To Clean Environment Commission

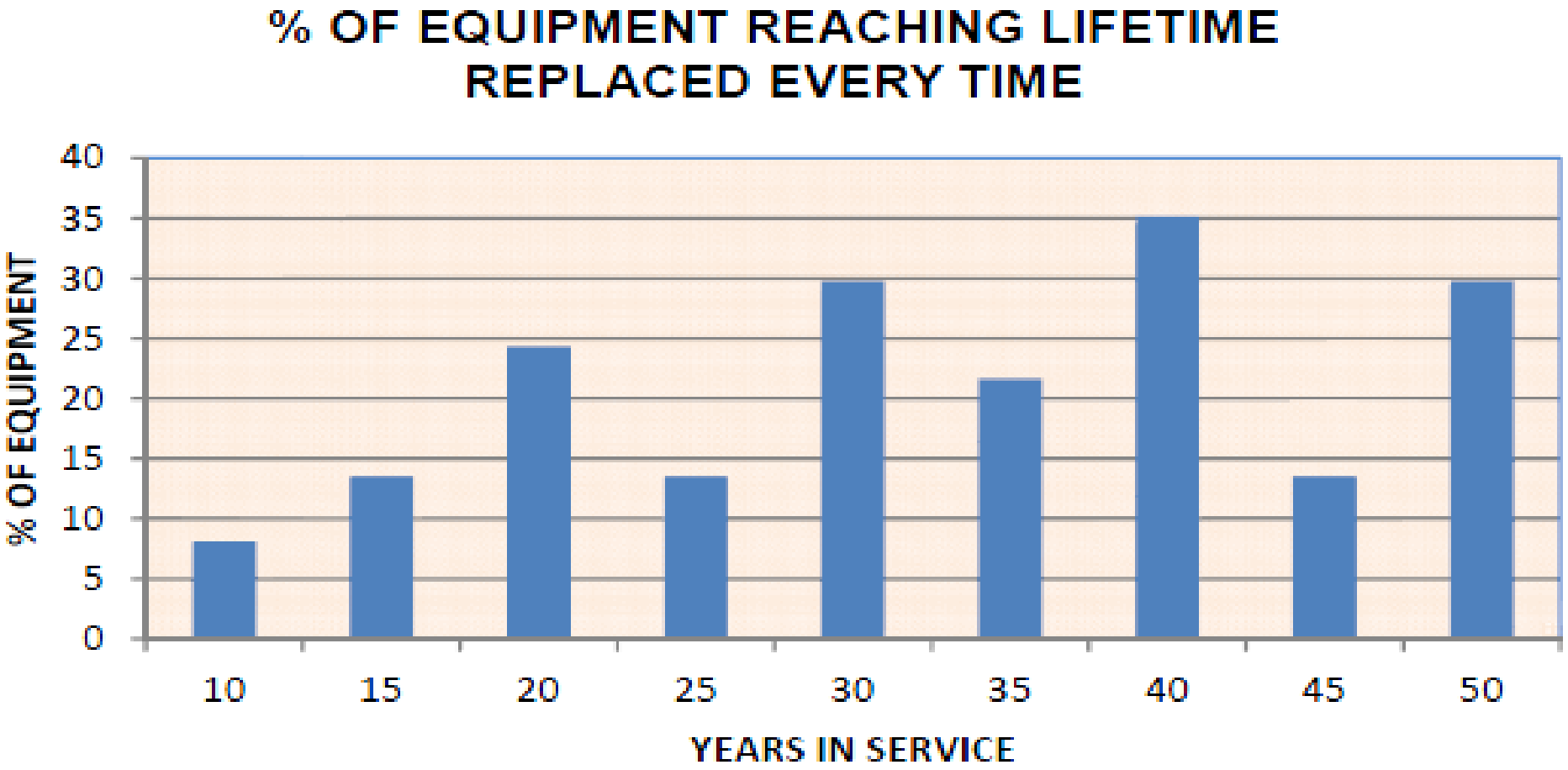
Location Options for Bipole Converter Stations near Winnipeg

Part 2

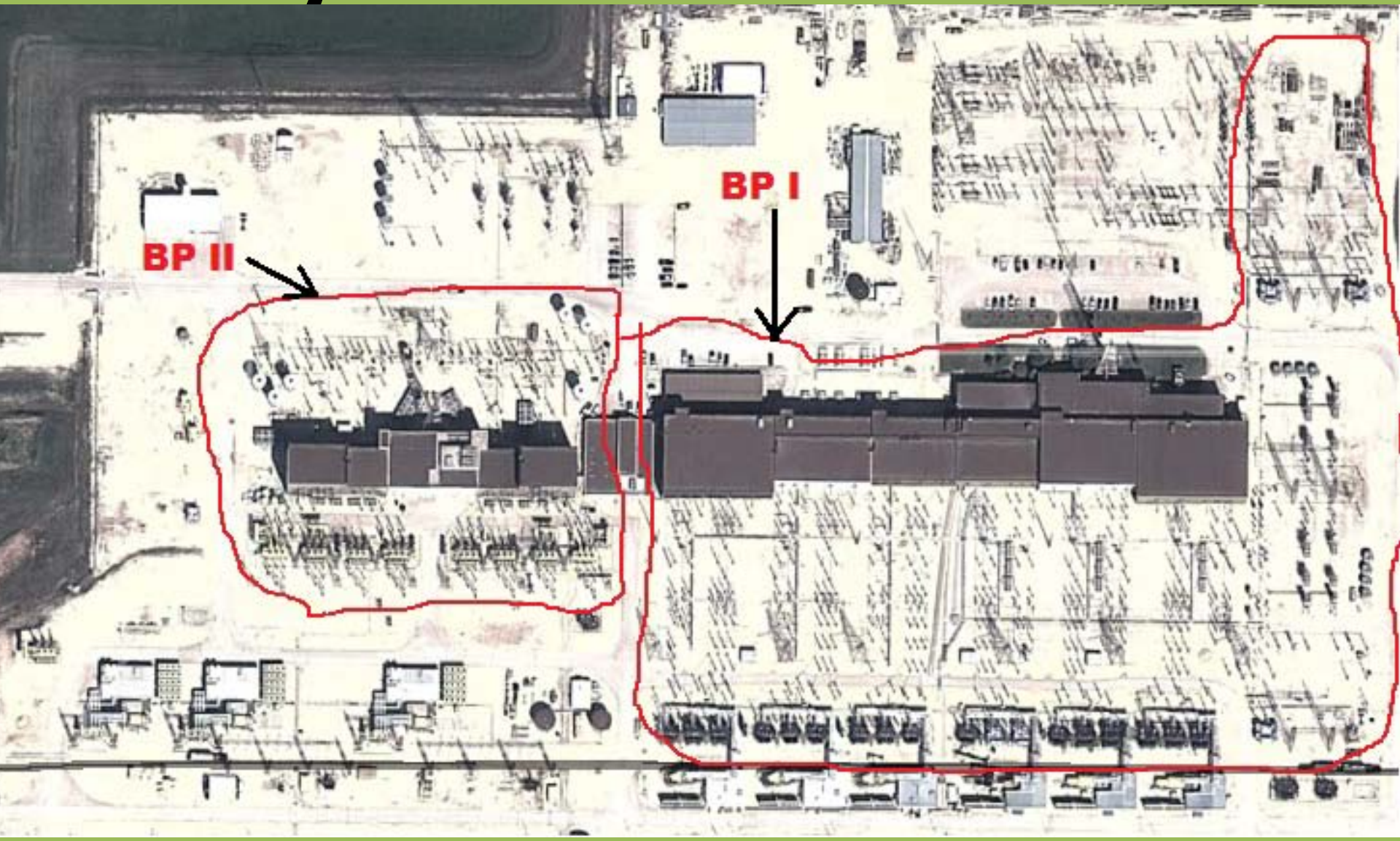
Dennis Woodford P.Eng.

