

October 13, 2021

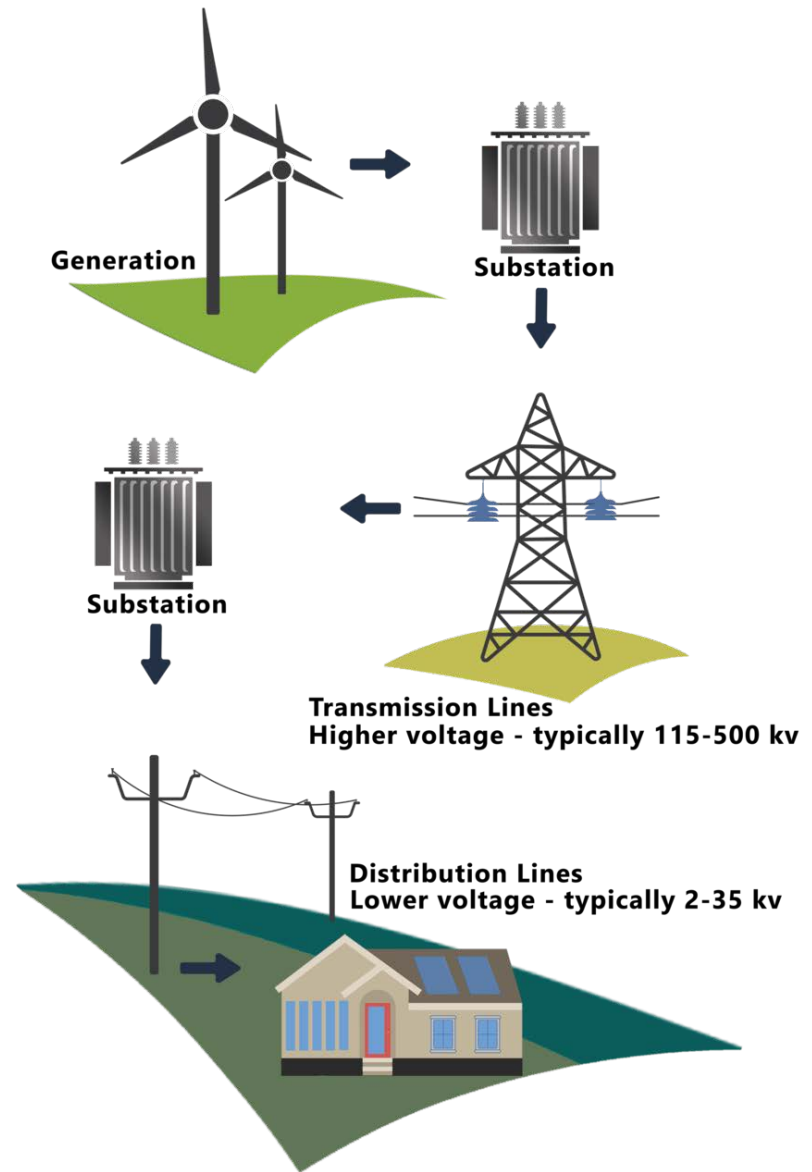
Jacob Lehmer

Computerized Wind Farm Generation Tie Line Infrastructure
Footprint Routing and Subsequent Dynamic Line Rating

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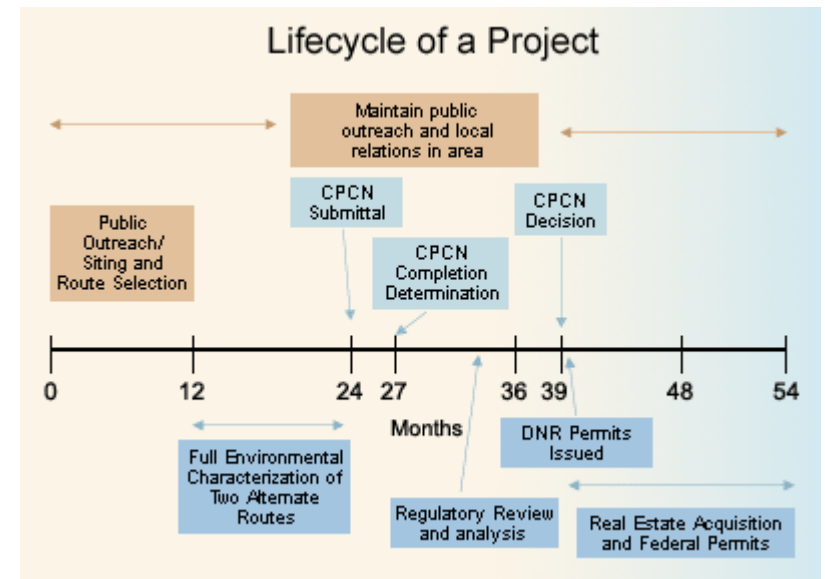
Introduction

