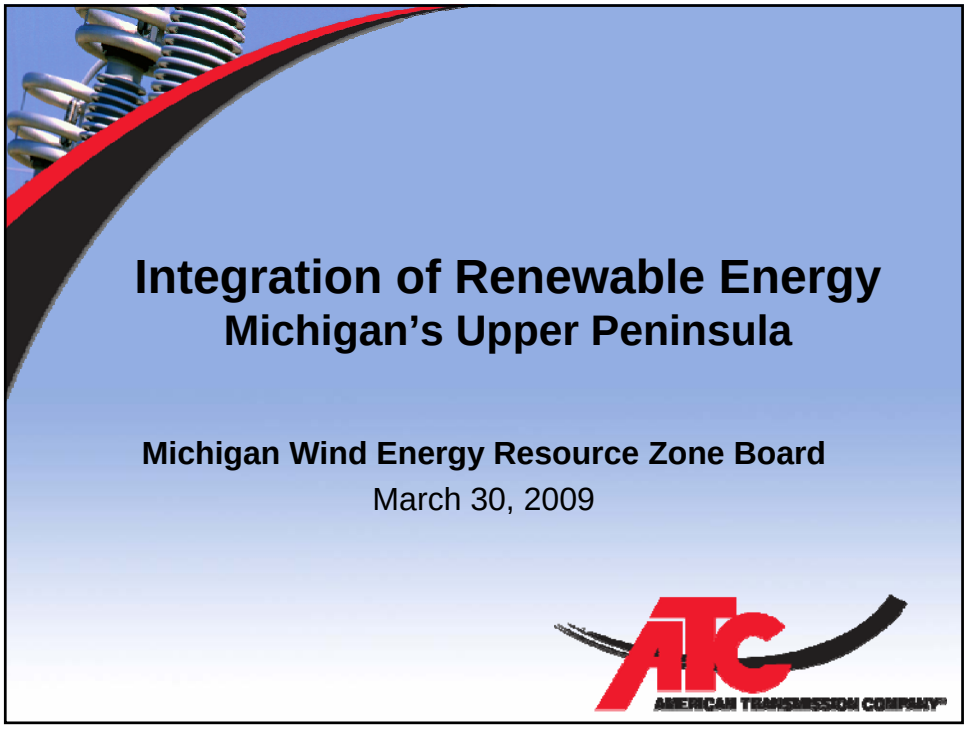
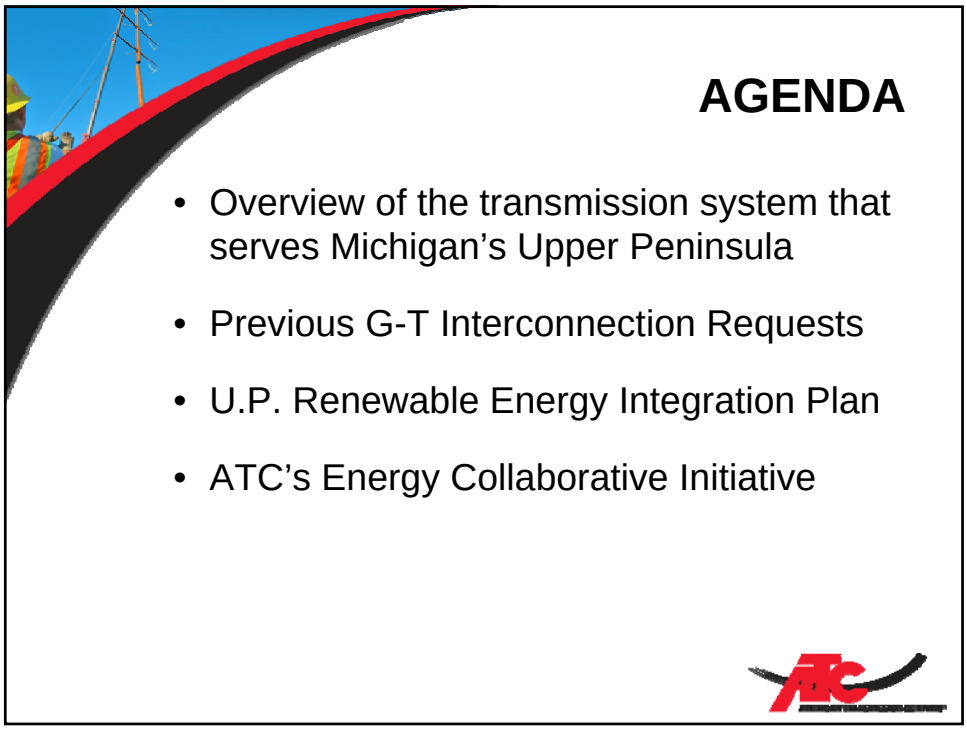


Integration of Renewable Energy
Michigan's Upper Peninsula

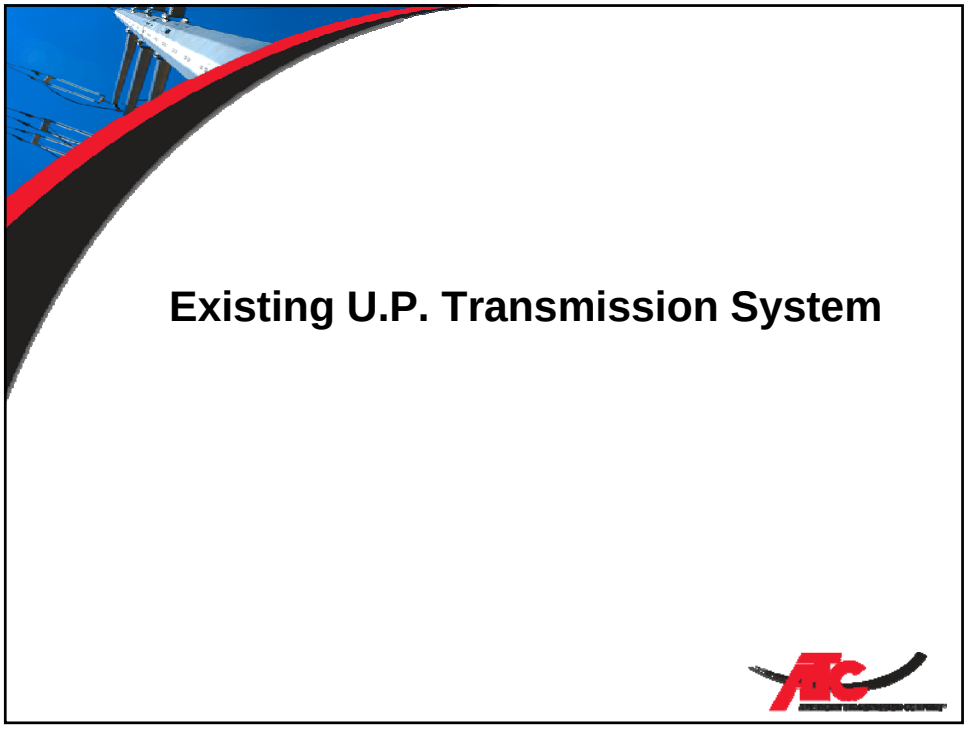
Michigan Wind Energy Resource Zone Board