5th March, 2013

% of BPII Equipment Replaced vs Years of Service

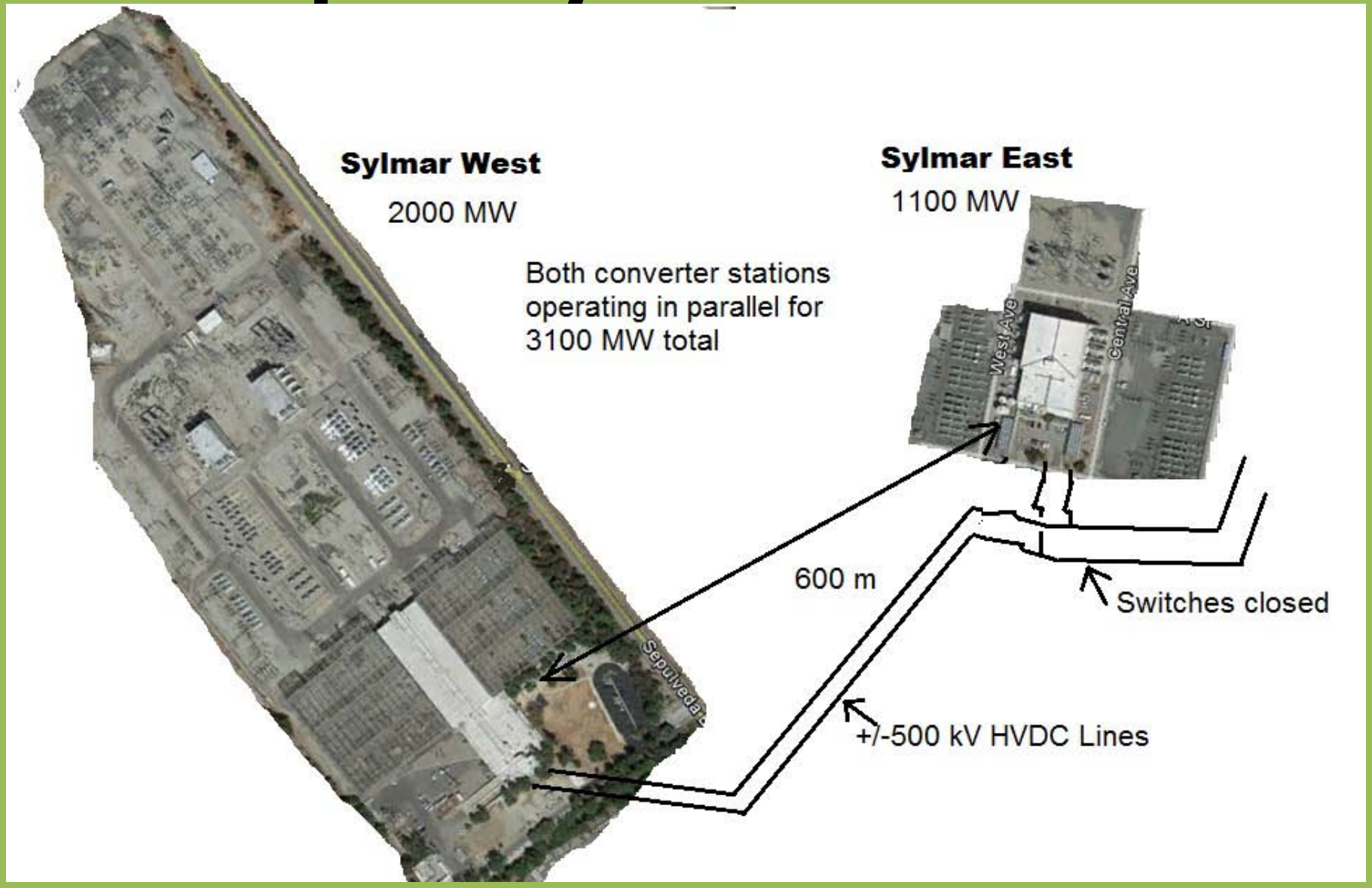


Dorsey Converters BP I & BP II