- Electrical Grid
 - Generation
 - Transmission
 - Distribution
- Modern Trends
 - Renewable Integration
 - Power Dispatching
 - Smart Grid Technologies



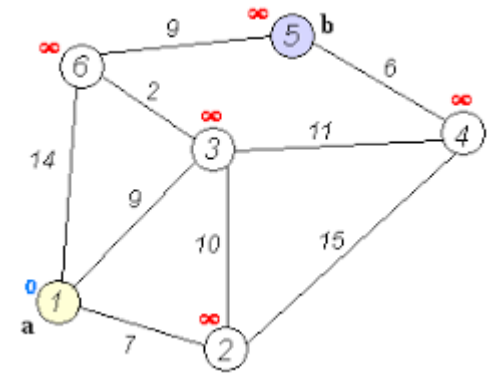
Transmission Route Engineering and Design

- Planning
 - Initial determination
 - Development of alternate routes
 - Public Opinion
 - Prefer a route
- Line Design
- Public Opinion
- Legal Battles
- Tower Construction



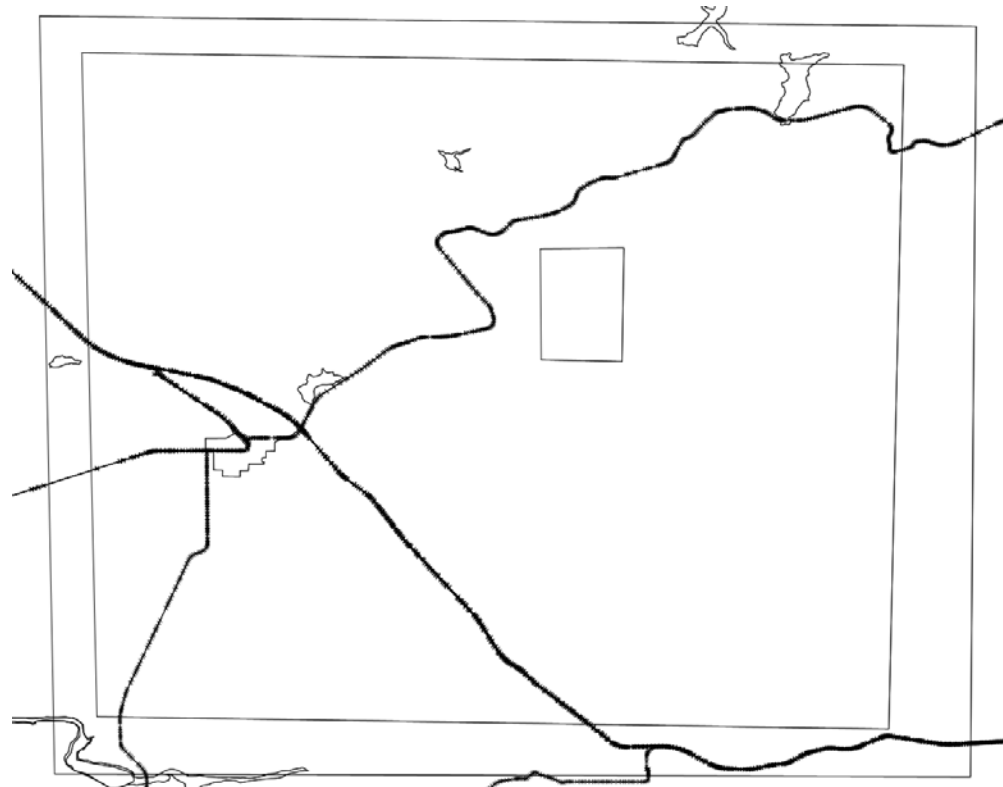
Path Finding Algorithm

- Dijkstra's Algorithm
 - Discrete Mathematical Graph Traversal
- A* Algorithm
 - Dijkstra's Algorithm
 - Create the discrete graph as the application runs from cartesian grid
 - Valuation of terrain data
 - Require system bounding and rectangular grid featuring system
- TREAD Algorithm
 - Grid system defined radially, optimizes to straight line segments



