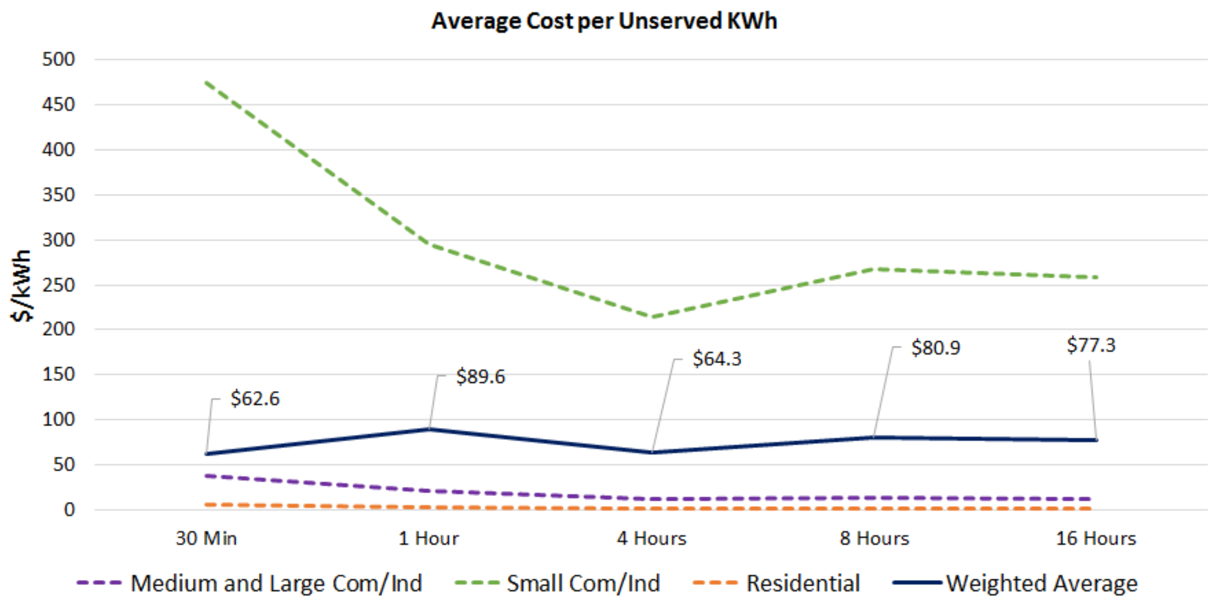
## IV. Reliability Benefits from Reduced Outages

Following the acquisition of Interstate Power and Light Company, ITC Midwest upgraded several 34.5 kV distribution circuits. ICF reviewed outage information on the 34.5 kV circuits and determined that the number of outages decreased between 2011 and 2014. ICF calculated the benefits as the reduction in societal cost to consumers due to the reduced outages. The factors ICF used to assessing the societal cost were:

- The frequency of outages. This was based on the System Average Interruption Frequency Index (SAIFI) of the distribution circuits. ICF's review of ITC data showed a reduction in the frequency of interruptions.

- The unserved energy, which was calculated using data on the load served on each circuit and the duration of each outage. ITC provided data on the load served, and the duration was determined from the System Average Interruption Duration Index (SAIDI).
- The Value of Lost Load (VoLL), which is a measure of the value of unserved energy to a consumer. ICF's VoLL assumptions were consistent with values determined in a Lawrence Berkeley National Laboratory assessment conducted in 2015 (see Exhibit 4)[2]. The LBNL study derived values for different customer classes. Because the ITC load could not be disaggregated by customer class, ICF used a weighted average of all customer classes. Based on the average duration of outages, ICF used a VoLL of $64.3/kWh.

### Exhibit 4 Average cost per unserved kWh




**Source**: average cost per unserved kWh values from LBNL (2015)[3]
**Note**: ICF calculated weighted average by proportion of each customer class facing each outage duration from LBNL (2009) metadata[4]

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[2] Sullivan et al. (2015). Updated Value of Service Reliability Estimates for Electric Utility Customers in the United States. Lawrence Berkley National Lab (LBNL). Accessed September 23, 2016, https://emp.lbl.gov/sites/all/files/value-of-service-reliability-final.pdf.pdf
[3] Sullivan et al. (2015). See previous footnote
[4] Sullivan et al. (2009). Estimated Value of Service Reliability for Electric Utility Customers in the United States. Lawrence Berkley National Lab (LBNL). Accessed September, 2016, https://emp.lbl.gov/sites/all/files/REPORT%20lbnl-2132e.pdf

Exhibit 5 summarizes the benefits from reduced customer outages. Between 2011 and 2014 ITC's upgrades resulted in $98 million (2015$) in savings to customers.