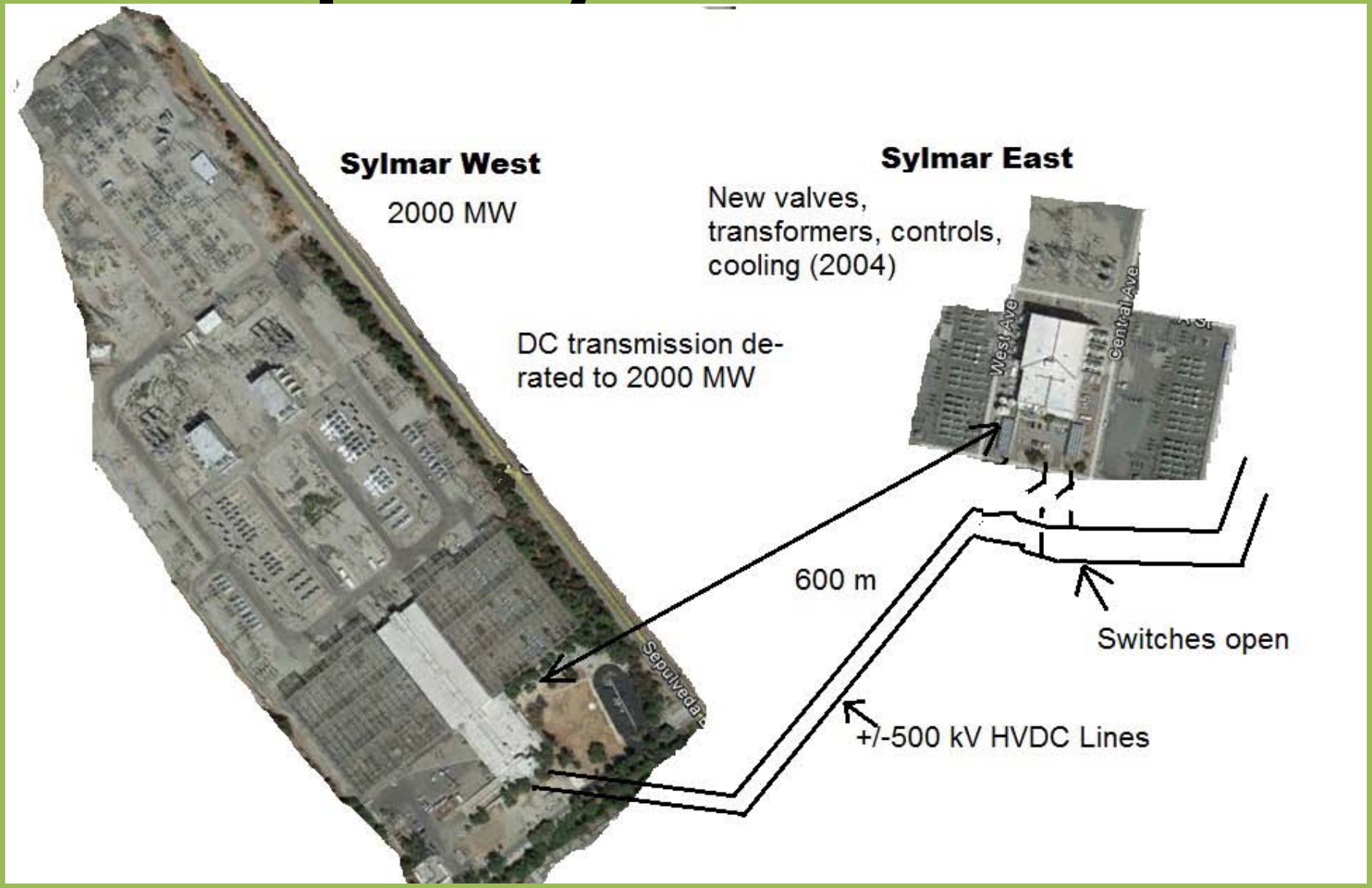


Dorsey Converters BP I Only

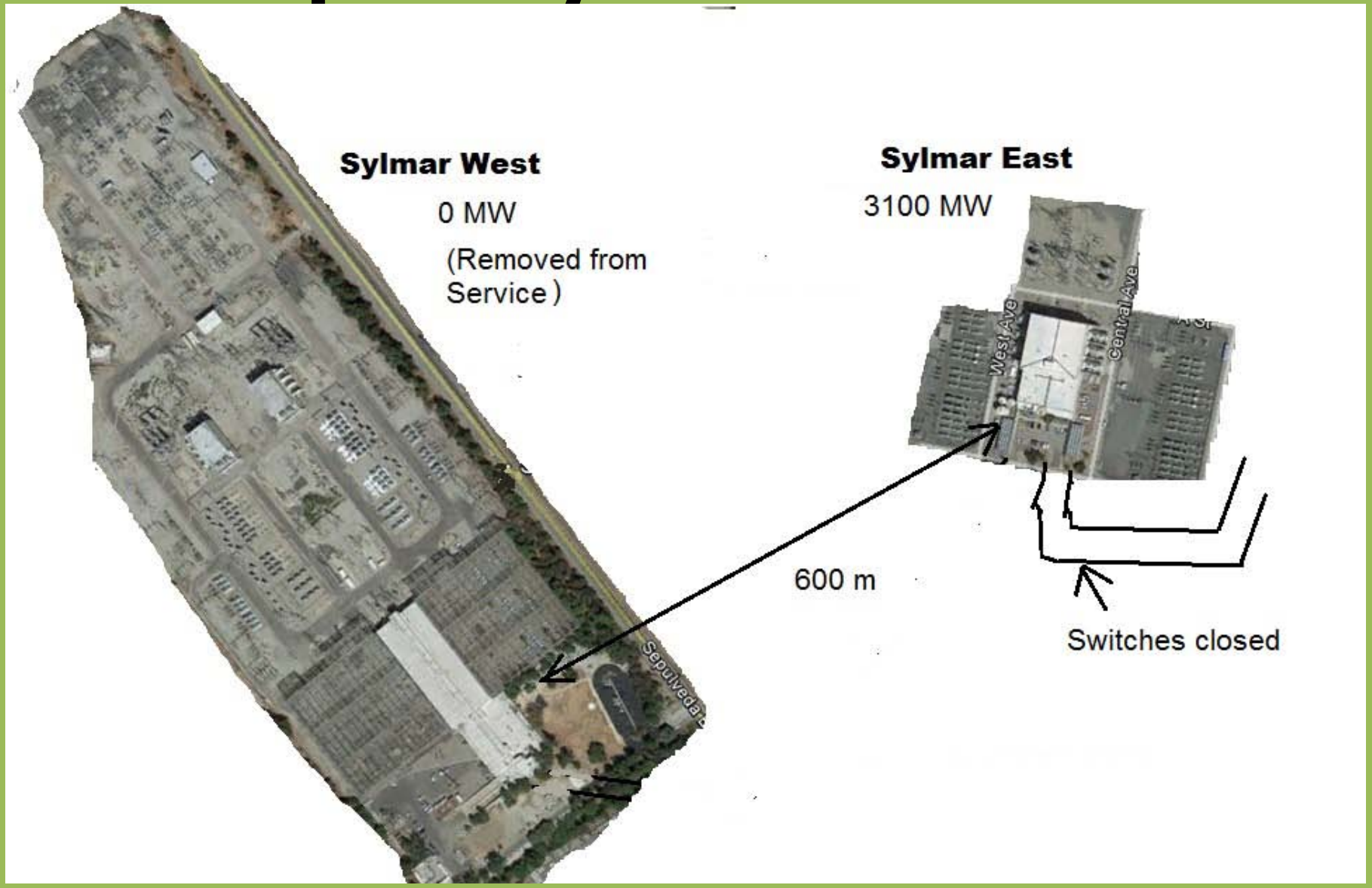
Example: Sylmar Converter



