

A prototypic implementation of an optimizing network expansion planning model considering the value perspective of the company and the effects of monopoly regulation in the objective function

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Agenda

- Regulation of Natural Monopolies and its influence on investment decisions
- Network Planning Models
- Alternative Objective Function: Value Maximization
- Exemplary Results

Regulation of Electricity Grid Operators and its influence on investment decisions

→ investment behavior is determined by expectations concerning the regulatory framework

➤ Milestones in Europe/Germany

- 1996 I. EU Energy Package
- 2005 II. Energy Industry Act (EnWG)
- 2006 Cost Plus Regulation (StromNEV)
- 2009 Incentive Regulation (ARegV)

➤ Regulation and Investment Behavior

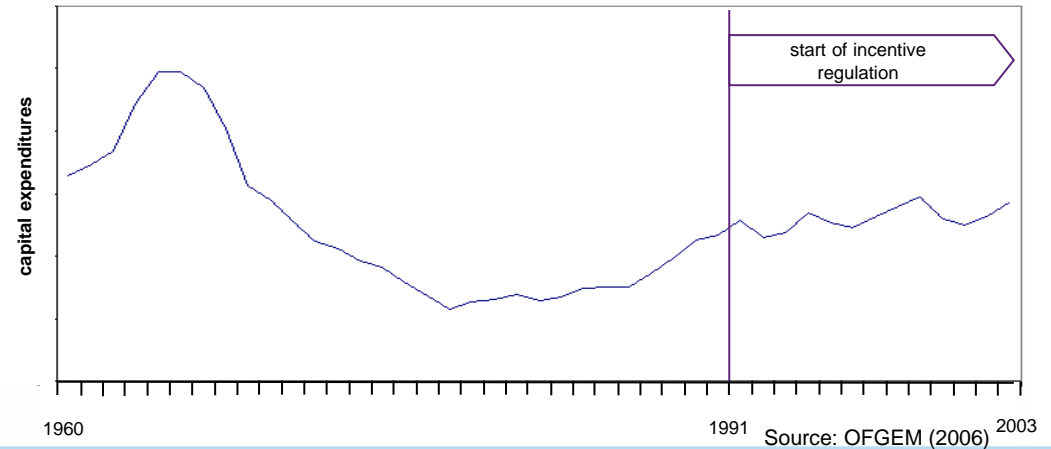
- 1962 Averch/Johnson: „Behavior of the firm under regulatory constraint“
- strategy implementation in companies
- Discussion about economic sufficiency of the incentive regulation (e.G. Ballwieser, WIK, DENA)

➤ Regulatory Uncertainty

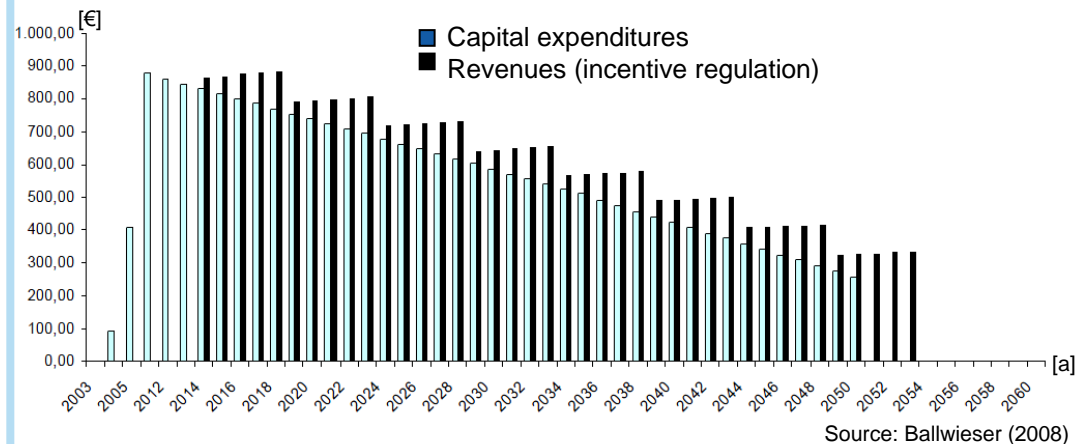
→ Investment strategy depends on regulatory system

