

# Upper North Island (UNI) Dynamic Reactive Support

Technical session  
Auckland, 30 June 2009

TRANSPower



# Overview

- Purpose of today session
- Overview Upper North Island (UNI) reactive needs
- Technical Analysis - Reactive power planning
- Process
- Questions



# UNI static voltage support

- Capacitor banks
  - Albany
  - Otahuhu
  - Penrose
  - Henderson
  - Hepburn
  - Bombay
- Committed - an additional 2 x 100 Mvar banks at OTA 220 kV
- Caps on 11 kV tertiaries (OTA, HEN, ALB) to be decommissioned
- Binary Switched banks
  - Kaitaia 22 Mvar, Kaikohe 20 Mvar
- Total UNI caps = 1352 Mvar (not including caps in distribution networks)



# UNI dynamic support sources

- Static Var Compensator (SVC)
  - Albany
- Generation
  - Southdown, Otahuhu, Ngawha (embedded)
- Synchronous condensers
  - Otahuhu, Southdown
- Total UNI dynamic = +292 (cap) /-148 (ind) Mvar, excl. generators



# Projects to reinforce Auckland

- NIGUP
  - Double circuit line: Whakamaru - Brown Hill
  - Cables: Brown Hill–Pakuranga,
- NAaN
  - Cross harbour cable: Penrose-Albany
- Pakuranga-Penrose cable
- Interconnecting transformer at Penrose
  
- Improve thermal capability / security / static voltage stability
- Dynamic Voltage stability still an issue
  - motor loads connected through relatively high impedance transformers



# SO reactive power planning

- Procured as ancillary service under Part C of EGR
- Cost is allocated on a Zonal basis as per the EGRs - currently only in Zone 1
- Considers steady state voltage stability of power system (maintain post contingency voltage with 100% load)
- Load flow analysis (PV curves), loads treated as constant PQ
- Time horizon: 2 to 3 years



# GO reactive power planning

- Time domain dynamic simulation (first 15 seconds after an event), in addition to load flows
- Detailed load models (e.g. includes motors)
- Determines appropriate static / dynamic Mvar mix
- Time horizon: up to 20 years
- Solution may require Grid Support Contract
- Costs allocated in accordance with the Transmission Pricing Methodology (TPM) under Part F of the EGRs



# Grid Support Contracts (GSC)

- There are 3 forms proposed:
  - Demand side participation (DSP)
  - Voltage support (VS)
  - Market generation (MG)
- Voltage support GSC discussed further



# Voltage Support GSC

- SO procures voltage support contracts under the ancillary service provisions of Part C
- GO will offer GSC for voltage support using the Part F framework. This will co-optimize non-transmission voltage support with significant investment in transmission reactive support planned
- SO role in procurement of voltage support moving towards contracts of more short term nature (availability of gen units when not otherwise offered)
- Subject of voltage support GSC already raised with industry



# Summary

- GO will use Part F to get long term solutions for UNI reactive support,
- SO will use Part C for short term voltage management
- UNI dynamic reactive investigation project is considering both static and dynamic voltage stability and any GUP will cover both needs
- Transpower will consider use of reactive devices (capacitor banks, SVCs, etc) and best use for local generation (if any).



# Consultation Technical analysis



# Two types of voltage stability

- Two types of voltage stability important to reliable operation of power systems:
  - **Steady state:** ability of power system to supply reactive power to steady state demands of load. Analysis considers power system over minutes and hours; and
  - **Transient:** ability of power system to maintain voltage in short timeframe (1-15 seconds) following short circuit fault.
- Term voltage stability tends to be used to describe both phenomena, although they are different and require different treatments to maintain stability.