**Exhibit 5 Value of reliability through reduced customer outages**

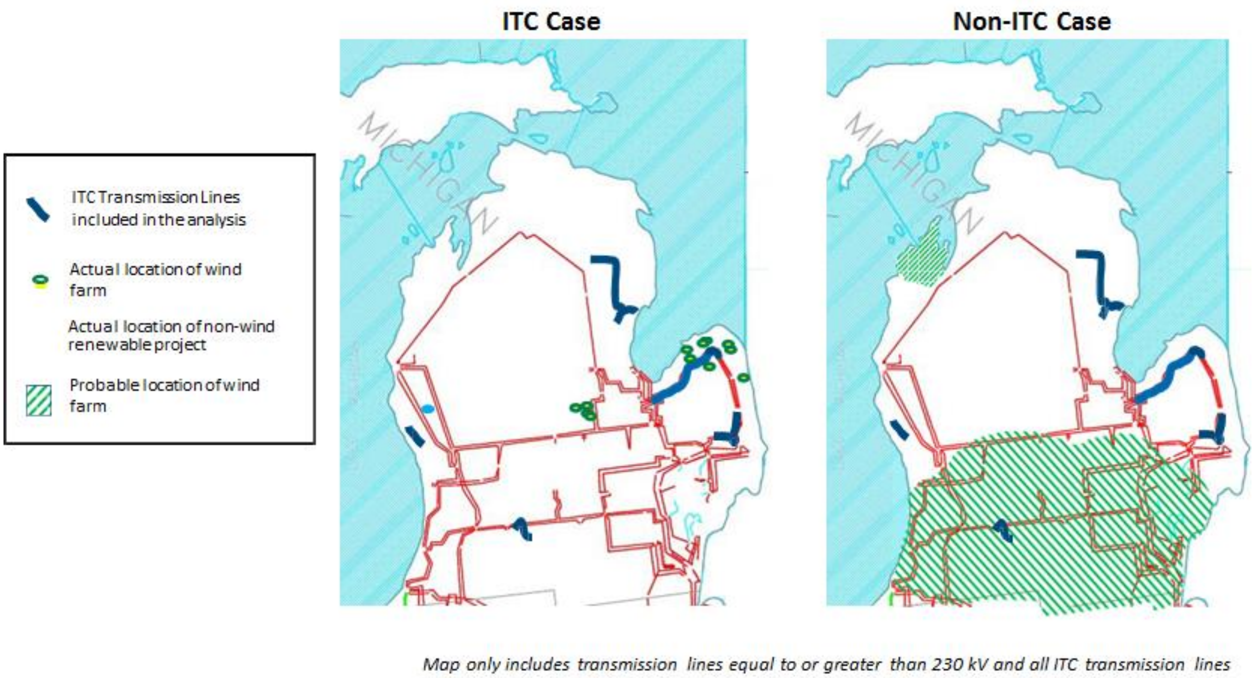

Source: ICF

## V. Environmental Benefits (from Increased Integration of Renewable Resources)

The aspect of renewable resource integration examined in this study was the reduction in cost to meet renewable portfolio standards (RPS). ICF's assessment of the location of wind projects built during the study period showed that in general, the ITC transmission projects enabled wind resources to be sited in favorable locations with relatively higher wind speeds. ICF assumed that if the ITC projects had not been developed, the wind resources required to meet RPS requirements would have been built in less favorable locations (locations with lower wind speeds) closer to load centers and existing transmission infrastructure. Wind capacity factors would thus have been lower in the Non-ITC Case, and more wind resources would be resources would be needed to produce the same amount of energy. This implies that without the ITC transmission projects, the overall cost to develop wind resources to meet RPS requirements would be higher than that in the ITC Case.

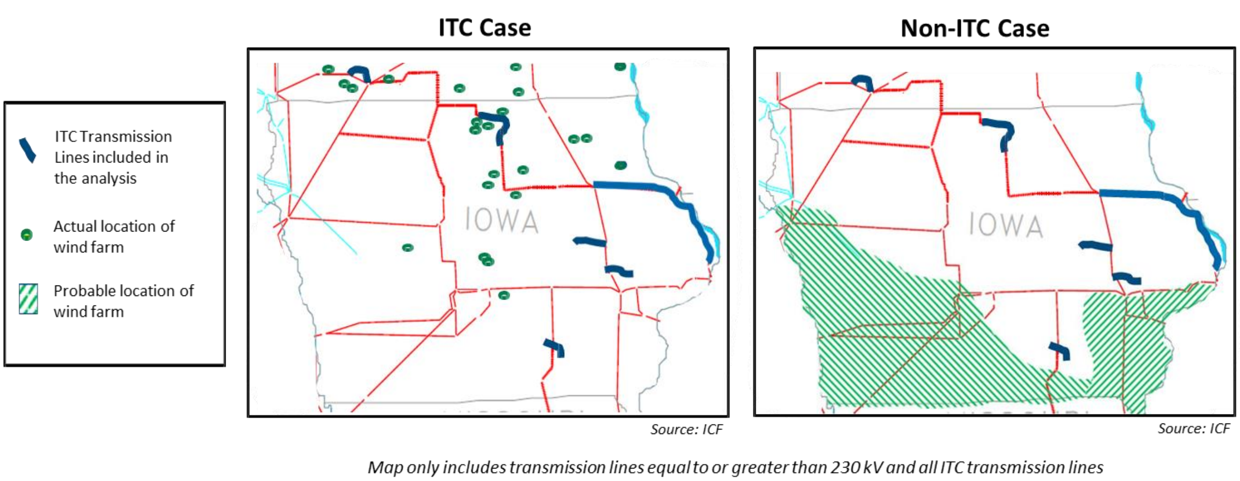
Exhibit 6 shows the location of renewable resources enabled by the ITCT and METC transmission projects, and the areas where ICF assumed wind farms would likely have been built in the absence of the ITC projects. The likely areas are shaded green in the Non-ITC Case. The likely locations for ITC Midwest are shown in Exhibit 7.