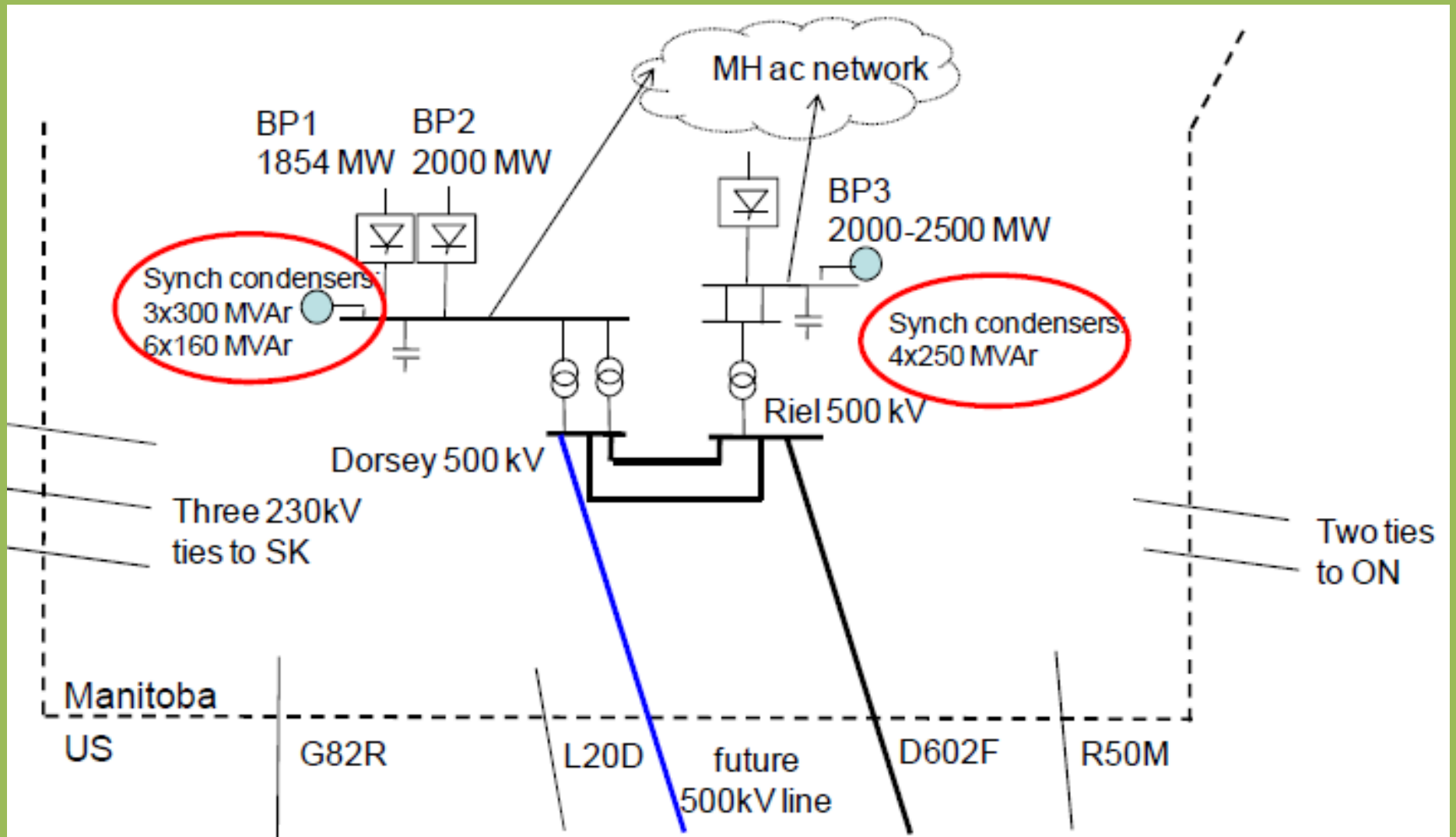
Example: Sylmar Converter



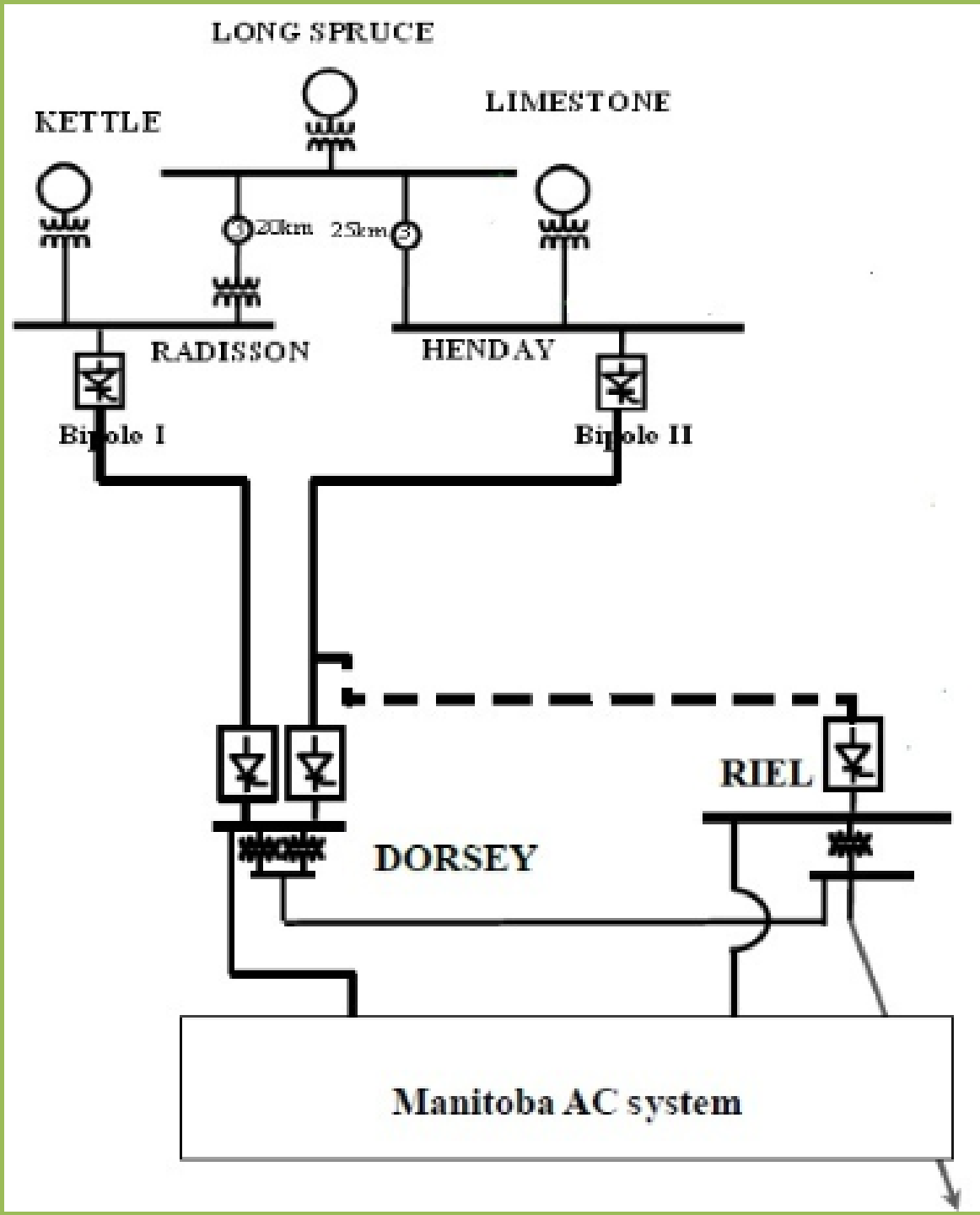
Example: Sylmar Converter