March 30, 2009

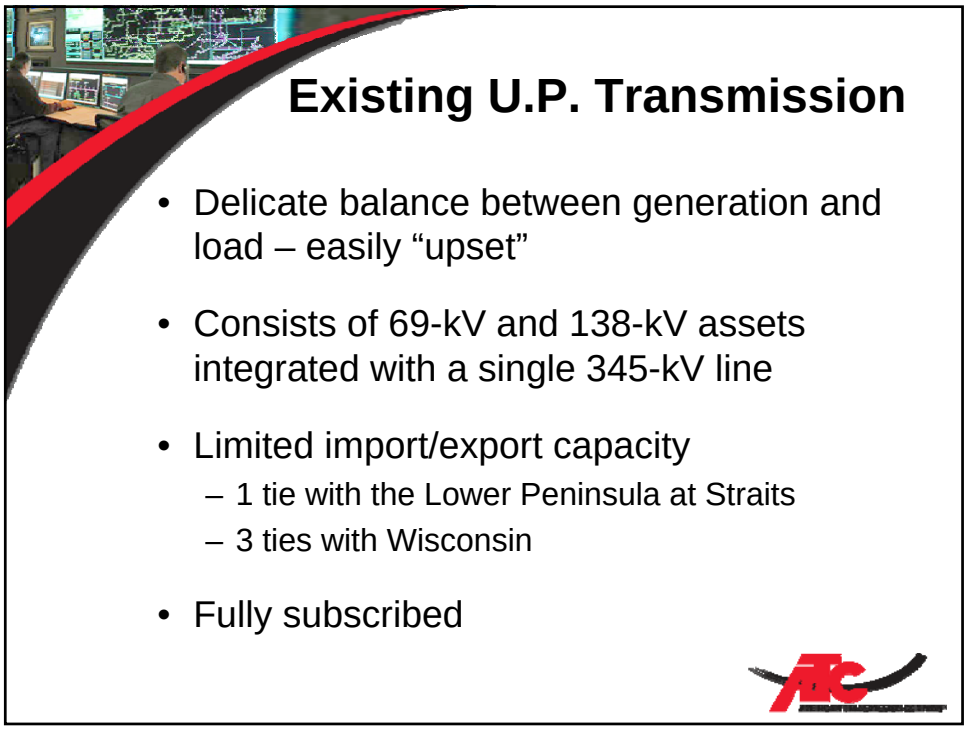


AGENDA

- Overview of the transmission system that serves Michigan's Upper Peninsula
- Previous G-T Interconnection Requests
- U.P. Renewable Energy Integration Plan
- ATC's Energy Collaborative Initiative