→ Profit/Value Maximization

Investment Behavior in GB after Introduction of the Incentive Regulation



Time Delay between Capital Expenditures and their Recognition in Revenues



Techno-Economical-Models in Network Planning

→ “traditional” planning models aim at minimization of system costs

Present Network Structure

10-20 years

20-50 years

Extension/Expansion Planning

Transition of existing network into target structures/final-state network

Degrees of freedom

- Projects
- Timing
- Order

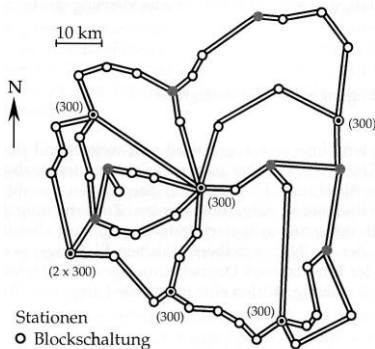
Long Term Planning

Optimal network structures for future supply task (green-field-approach)

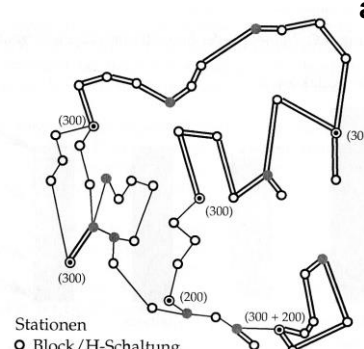
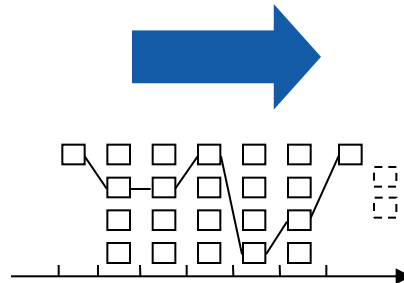
Degrees of freedom

- Structure
- Equipment types

Integrated Approach

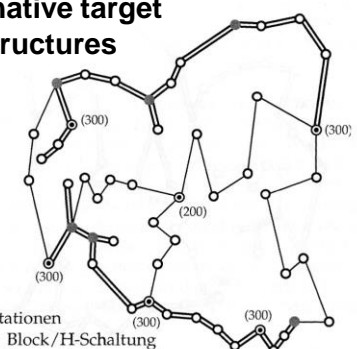


- Stationen
- Blockschaltung
 - Sammelschienenanlage
 - ⊙ 380/110-kV-Umspannstation (Inst. Transformatorkapazität in MVA)



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alternative target structures



- Stationen
- Block/H-Schaltung
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 - ⊙ 380/110-kV-Umspannstation (Inst. Transformatorkapazität in MVA)

Source: Maurer (2004)