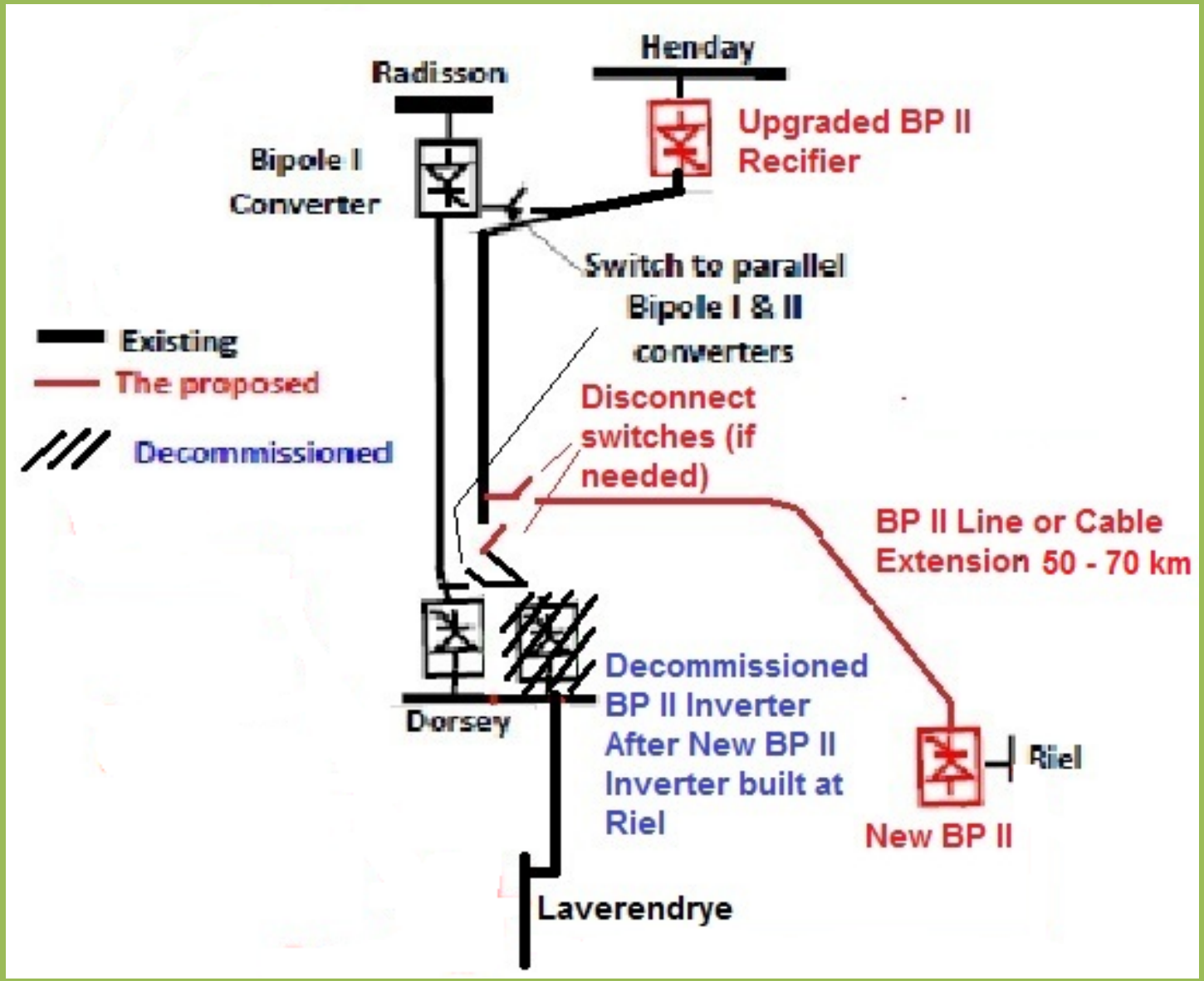
High level diagram of Manitoba Hydro's southern system DC inverters and tie lines (CIGRE August 2012 paper B4-103)