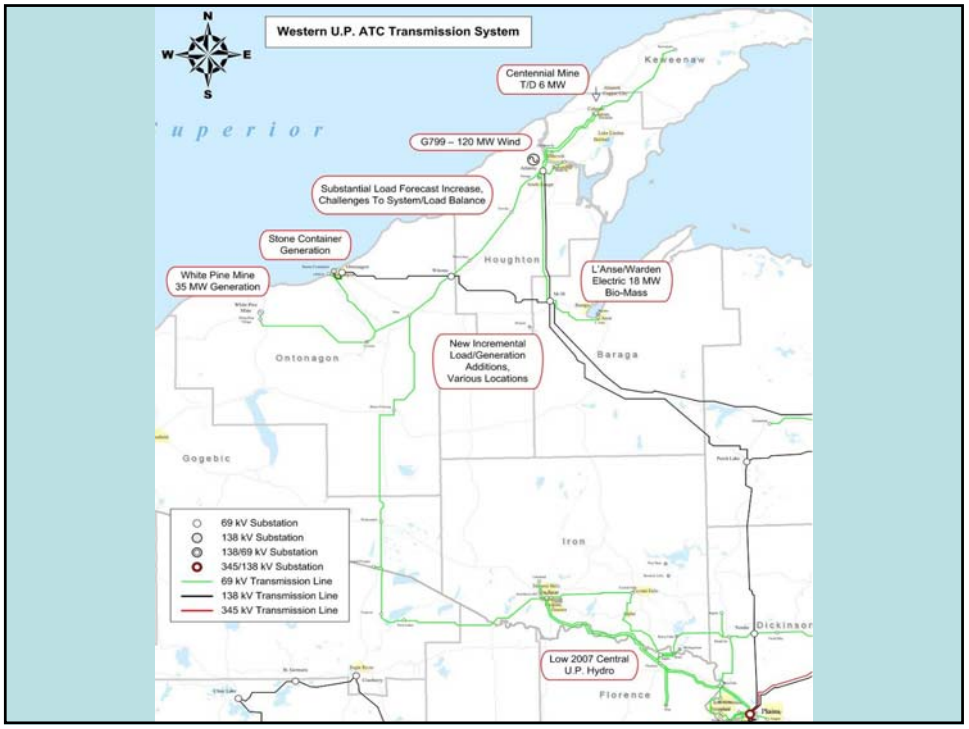


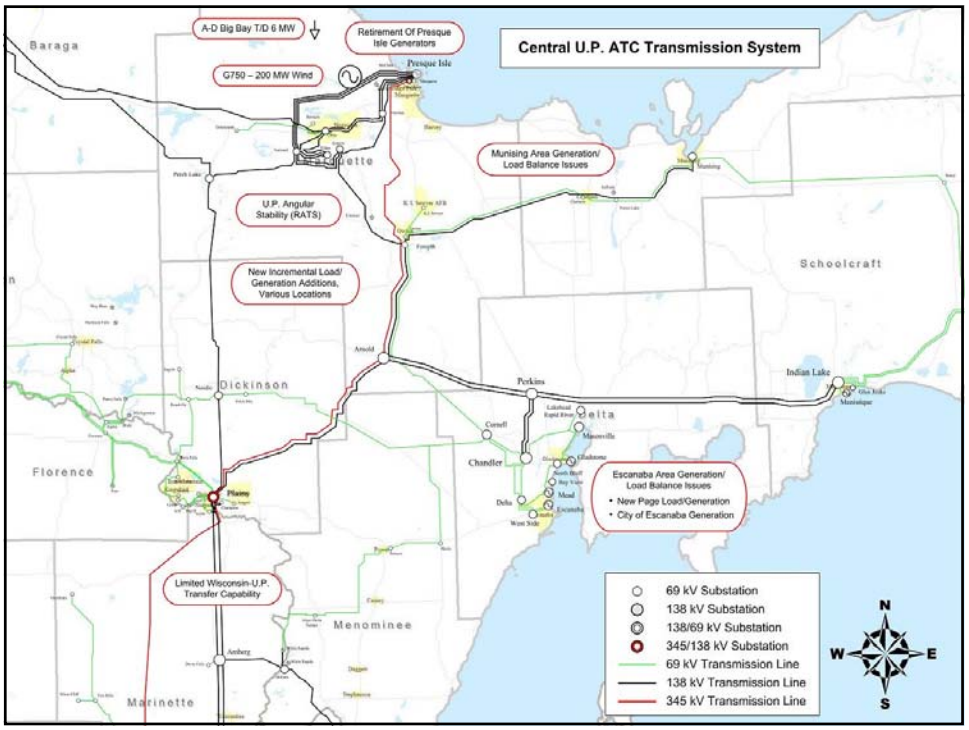
Existing U.P. Transmission System

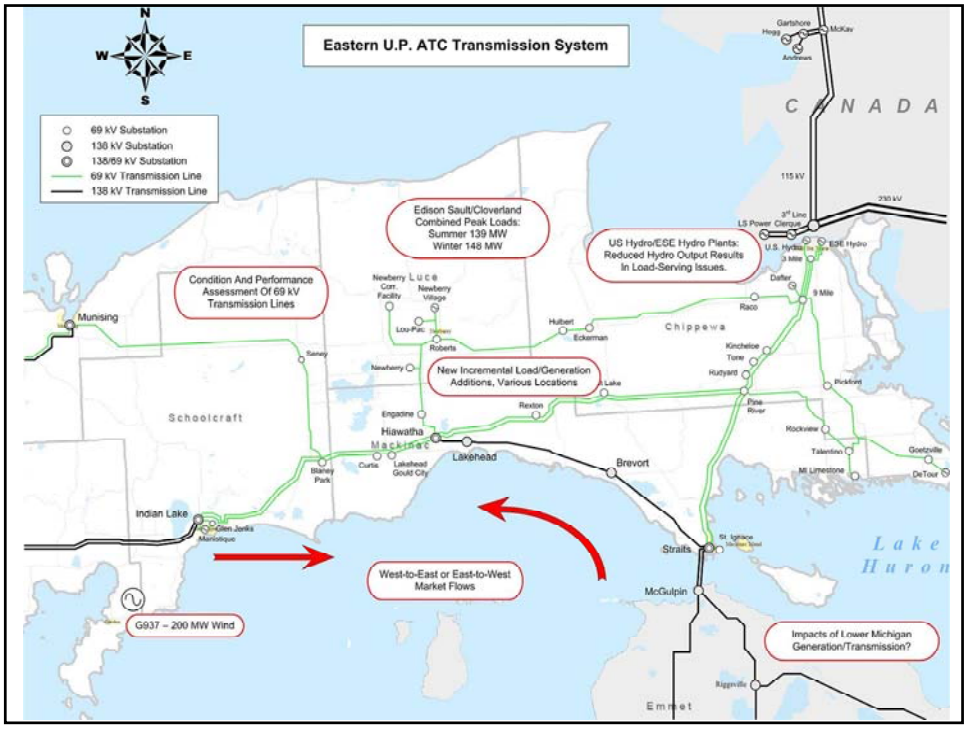


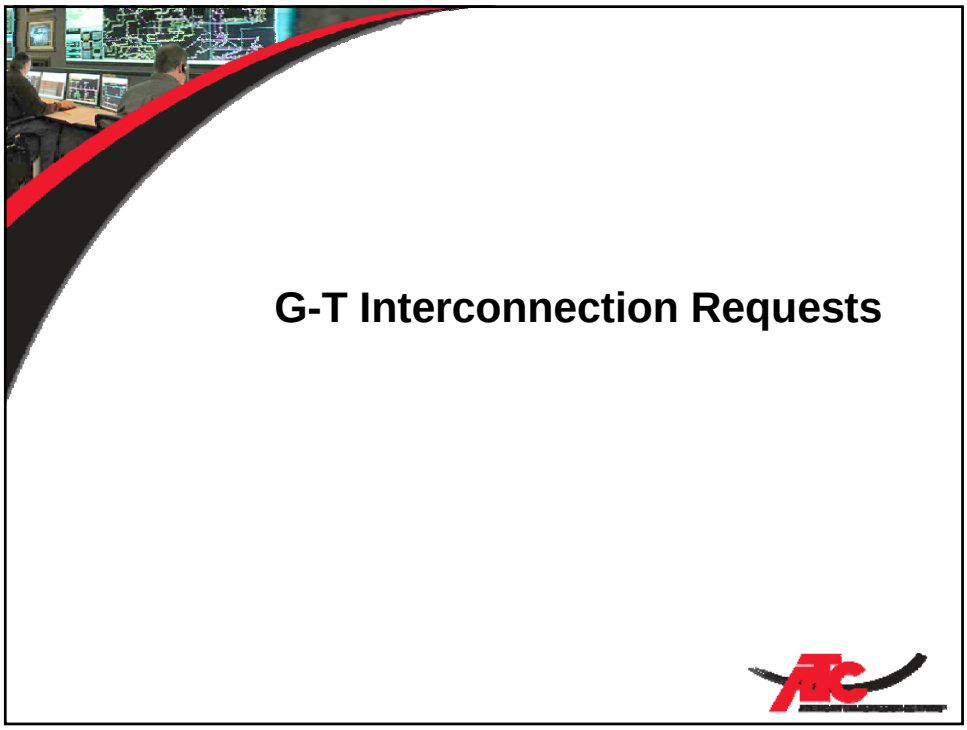
Existing U.P. Transmission

- Delicate balance between generation and load – easily “upset”
- Consists of 69-kV and 138-kV assets integrated with a single 345-kV line
- Limited import/export capacity
  - 1 tie with the Lower Peninsula at Straits
  - 3 ties with Wisconsin
- Fully subscribed


Western U.P. ATC Transmission System
Centennial Mine T/D 6 MW
G799 – 120 MW Wind
Substantial Load Forecast Increase, Challenges To System/Load Balance
Stone Container Generation
White Pine Mine 35 MW Generation
L'Anse/Warden Electric 18 MW Bio-Mass
New Incremental Load/Generation Additions, Various Locations
Low 2007 Central U.P. Hydro
Houghton
Ontonagon
Baraga
Gogebic
Iron
Florence
69 kV Substation
138 kV Substation
138/69 kV Substation
345/138 kV Substation
69 kV Transmission Line
138 kV Transmission Line
345 kV Transmission Line


Central U.P. ATC Transmission System
A-D Big Bay T/D 6 MW
Retirement Of Presque Isle Generators
G750 – 200 MW Wind
Munising Area Generation/ Load Balance Issues
U.P. Angular Stability (RATS)
New Incremental Load/ Generation Additions, Various Locations
Escanaba Area Generation/ Load Balance Issues
• New Page Load/Generation
• City of Escanaba Generation
Limited Wisconsin-U.P. Transfer Capability
Baraga
Schoolcraft
Dickinson
Florence
Menominee
Marinette
Perkins
Indian Lake
Chandler
69 kV Substation
138 kV Substation
138/69 kV Substation
345/138 kV Substation
69 kV Transmission Line
138 kV Transmission Line
345 kV Transmission Line

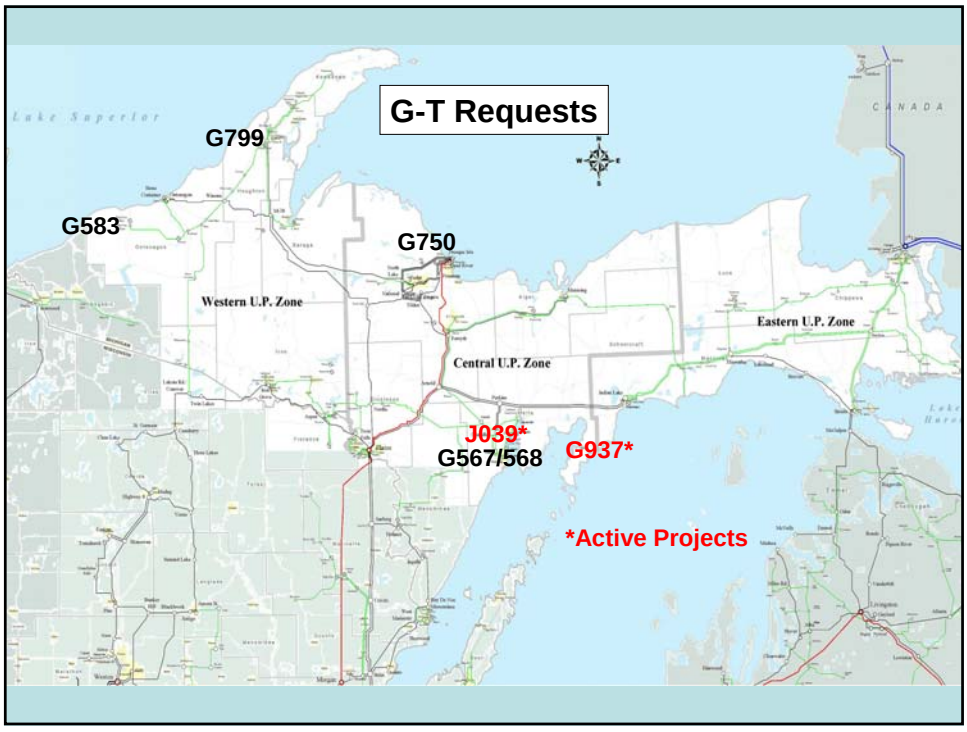

Eastern U.P. ATC Transmission System
N
W
E
S
69 kV Substation
138 kV Substation
138/69 kV Substation
69 kV Transmission Line
138 kV Transmission Line
Edison Sault/Cloverland Combined Peak Loads: Summer 139 MW Winter 148 MW
US Hydro/ESE Hydro Plants: Reduced Hydro Output Results In Load-Serving Issues.
Condition And Performance Assessment Of 69 kV Transmission Lines
New Incremental Load/Generation Additions, Various Locations
West-to-East or East-to-West Market Flows
G937 – 200 MW Wind
Impacts of Lower Michigan Generation/Transmission?
CANADA
Lake Huron
Munising
Schoolcrest
Hiawatha
Lakehead
Brevort
Indian Lake
Straits
McGulpin
Chippewa
Luce
Mackinac
Emmet