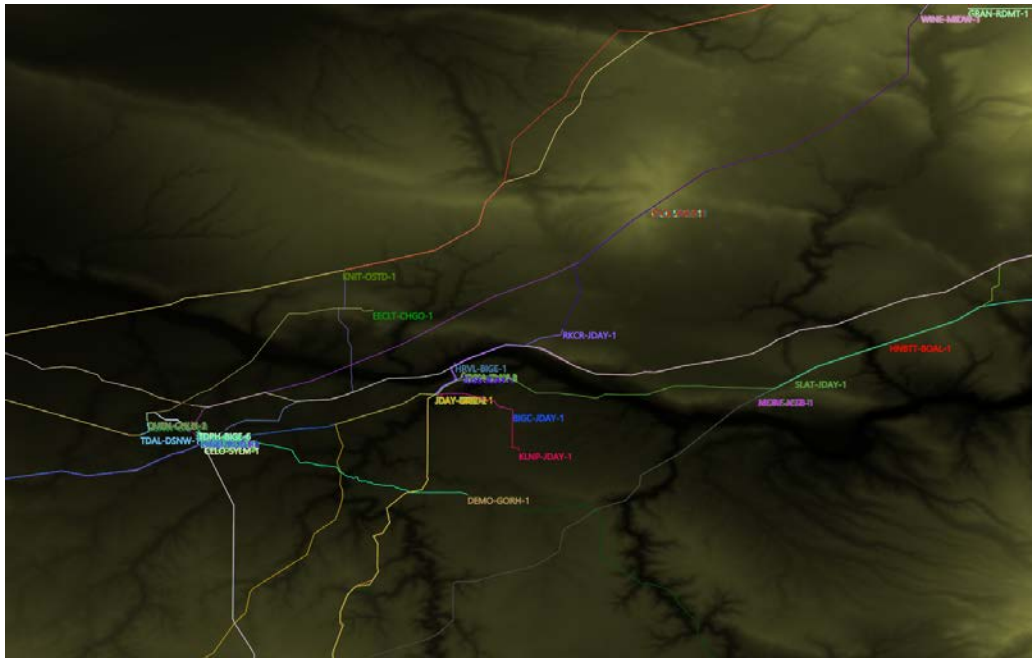
Cartographic Data

- Geographic 2d representation
 - Shape Files
 - Polygonal Data
 - Line Data
 - Right of way around the line generated
 - KML Files
- 3d Data
 - GWS
- Weather Data
 - Forecasted
 - Historical



Terrain Data

- Graphical data has some effect on line construction
- Determining a reasonable value to adjust routing is a considerable issue
- Common sense routing effects can be quite reliable
 - Slopes are more difficult to construct on



Utility Integration

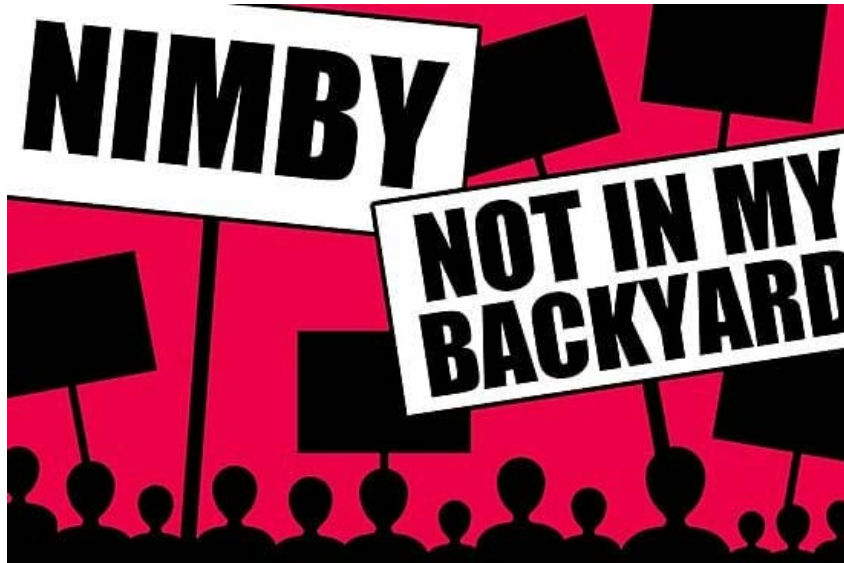
- Utility usage of transmission lines rely on ratings and usage planning
- Ratings are developed through static line rating calculation methods
- Generalized Line Ampacity State Solver Allows for rating transmission lines dynamically with hypothetical route
- Build possible routes from the planned wind generation capability and the location to the tie line as a basis