New BP II Inverter at Riel



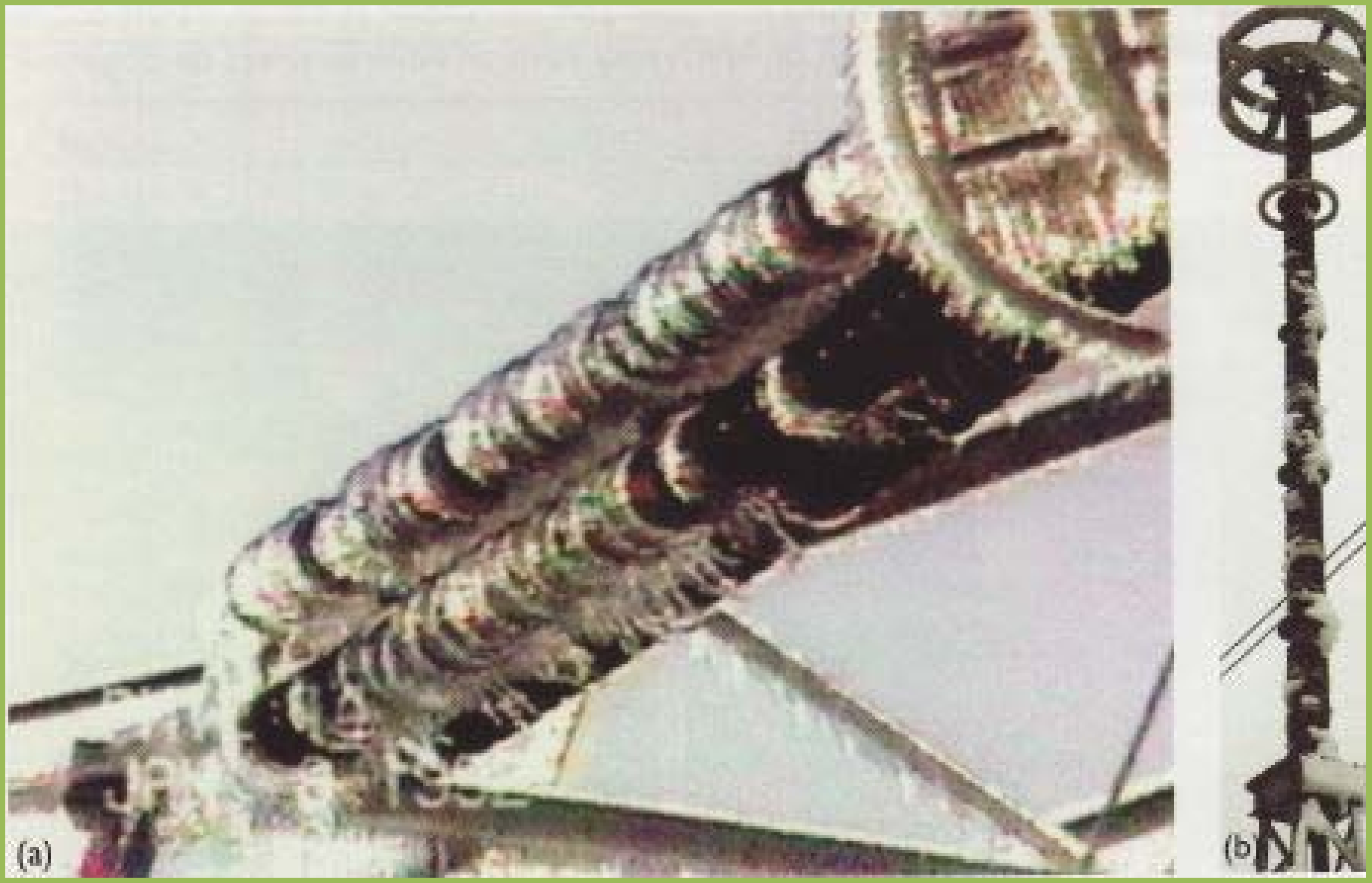
New BP II Inverter at Riel



HVDC Transmission & Wind

- Tower failures usually limited to short distances
- Tower, conductor, insulator inventory necessary
- Good restoration practice essential
- Will severe wind occur in a forest?

Iced Transmission Insulator

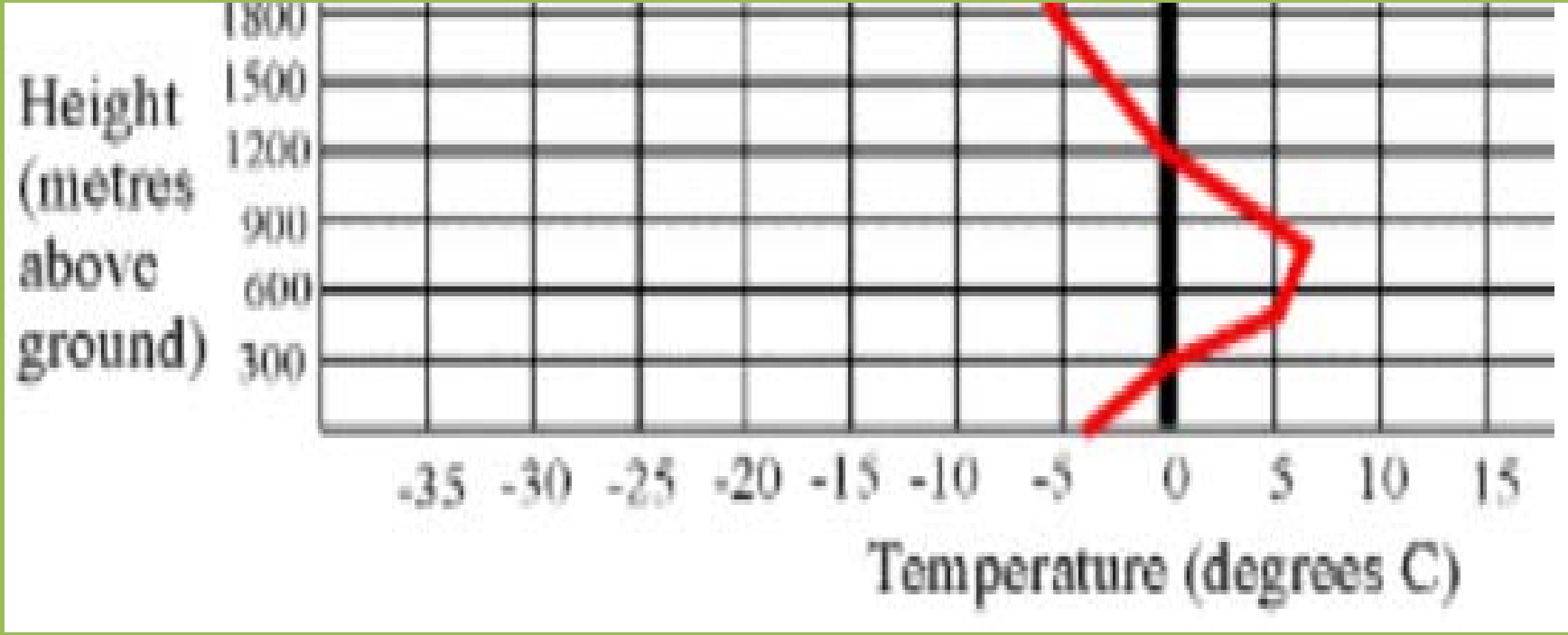


Icing Conditions

- Temperature October 5, 2012 ice storm SE Manitoba (Steinbach temperatures: Max 1.9 Deg C, Min -0.1 Deg C)