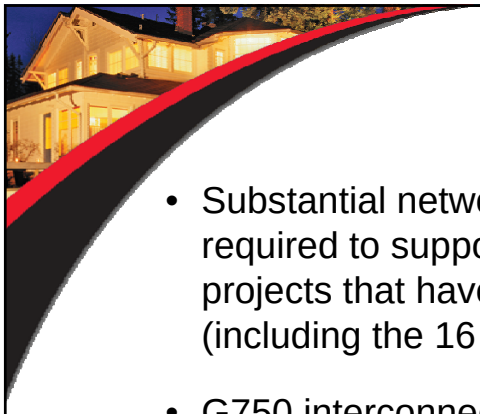

G-T Interconnection Requests

G-T Requests

- Three G-T Requests for Wind
  - G750 Marquette County – 201 MW
  - G799 Houghton County – 120.45 MW
  - **G927 Delta County – 200 MW***
- Two G-T Requests for Biomass
  - G583 Ontonagon County – 16 MW
  - **J039 Delta County – 50 MW***
- Two G-T Requests for Fossil Fuel
  - G567 Delta County – 165 MW
  - G568 Delta County – 300 MW

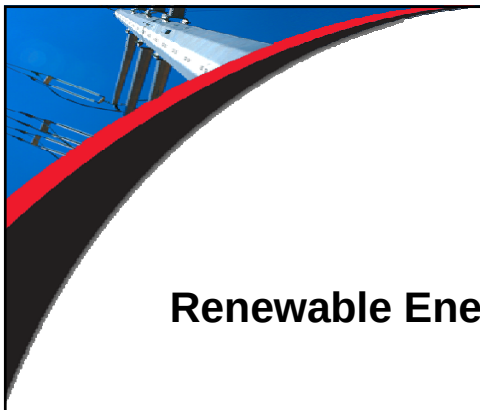
***Denotes Active Projects in the MISO Queue**



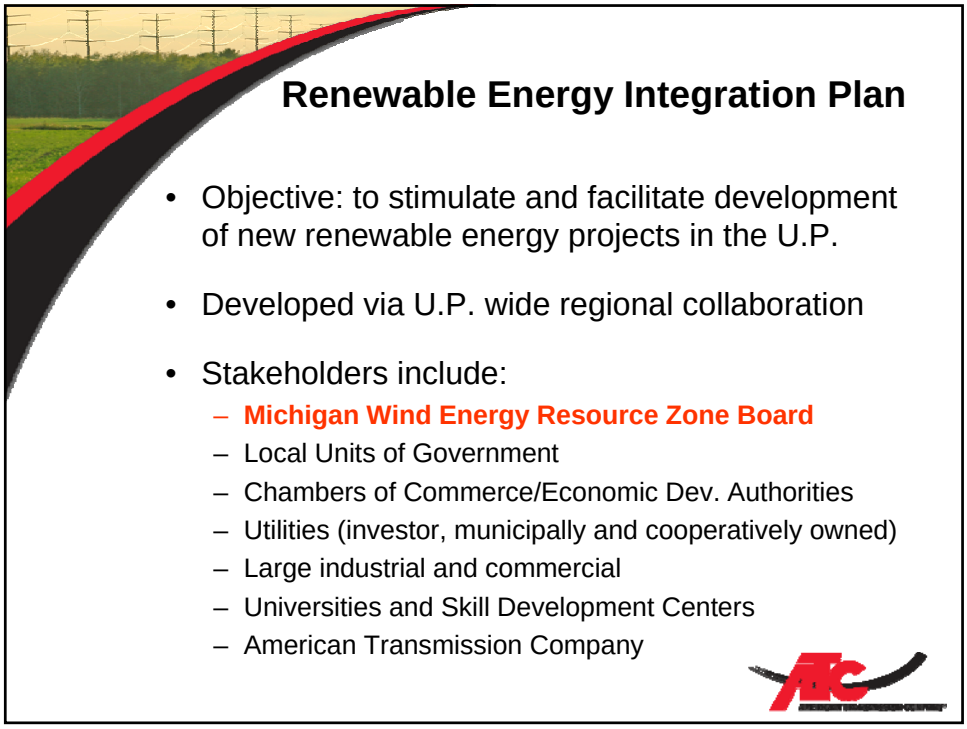


G-T Requests

- Substantial network upgrades were required to support all of the generation projects that have been studied to date (including the 16 MW Biomass project)
- G750 interconnection and network upgrade costs were estimated to be in excess of **$1.16M per MW** of installed capacity (range of ~$232M - $252M)

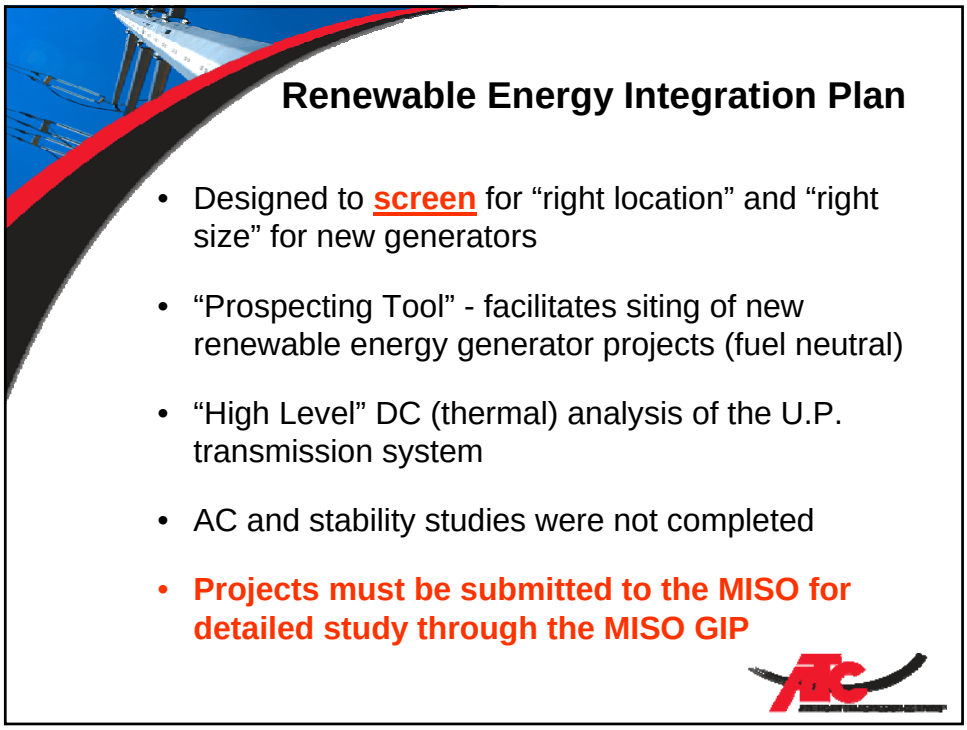


Renewable Energy Integration Plan



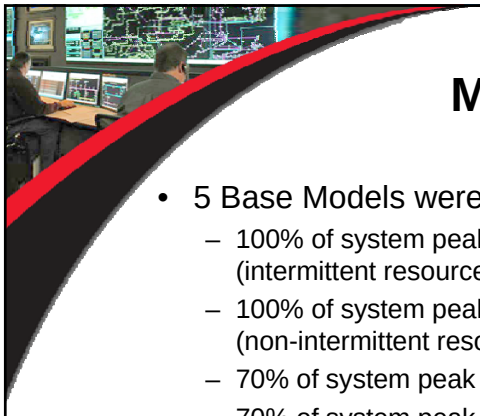
Renewable Energy Integration Plan

- Objective: to stimulate and facilitate development of new renewable energy projects in the U.P.
- Developed via U.P. wide regional collaboration
- Stakeholders include:
  - **Michigan Wind Energy Resource Zone Board**
  - Local Units of Government
  - Chambers of Commerce/Economic Dev. Authorities
  - Utilities (investor, municipally and cooperatively owned)
  - Large industrial and commercial
  - Universities and Skill Development Centers
  - American Transmission Company