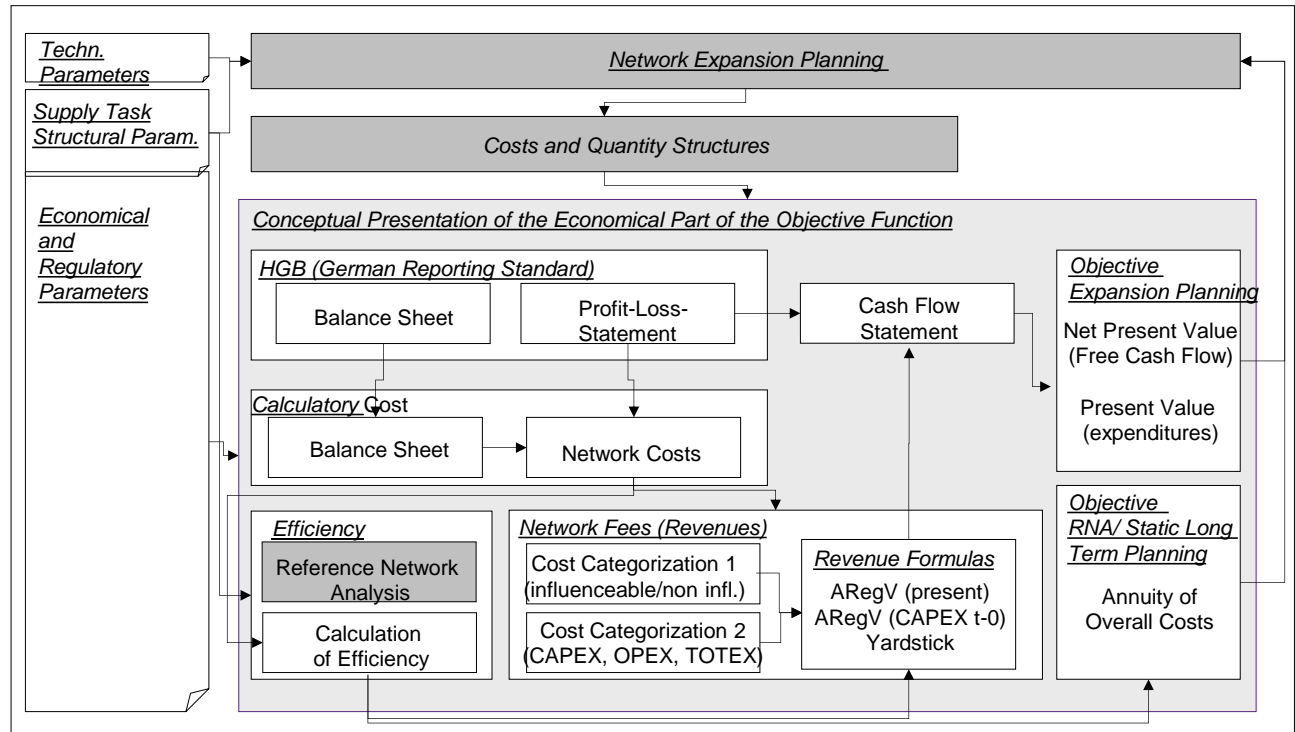
→ Due to the assumption that network fees are fixed „traditional“ approaches aiming at minimizing of system costs

→ Since this assumption is not necessarily given, plans can be suboptimal from a company point of view

Alternative Approach:

→ Modelling of an objective function under consideration of regulatory system(s)

Conceptual structure of the modeled objective function (including the present system regime of Germany)