Not In My Backyard

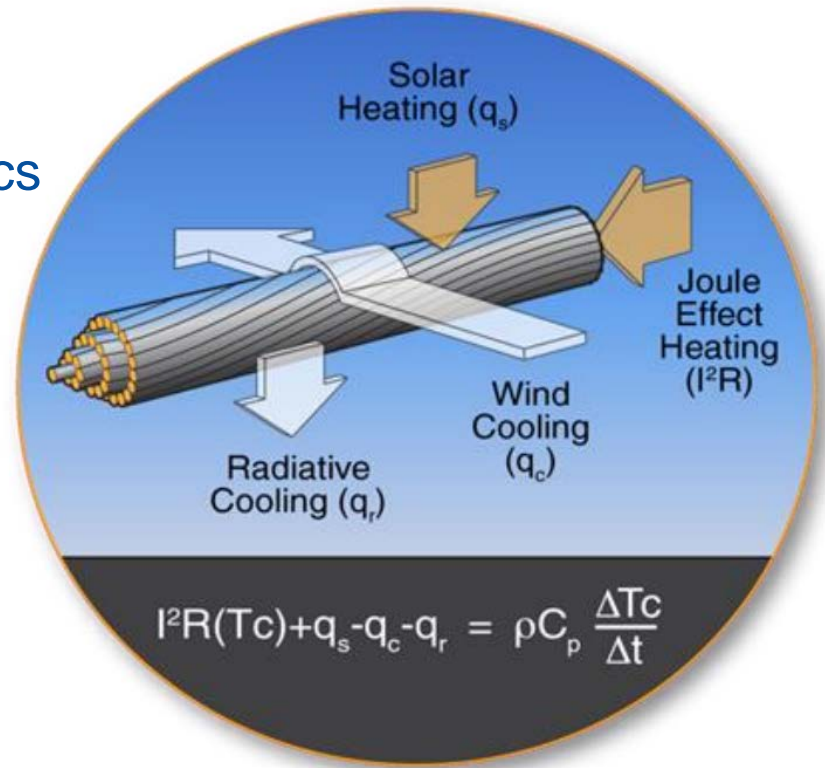
The Court Of Public Opinion

- All transmission routes travel across different political areas
- Some landowners do not want to have a transmission line built on their owned land
- Tread allows for these landowners to have their land marked as a no build zone
- Rapid re-development could be made that will allow for people to have their voices heard



Dynamic Line Rating

- Dynamic Line Rating (DLR) is the process of using real time conditions to change the allowed capacity of the line
- DLR can be performed in several different ways
 - On Line Sensors
 - Environmental Monitoring
 - Computational Fluid Dynamics
 - Historical Analysis
 - Requires sufficient data
 - Forecasted Data



Wind Generation and DLR Synergy

- Dynamically adjusting a transmission line requires a change in environmental conditions that allow for higher capacity
 - Reduction in temperature
 - Increase in wind speed
- Wind generation increases in generated capacity when there is an increase in wind speed
- Dynamic Line Rating can reduce curtailment of a wind plant
 - Increase in generation is matched with an increase in capacity
- TREAD can use forecasted data as well as computational fluid dynamics to maximize the dynamic line rating of a possible transmission route

Wind Generation and DLR Synergy