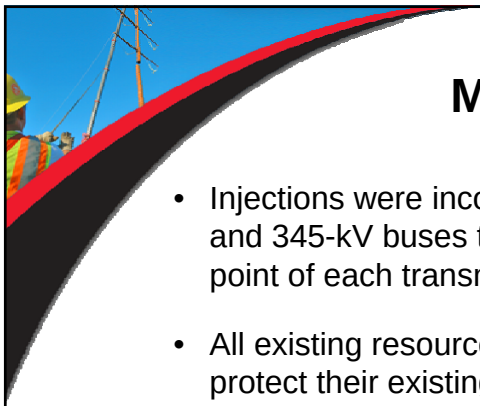
Renewable Energy Integration Plan

- Designed to **screen** for "right location" and "right size" for new generators
- "Prospecting Tool" - facilitates siting of new renewable energy generator projects (fuel neutral)
- "High Level" DC (thermal) analysis of the U.P. transmission system
- AC and stability studies were not completed
- **Projects must be submitted to the MISO for detailed study through the MISO GIP**



Model Assumptions

- 5 Base Models were studied
  - 100% of system peak w/Ludington in generating mode (intermittent resources)
  - 100% of system peak w/Ludington in generating mode (non-intermittent resources)
  - 70% of system peak w/Ludington in generating mode
  - 70% of system peak w/Ludington in pumping mode
  - 50% of system peak w/Ludington in pumping mode
- Non-simultaneous, DC (linear) transfer analysis was performed for single contingencies



Model Assumptions

- Injections were incorporated at 69-kV, 138-kV and 345-kV buses that were created at the mid-point of each transmission line in the model
- All existing resources were fully dispatched to protect their existing delivery rights
- MISO Business Practice Manuel rules for studying generator interconnections were utilized
- **Additional studies and assessments must be performed before a new G-T interconnection will be permitted**

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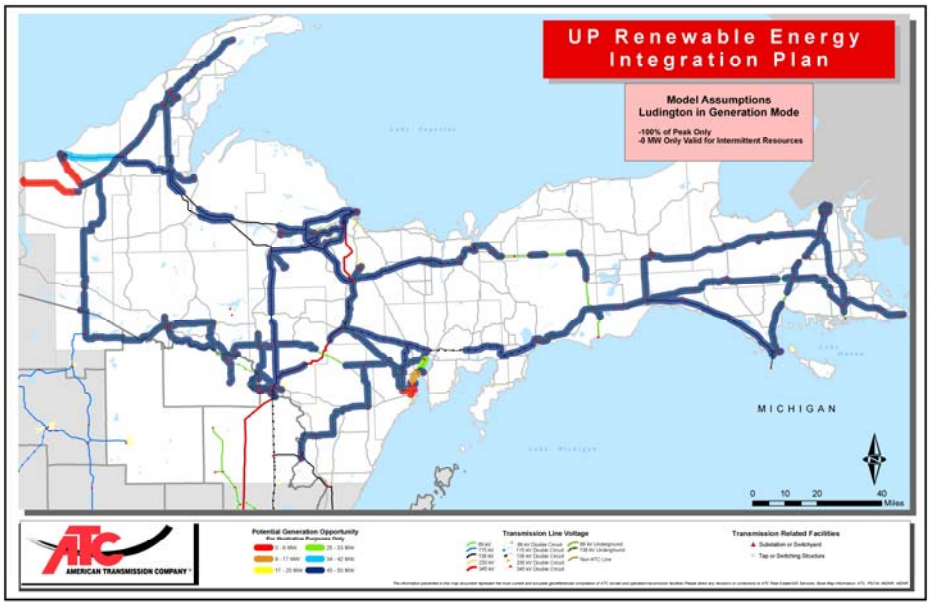

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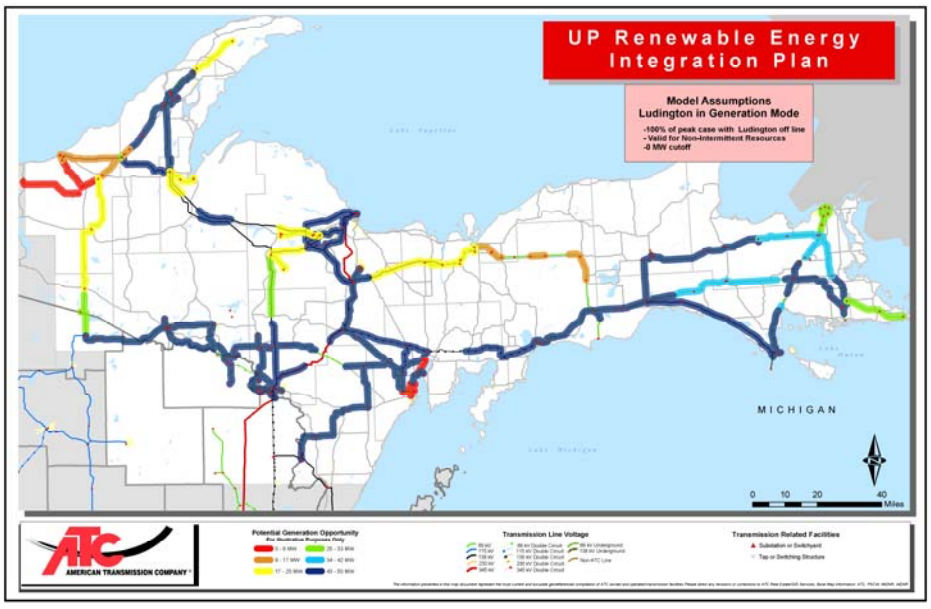

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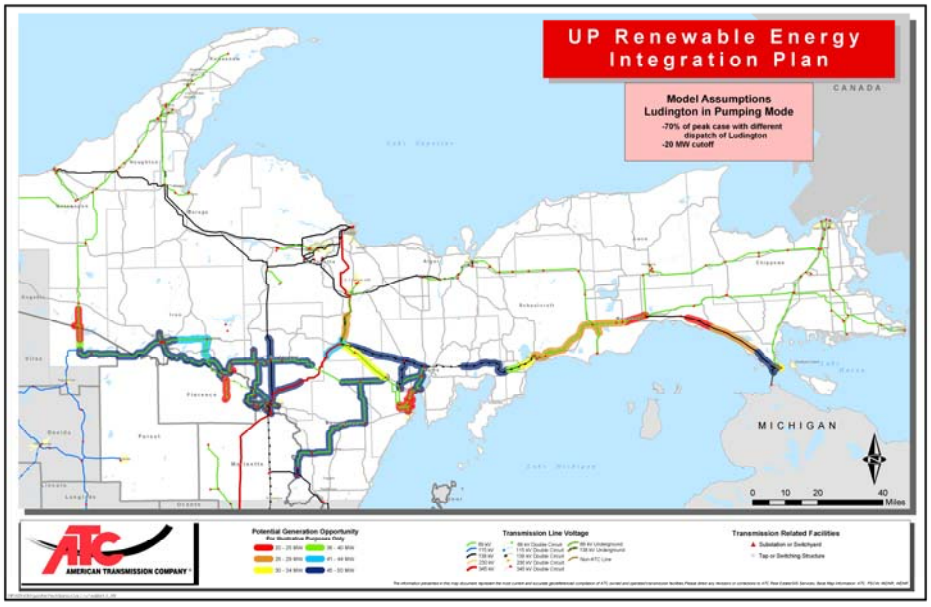