### Exhibit 6 Location of ITCT and METC renewable resources in ITC Case and assumed locations in Non-ITC Case




Source: Map compiled by ICF

### Exhibit 7 Location of ITC Midwest renewable resources in ITC Case and assumed locations in Non-ITC Case




Source: Map compiled by ICF

The average wind speed for each case, and the impact on wind capacity factors ae shown in Exhibit 8. For example, the average wind speed for existing wind resources in ITCT is 7.25 m/s. Without the ITC projects the wind resources would likely have been developed in areas with an average wind speed of 6.5 m/s. The change in wind speed corresponds to a 5.63% reduction in capacity factor of wind resources in the Non-ITC Case relative to the ITC Case.

**Exhibit 8 Average change in capacity factor of each wind farm by ITC region**

| Region | ITC Case: Average Wind Speed (m/s) | Non-ITC Case: Average Wind Speed (m/s) | Average Change in Capacity Factor (%) |
|---|---|---|---|
| ITCT | 7.25 | 6.5 | **5.63** |
| METC | 6.75 | 6.5 | **1.88** |
| ITC Midwest | 8 | 7.5 | **3.75** |

Source: Compiled by ICF based on client input.

Note: The change in capacity factor for changes in wind speed is based on a report from LBNL (2006).[5]

Due to the reduced capacity factor of the wind turbines in the non-ITC case, additional wind turbines would need to be installed to produce equivalent amounts of renewable electricity and meet RPS requirements. The capital and operating costs of the wind turbines are equivalent between the ITC and non-ITC case; therefore, the weighted average change in the Levelized Cost of Energy (LCOE) is a function of the change in capacity factor and equals $9.99/MWh (see Exhibit 9 for the formula).

**Exhibit 9 LCOE Formula**

$$LCOE = \frac{Capital\ Project\ Cost * Capital\ Charge\ Rate + O\&M\ Expenses - Production\ Tax\ Credit}{8760 * Capacity\ Factor}$$

The renewable energy technologies were installed over a period spanning from 2008 to 2015. The resulting annual renewable energy benefits from reduced LCOE are shown in Exhibit 10. The present value of total benefits for the 2008 to 2015 period is $587M in 2015$. Michigan projects saved customers approximately $250 million in reduced cost to meet renewable requirements, and Midwest projects saved customers approximately $337 million.

[5] Fripp, Matthais and Wiser,Ryan. Analyzing the Effects of Temporal Wind Patterns on the Value of Wind-Generated Electricity at Different Sites in California and the Northwest. Lawrence Berkley National Lab (LBNL). Accessed September, 2016, https://emp.lbl.gov/sites/all/files/REPORT%20lbnl%20-%2060152.pdf

**Exhibit 10 Annual renewable energy benefits**

| Year | Annual Renewable Benefit ($M) |
|---|---|
| **2008** | 16.9 |
| **2009** | 47.7 |
| **2010** | 48.0 |
| **2011** | 66.8 |
| **2012** | 97.3 |
| **2013** | 103.2 |
| **2014** | 114.9 |

Source: Compiled by ICF

# VI. Other Benefits

ICF did not perform an exhaustive analysis of all the benefits available from the transmission improvements implemented by ITC. Market efficiency and reliability benefits prior to 2010 were not assessed. Other benefits that were not explicitly quantified include:

- Environmental benefits of wind projects enabled by ITC in SPP. The analysis in the report was limited to ITCT, METC and ITC Midwest. Benefits from ITC Great Plains projects were not included.
- Other environmental benefits. Assessment of environmental improvements such as reduced emissions were not included in ICF's study.
- Benefits of reduced outages of high voltage transmission lines. Reduced outages resulting from ITC's transmission line upgrades and improvements we not included in ICF's market efficiency analysis. Therefore any related operational efficiency benefits were not assessed.
- Deferred or displaced infrastructure upgrades. ITC's transmission projects could defer or displace the need for other upgrades that would otherwise have to be made. These benefits were not assessed in the study.
- Resource adequacy benefits. ITC's transmission projects can help meet the region's resource adequacy needs by enabling capacity additions through interconnection access to the system, maintaining capacity transfer limits, maintaining system reliability and enabling additional participants in the market (such as wind developers) and increasing transparency of the market for participants. The contribution of the ITC projects to the ability to meet the resource adequacy needs has not be included in this assessment.