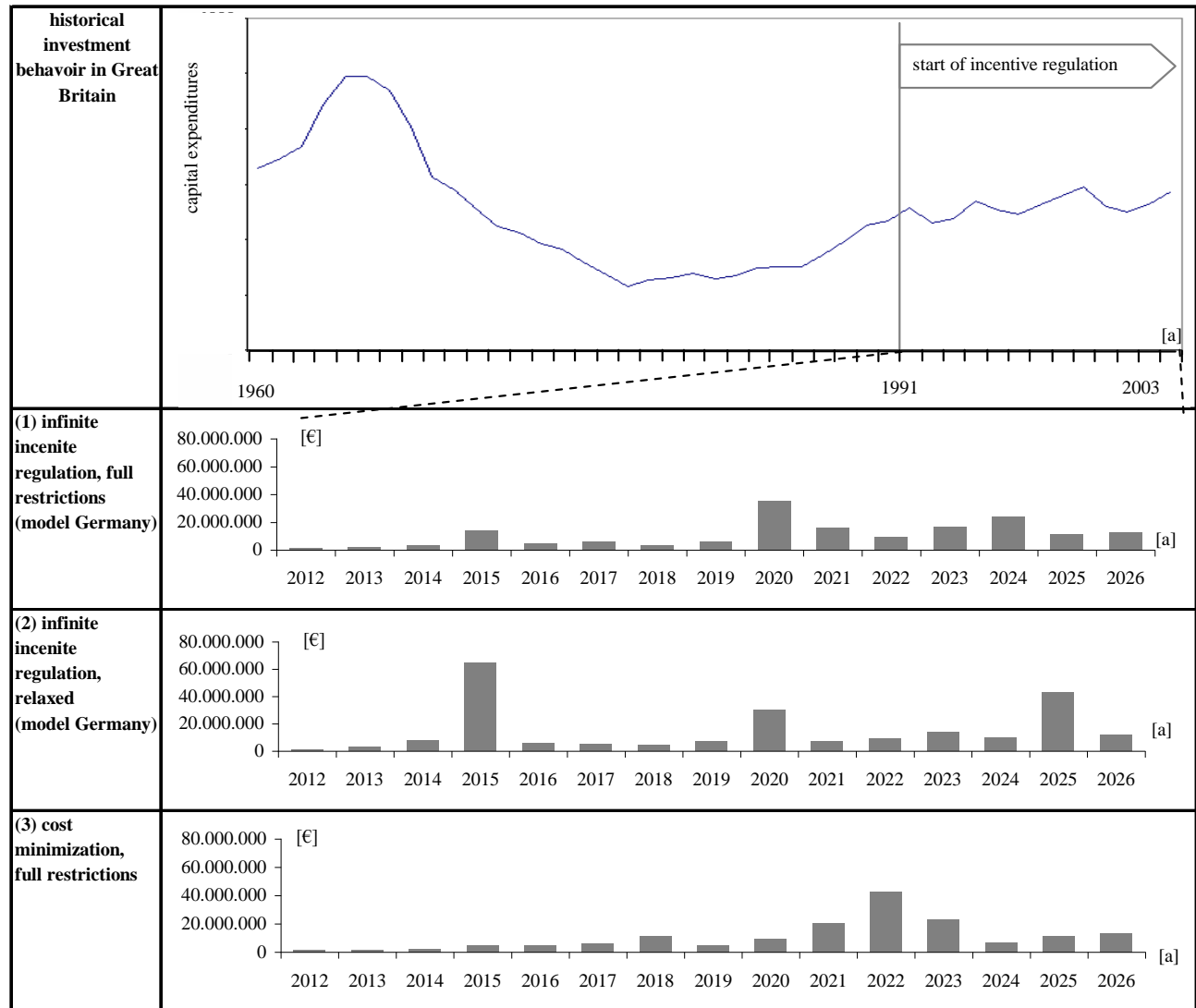


→ There cannot be a general planning approach, since the objective function changes over time and depends on the national regulatory framework, company specific economical parameters

Model Results (Expansion Planning)

Main Results

- Confirmation of influence of the regulatory system
- Cost minimizing expansion strategies can be economically suboptimal
- Technical constrains and regulatory mechanism limit the possibilities of economical optimization