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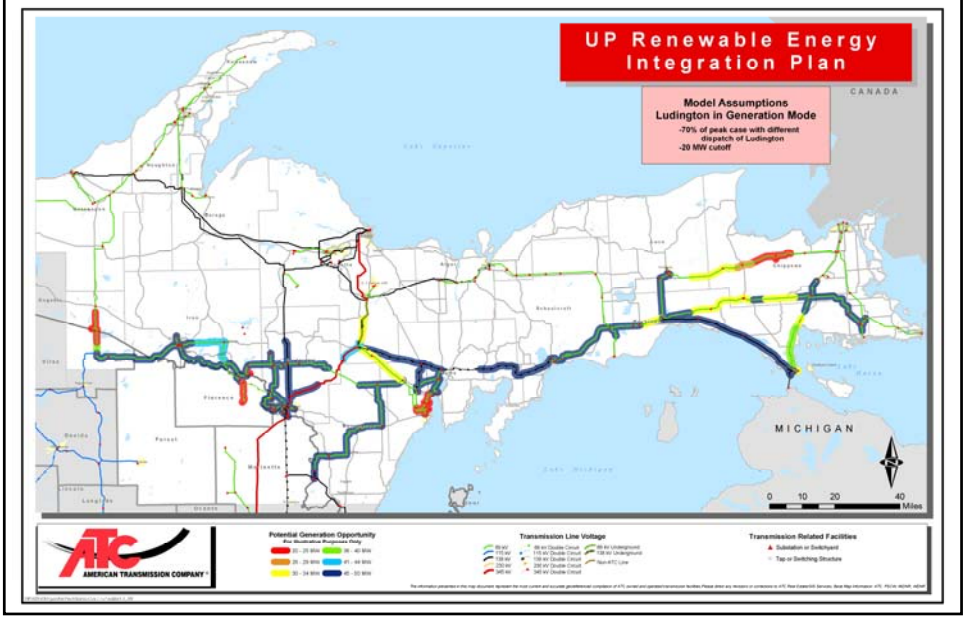

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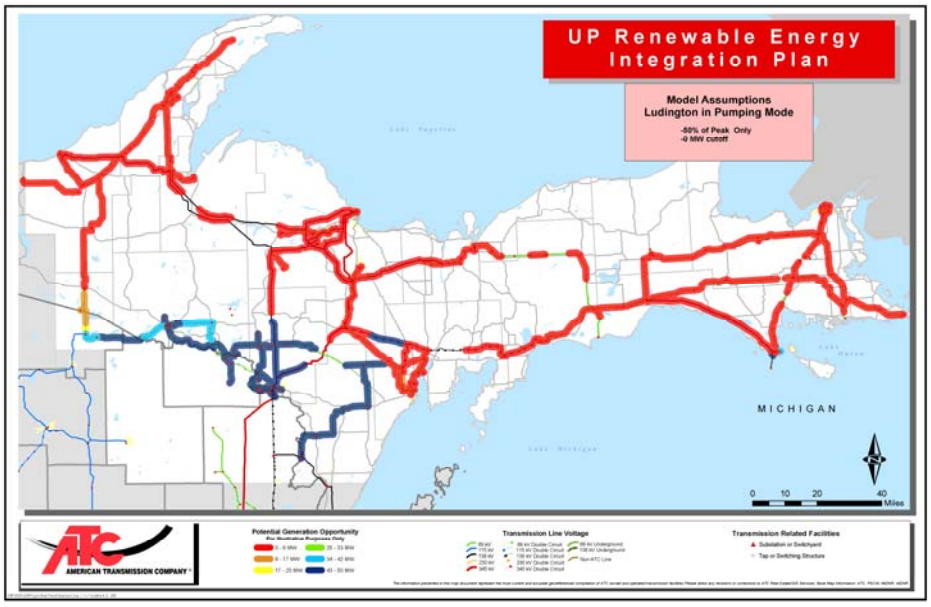
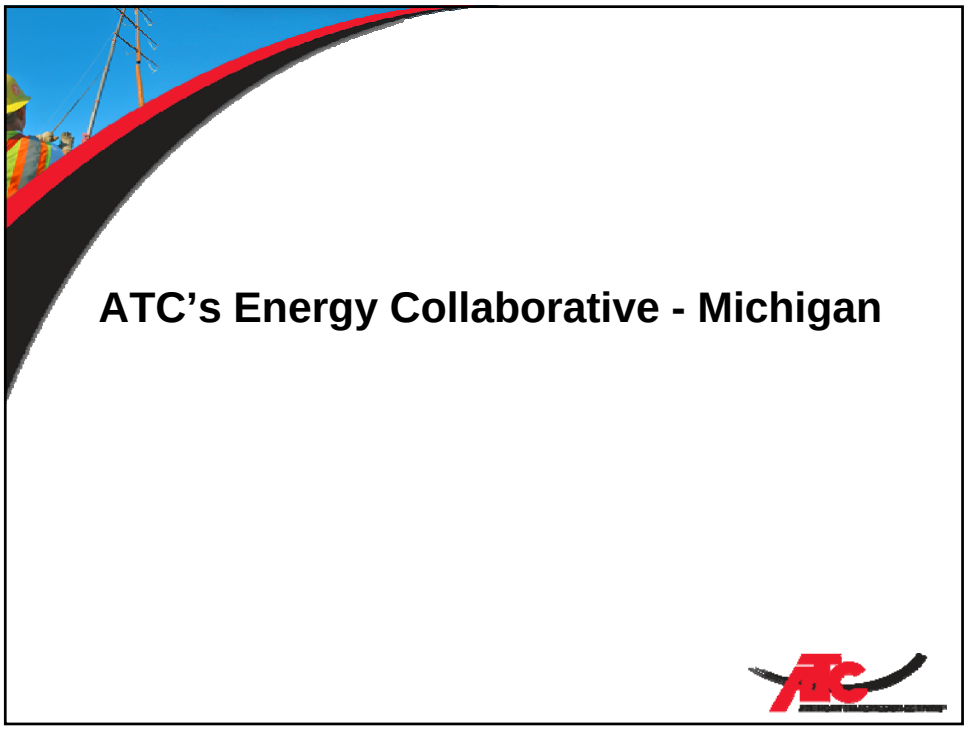
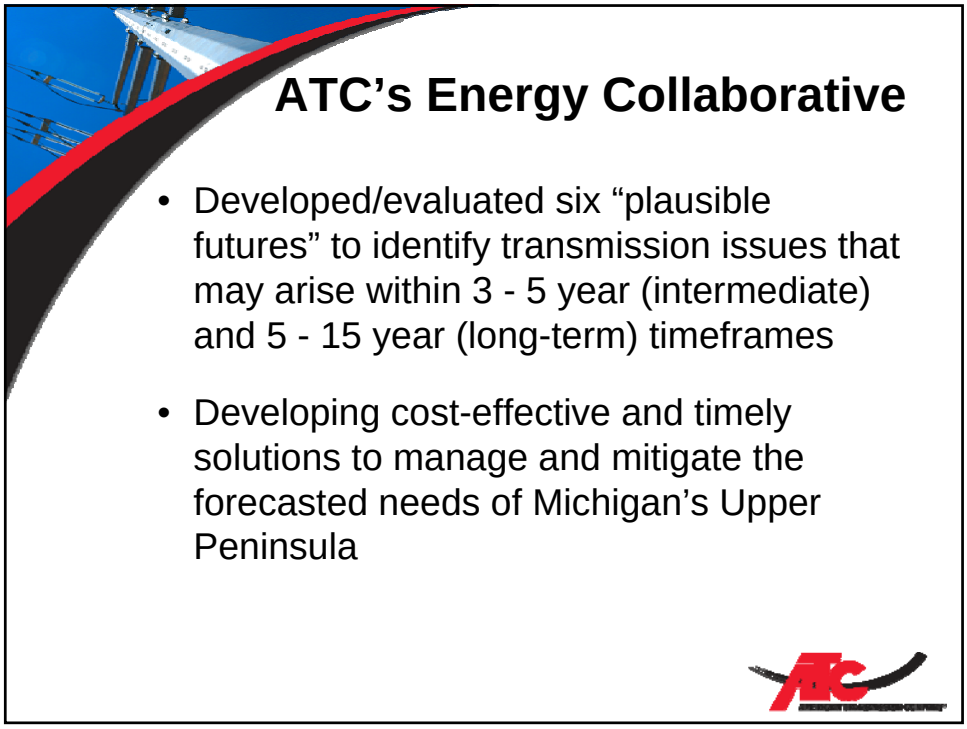