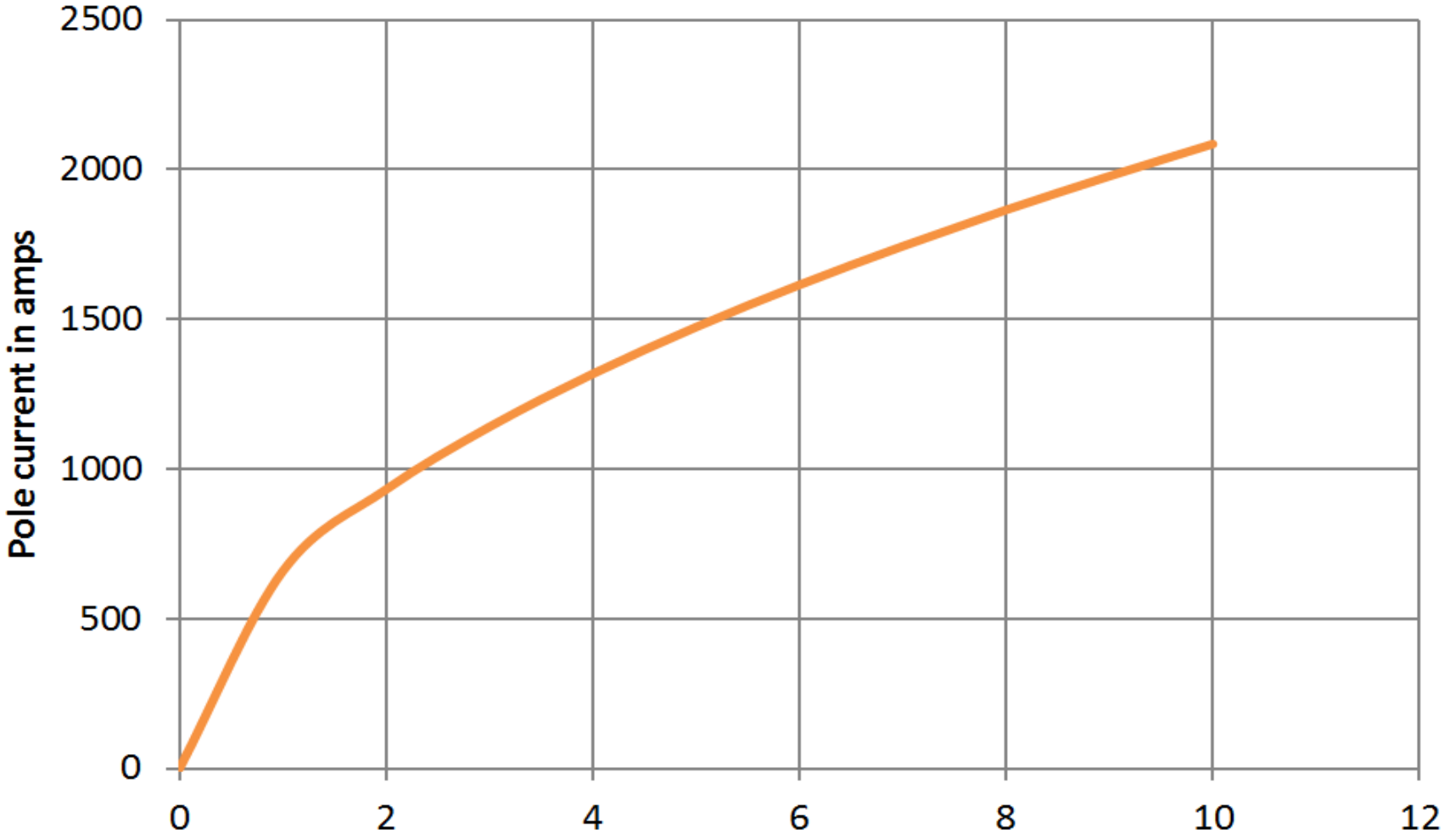
- Ice storm impacts Manitoba and Saskatchewan February 9, 2009 (Brandon temperatures: Max 0.8 Deg C, Min -5.6 Deg C)

Typical altitude temperature profile associated with freezing rain



E.L. Lecomte, A.W.Wang, J.W. Russell, "*ICE STORM '98"*, Institute for Catastrophic Loss Reduction, Research Paper Series – No. 1. http://cip.management.dal.ca/publications/ICE%20STORM%2098.pdf

BP I & II Conductor Temperatures



Converter Controls

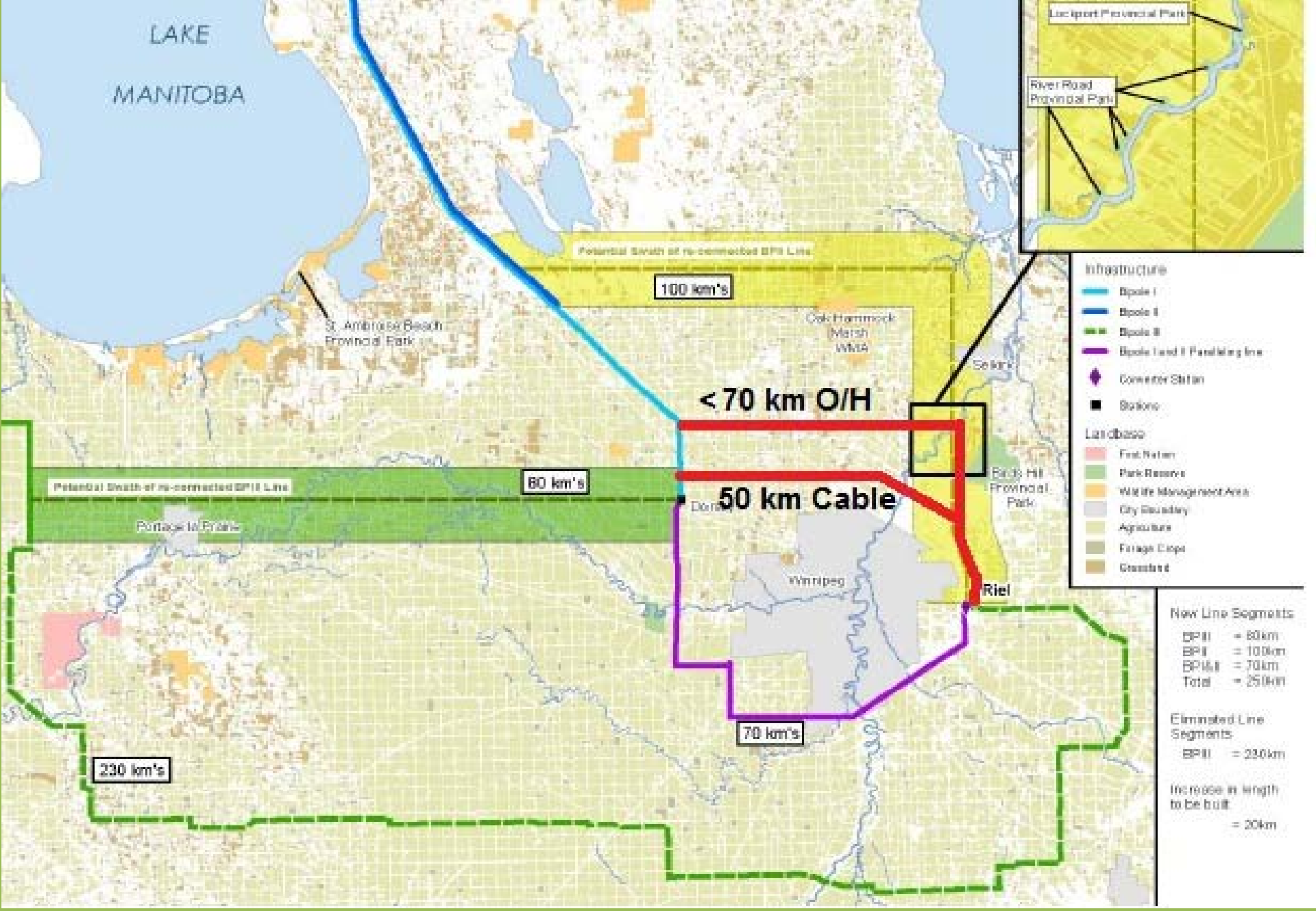
- Today BP I and BP II controls are analogue (30 year old technology) which eventually must be replaced