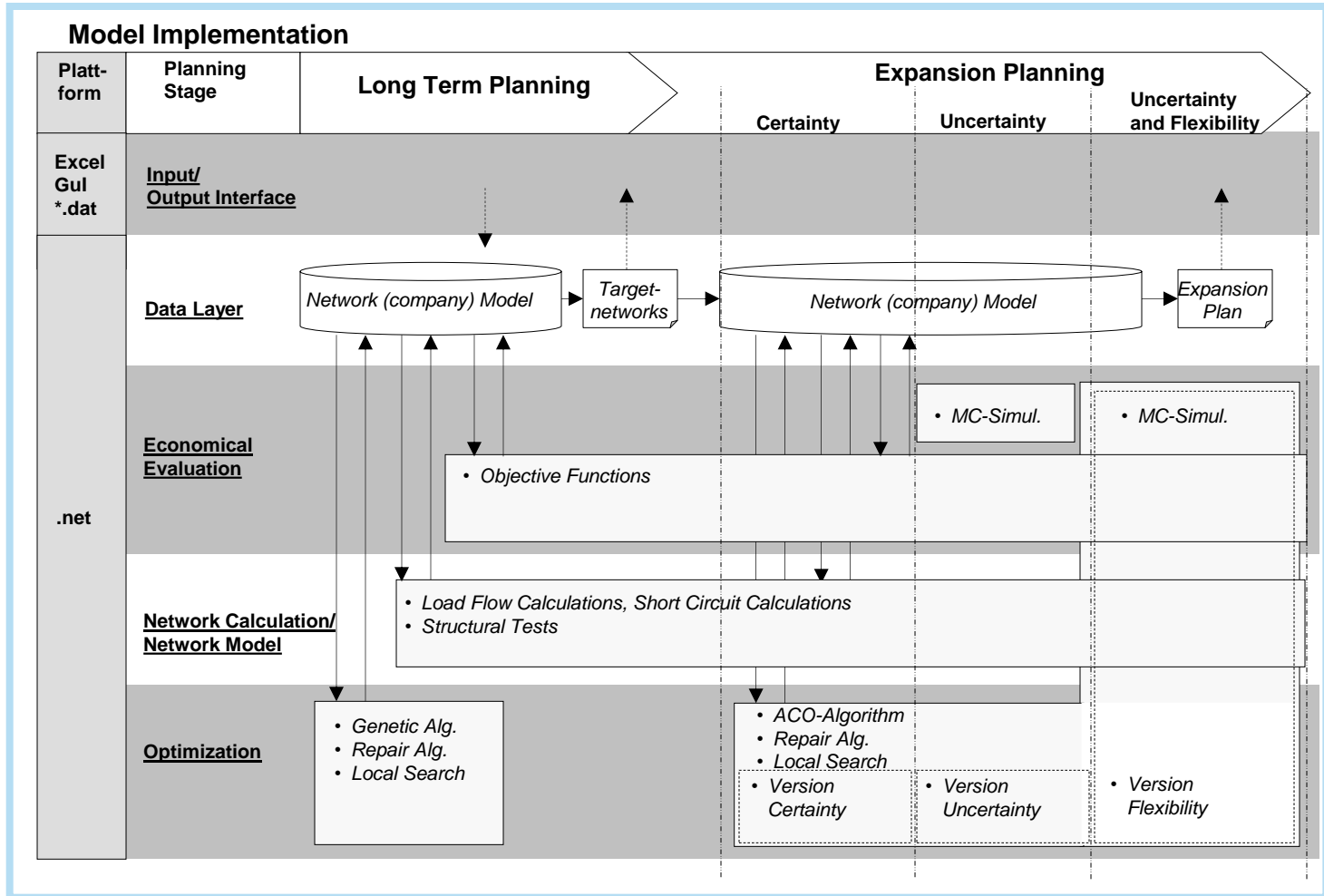
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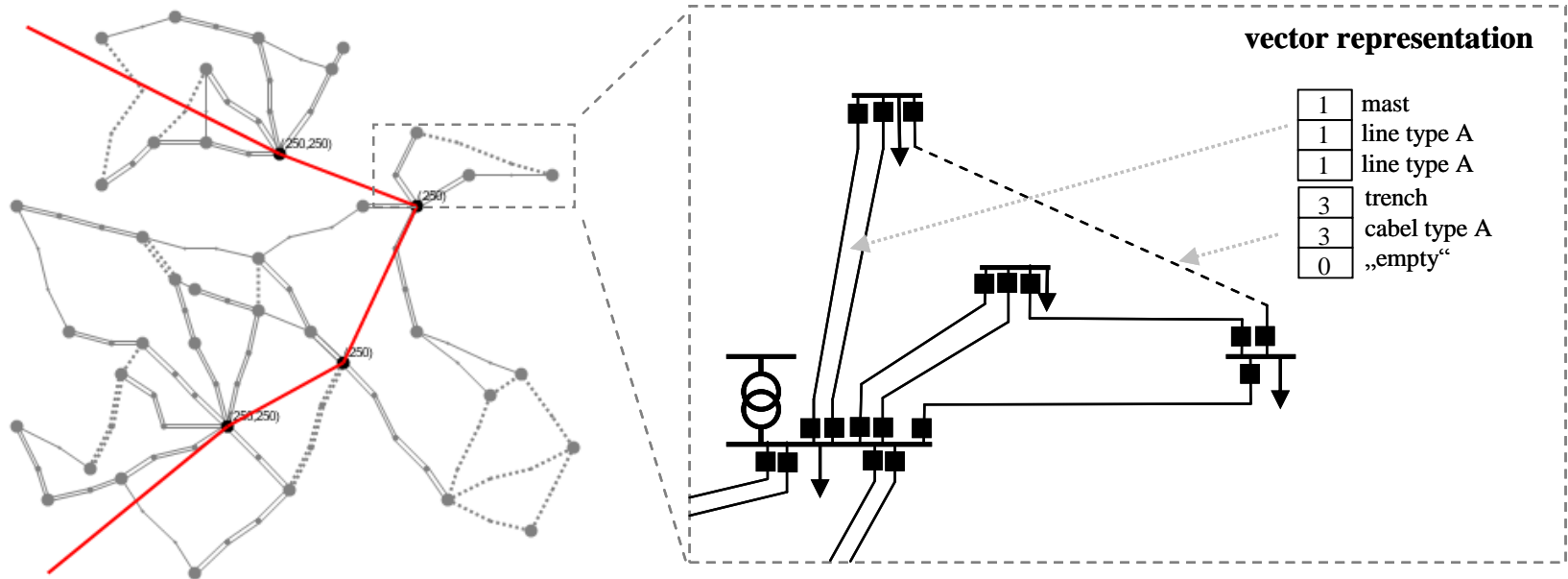
Appendix