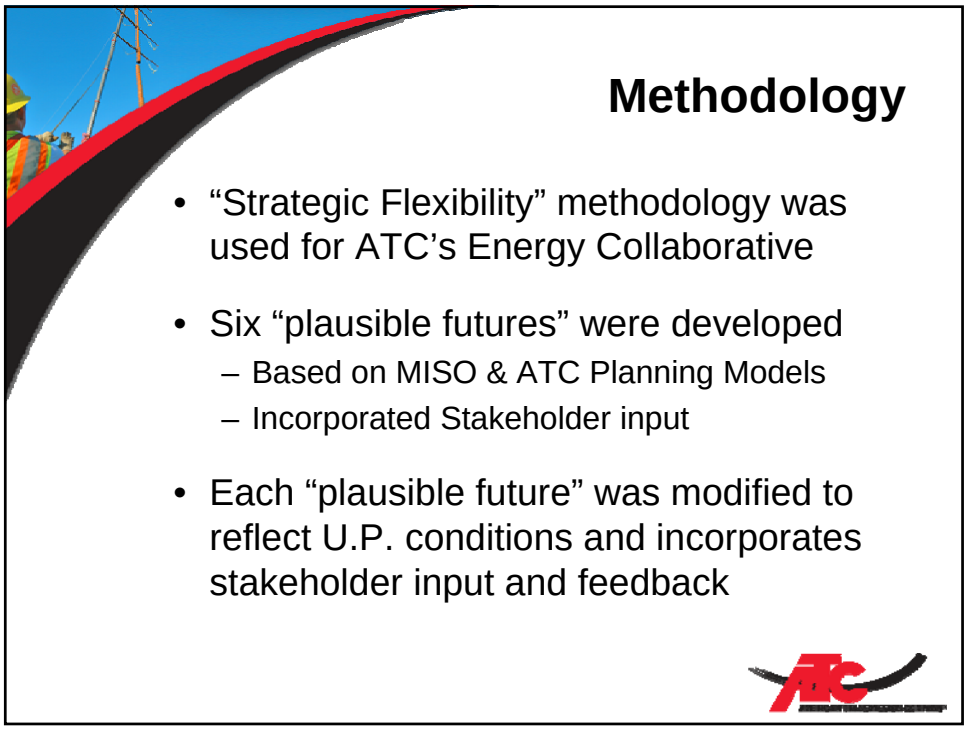


ATC's Energy Collaborative - Michigan



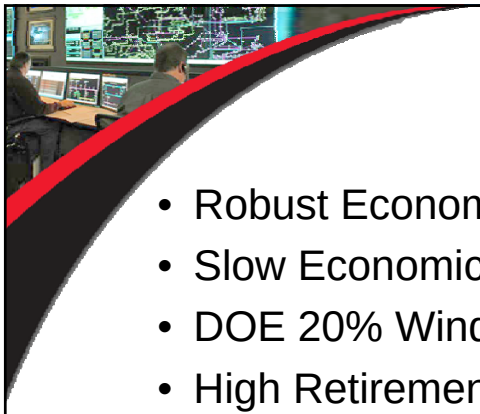
ATC's Energy Collaborative

- Developed/evaluated six "plausible futures" to identify transmission issues that may arise within 3 - 5 year (intermediate) and 5 - 15 year (long-term) timeframes
- Developing cost-effective and timely solutions to manage and mitigate the forecasted needs of Michigan's Upper Peninsula



Methodology

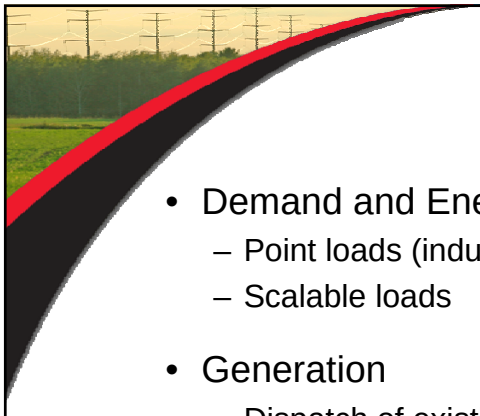
- "Strategic Flexibility" methodology was used for ATC's Energy Collaborative
- Six "plausible futures" were developed
  - Based on MISO & ATC Planning Models
  - Incorporated Stakeholder input
- Each "plausible future" was modified to reflect U.P. conditions and incorporates stakeholder input and feedback



Plausible Futures

- Robust Economy
- Slow Economic Growth
- DOE 20% Wind
- High Retirements (generation)
- High Environmental Limitations
- Fuel & Investment Limitations

Details regarding ATC's Energy Collaborative and the various futures that were modeled can found at http://oasis.midwestiso.org/documents/ATC/planning.html

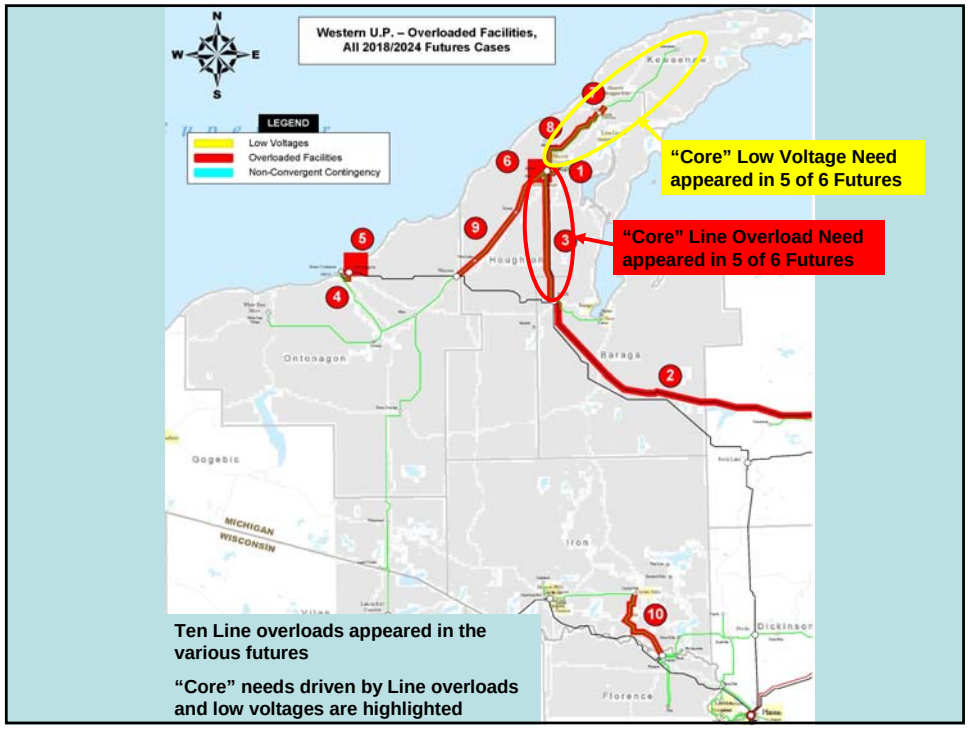


Study Parameters

- Demand and Energy
  - Point loads (industrial/commercial)
  - Scalable loads
- Generation
  - Dispatch of existing units
  - Retirement of existing generators
  - Addition of new generators
- Energy Market Flows

