



Upgrading Transmission Voltage - Planning Perspective

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Outline

1. Planning Process

2. Reinforcement Options

3. Planning for Voltage Upgrading

4. Case Studies

Planning Objectives

- Maximize **benefits** from the transmission system
- Minimize **costs**
- In other words: **balance cost and reliability**
- Represent **uncertainties**
- Handle **risks**

The Planning Process

1

Identify Existing Problems and Weaknesses

2

Develop List of Options
- Detailed Analysis and Modeling

3

Develop a Plan from the Options

Planning Horizons

Full Spectrum Plan



Uncertainties



A Sample Planner's Toolbox

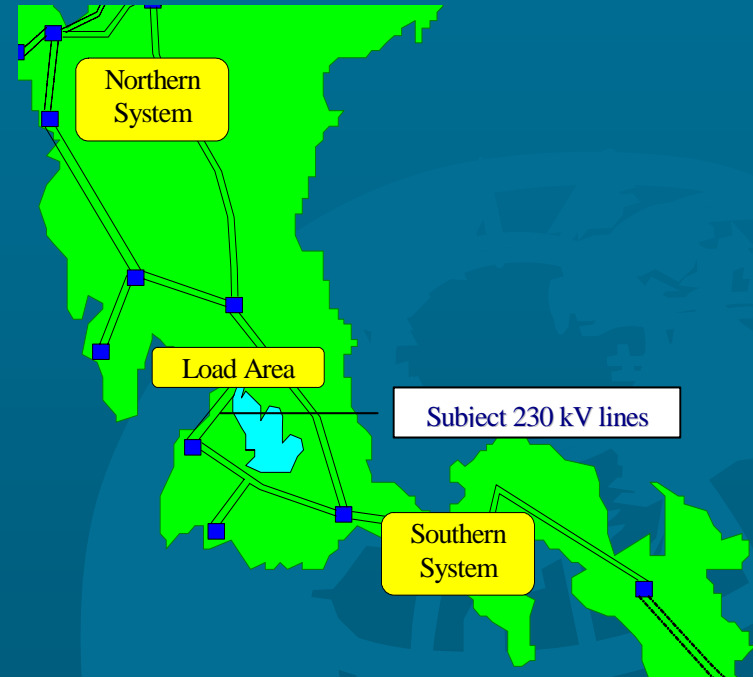
	New Line	Rebuild Line	Voltage Upgrading	Current Upgrading	Dynamic Rating
Horizon Period	Long-term	Long-term	Short to Medium term	Short to Medium term	Short-term
Technical Issues	Right-of-Way and Siting	Outage Time	Feasibility	Feasibility	Feasibility
	Lead-time	Lead-time	Outage Time	Outage Time	Operator Agreement
Cost	High	High	Medium	Medium	Low

Voltage Upgrading

- Planning Applications
 - Increase transfer capability
 - Voltage regulation
 - Stability countermeasure
- Implementation
 - Incremental increase in operating voltage
 - Include cost of transformation equipment
 - Increase voltage to next operating level
 - Typical 2X increase
 - May require rebuilding the line

Case Study 1

- 230 kV line overload 10% on contingencies
- Congested area - no other ROW
- Line is over 40 years old
- Options:
 - Rebuild line
 - Uprate voltage
 - Reconductor
 - Dynamic rating
 - Special protection scheme



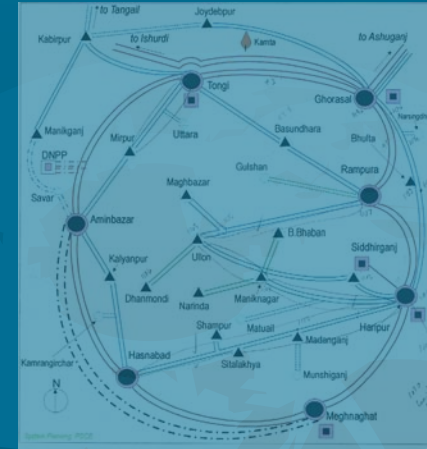
Case Study 1

- Comparison of Options

	Technical Challenges	Non-technical issues	Cost
Rebuild Line	Provide temporary line	Underbuilding/ Access to ROW	1.0
Reconductor	Tower strength		0.4
Uprate Voltage	Transformation at both ends		0.88
Dynamic Rating	Monitoring points	Operator Cooperation	0.13
Special Protection Scheme	Reliable communications		.06

Case Study 2

- Urban area triples load in next 20 years
- Very limited ROW
- Solutions
 - Build new 230 kV on steel poles
 - Uprate 115 to 230 kV
 - Reconductor
 - Underground cables



Case Study 2

- Relative Value of Options

	Incremental Gain	Cost
New 230 kV lines on steel poles	New capacity, increase redundancy	1.0
Uprate 110 kV lines to 220 kV	Double capacity	0.7
Reconductor Lines	Increase capacity	0.3
Underground cables	New capacity, increase redundancy	4.0

Case Study 2

Plan A

New 230 kV on Steel Poles

- Uprate Voltage
- Re-conductor

Plan B

No New 230 kV

- Split System
- Uprate Voltage
- Re-conductor

Plan C

110 kV Under-ground Cables

- Re-conductor

Plan D

Hybrid New 230/110 kV OH and UG

Wrap-up

- Planning for voltage uprating in the near-term:
 - Quick assessment of feasibility and cost
- Planning for voltage uprating in the long-term:
 - Part of a robust solution
 - Account for relative cost:
 - Less than line rebuilds
 - Cost per added capacity is close to or less than current uprating options

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