Model and Implementation

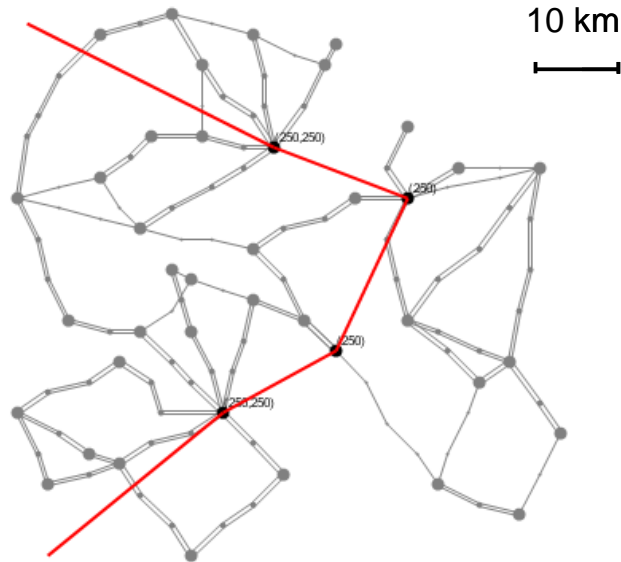
Characteristics

- optimization problem:
Combinatory, non-linear, large-scale
Assignment Problem
- Long term planning:
Genetic Algorithm
- Expansion planning:
Ant Colony Optimization
- Objective function(s)
PV → Min
NPV → Max
- Technical Constrains:
Load Flow
Voltage Level
Short Circuit Current (n-1)
and other
- Flexibility evaluation
stochastic simulation
European Option

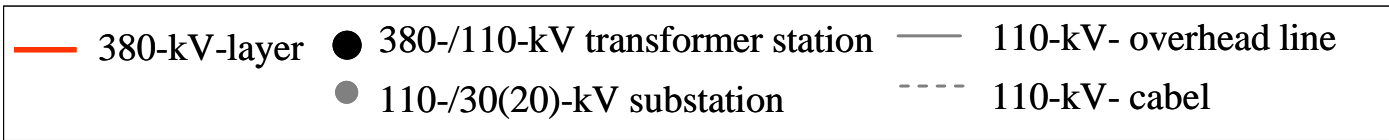
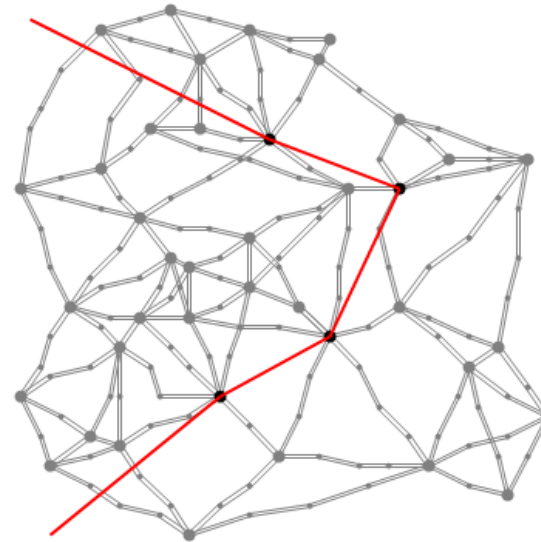




Existing Network and used Trails



Trails to be used



Case Study