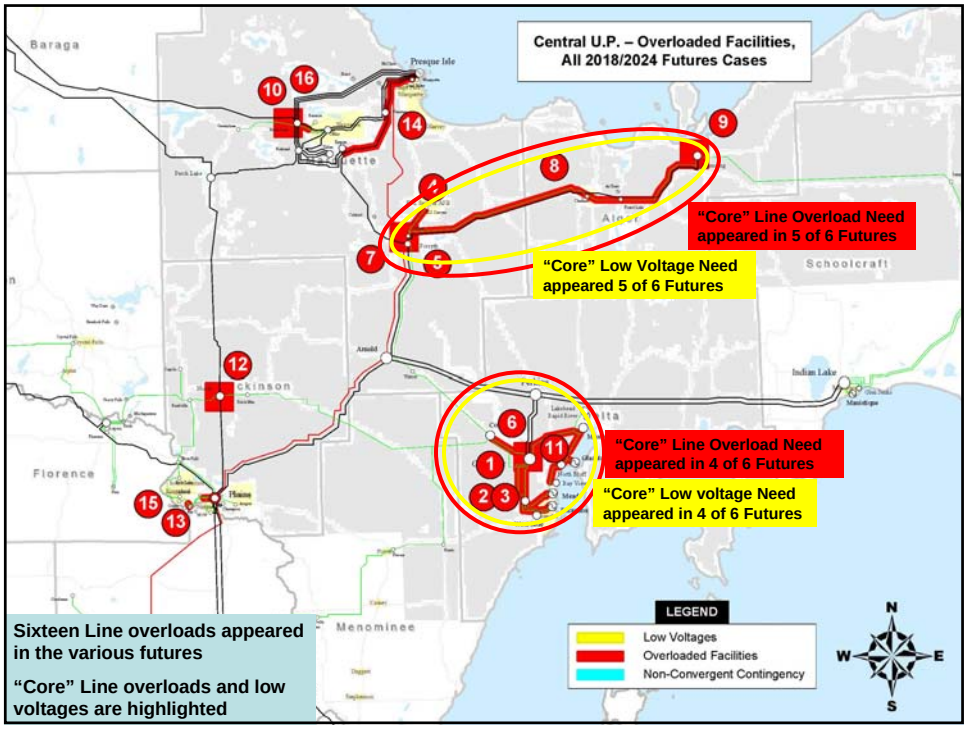
Identification of Needs

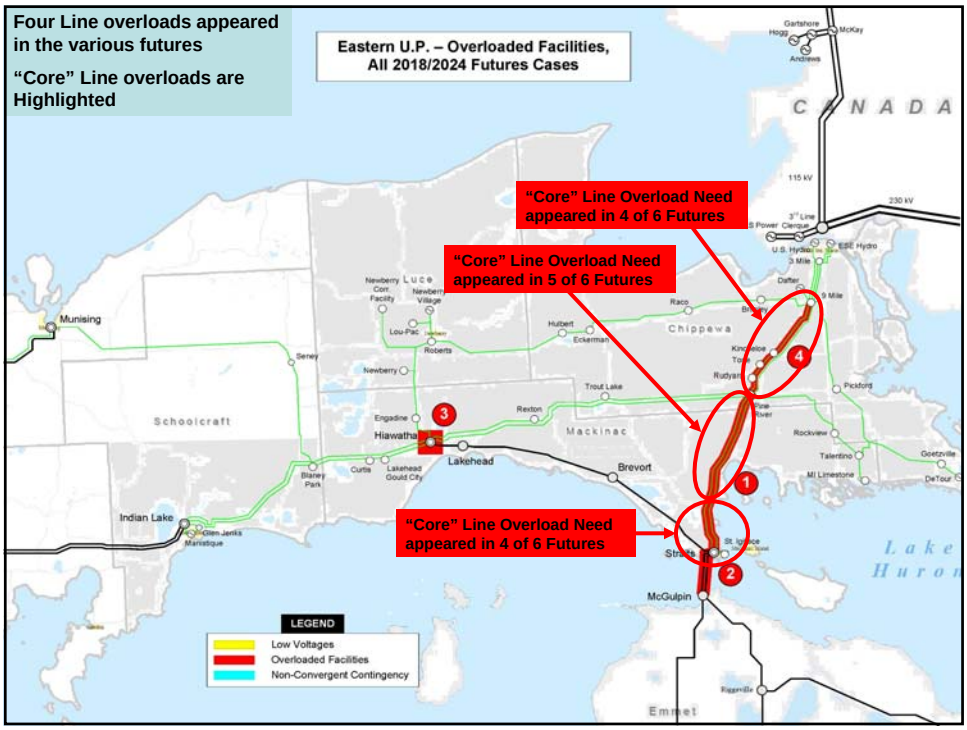
- Network “Needs” are driven by:
  - Planning
    - Thermal loading and voltage profiles
  - System Operations
    - Op. Guides and Special Protection Schemes
  - Asset Management
    - Line Performance
    - Transformer, circuit breakers and relays
  - New Interconnections
    - T-D load interconnections
    - G-T generator interconnections
  - Smart Grid Initiatives
    - Deployment of additional fiber
    - SCADA and RTU upgrades

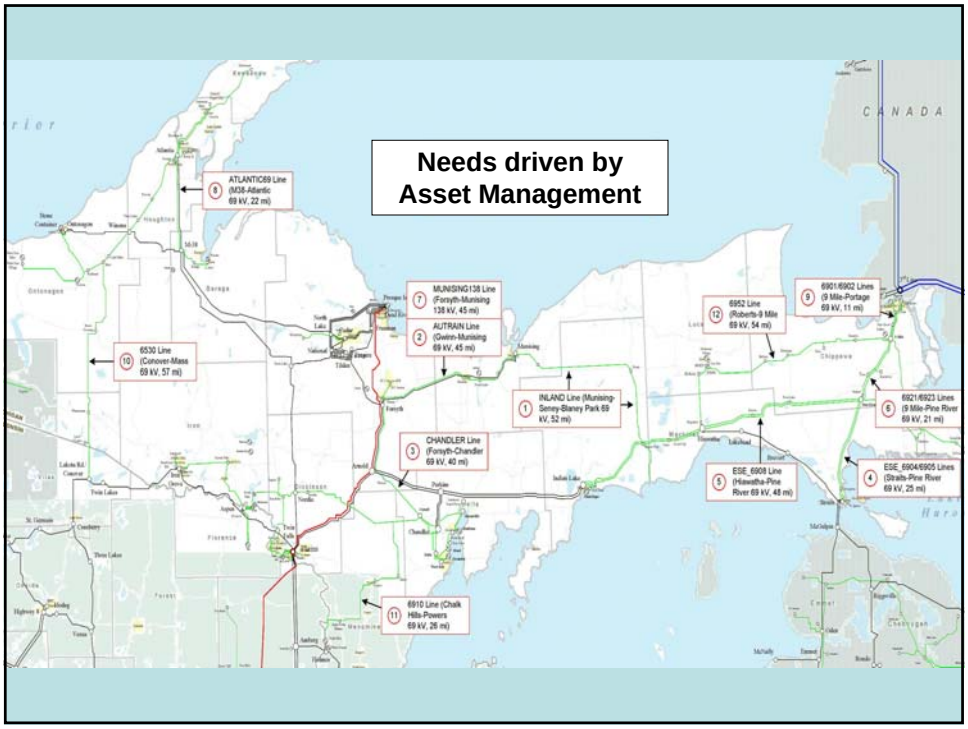


Ten Line overloads appeared in the various futures

“Core” needs driven by Line overloads and low voltages are highlighted


Central U.P. – Overloaded Facilities,
All 2018/2024 Futures Cases
"Core" Line Overload Need appeared in 5 of 6 Futures
"Core" Low Voltage Need appeared 5 of 6 Futures
"Core" Line Overload Need appeared in 4 of 6 Futures
"Core" Low voltage Need appeared in 4 of 6 Futures
Sixteen Line overloads appeared in the various futures
"Core" Line overloads and low voltages are highlighted
LEGEND
Low Voltages
Overloaded Facilities
Non-Convergent Contingency
N
W
E
S


Four Line overloads appeared in the various futures
"Core" Line overloads are Highlighted
Eastern U.P. – Overloaded Facilities,
All 2018/2024 Futures Cases
"Core" Line Overload Need appeared in 4 of 6 Futures
"Core" Line Overload Need appeared in 5 of 6 Futures
"Core" Line Overload Need appeared in 4 of 6 Futures
LEGEND
Low Voltages
Overloaded Facilities
Non-Convergent Contingency



Next Steps

- Review “Needs” with Stakeholders
- Solution screening
  - Preliminary development within ATC
    - Holistic approach
      - Planning, System Operations, Asset Management, Local Relations, Real Estate, Environmental
  - Stakeholder involvement
    - **Generation solutions**
      - **Right size & right location**
      - **U.P. Renewable Energy Integration Plan**
    - Demand Response
- Decide upon “Core Projects”

Stakeholder Participation

To discuss any questions you may have or to arrange a convenient meeting time to review and discuss these materials please contact:

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