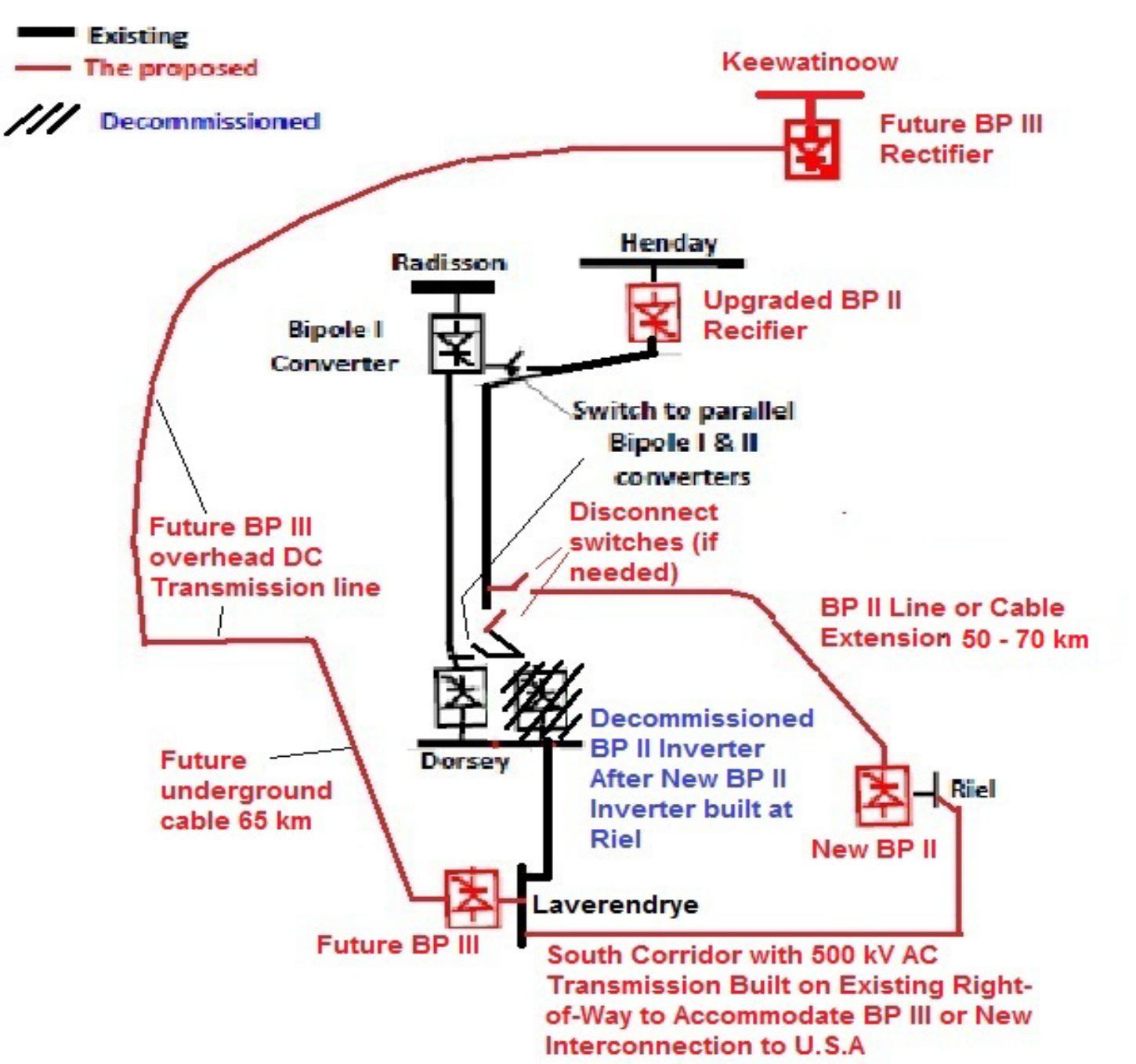
- Tomorrow BP I, BP II and Bipole III controls will be digital – State of the art – Will facilitate locating BP II at Riel with fast, redundant fibre optic telecommunications

HVDC Transmission Line Resonance

- Resonance (a sustained oscillation of DC line voltage and current) is common and expected in designing new HVDC Transmission Lines

- With HVDC Engineers in Manitoba Hydro, Teshmont Consultants and HVDC Equipment Suppliers, HVDC resonance problems can be remedied as have been done in the past


LAKE
MANITOBA
Lockport Provincial Park
River Road
Provincial Park
Potential Stretch of re-connected BP II Line
100 km's
St. Ambroise Beach
Provincial Park
Oak Hammock
Marsh
WMA
Selkirk
< 70 km O/H
50 km Cable
80 km's
Potential Stretch of re-connected BP II Line
Portage la Prairie
Winnipeg
Riel
Birds Hill
Provincial
Park
70 km's
230 km's
Infrastructure
Bipole I
Bipole II
Bipole III
Bipole I and II Paralleling line
Converter Station
Stations
Landbase
First Nation
Park Reserve
Wildlife Management Area
City Boundary
Agriculture
Forage Crops
Grassland
New Line Segments
BPIII = 80km
BPII = 100km
BPI&II = 70km
Total = 250km
Eliminated Line
Segments
BPIII = 230km
Increase in length
to be built
= 20km


Existing
The proposed
Decommissioned
Keewatinoow
Future BP III
Rectifier
Henday
Radisson
Upgraded BP II
Recifier
Bipole I
Converter
Switch to parallel
Bipole I & II
converters
Disconnect
switches (if
needed)
Future BP III
overhead DC
Transmission line
BP II Line or Cable
Extension 50 - 70 km
Decommissioned
BP II Inverter
After New BP II
Inverter built at
Riel
Dorsey
Future
underground
cable 65 km
Riel
New BP II
Laverendrye
Future BP III
South Corridor with 500 kV AC
Transmission Built on Existing Right-
of-Way to Accommodate BP III or New
Interconnection to U.S.A

Conclusions Part 2

- Bipole II inverter could be located at Riel with little disruption of power
- Three inverters at three different locations around Winnipeg increases reliability
- Ice storms can be managed effectively to prevent DC transmission line failure
- Wind storm failures must be anticipated with inventory and heavy lift helicopters

Thank you