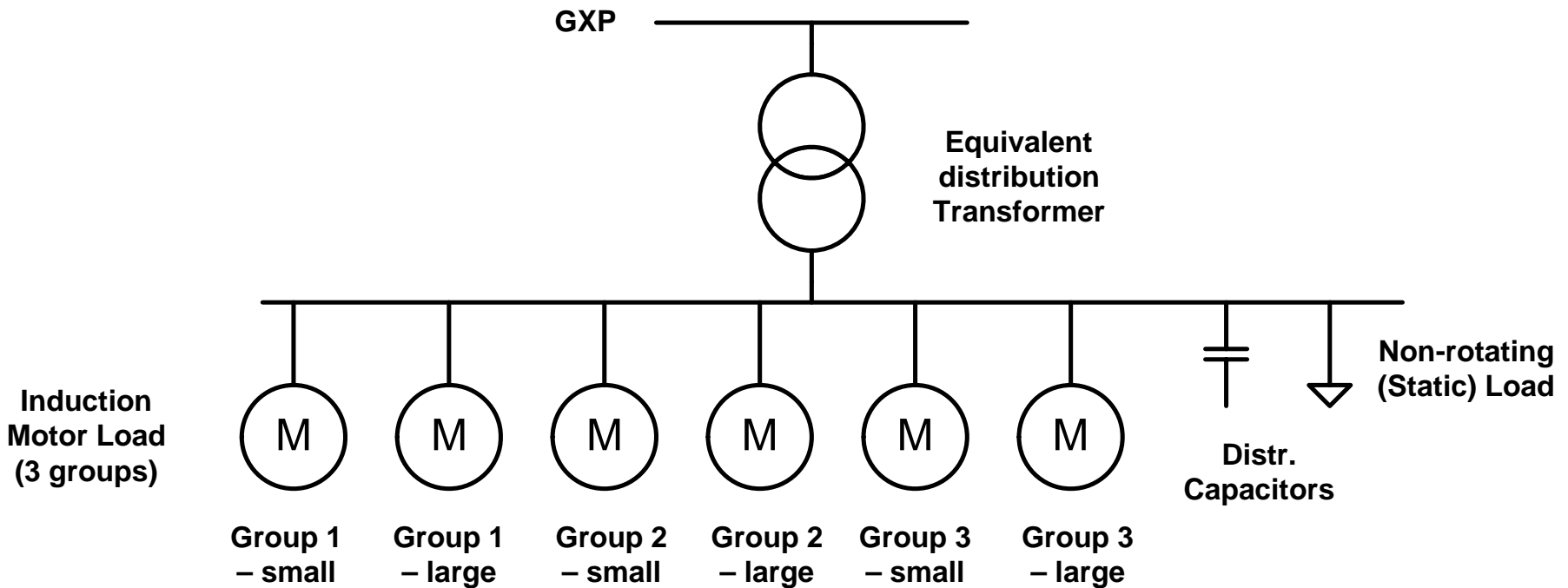


# Power Factor considerations

- If p.f.  $\sim 1$ 
  - less static capacitors required in transmission network
- Dynamic reactive planning
  - no impact



# Dynamic Voltage Stability Analysis – Load model

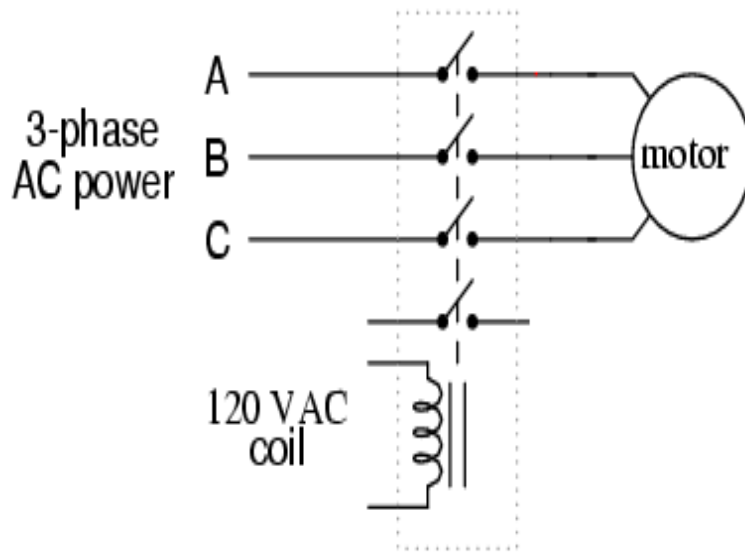


# Load survey results

Period	Static Percentage	Induction motors					
		Group1		Group2		Group3	
		Large	Small	Large	Small	Large	Small
Winter GXP average	61.9%	3.8%	11.8%	0.9%	13.1%	1.7%	7.0%
Extreme Summer GXP average	36.0%	6.5%	20.4%	1.5%	20.3%	2.9%	12.5%

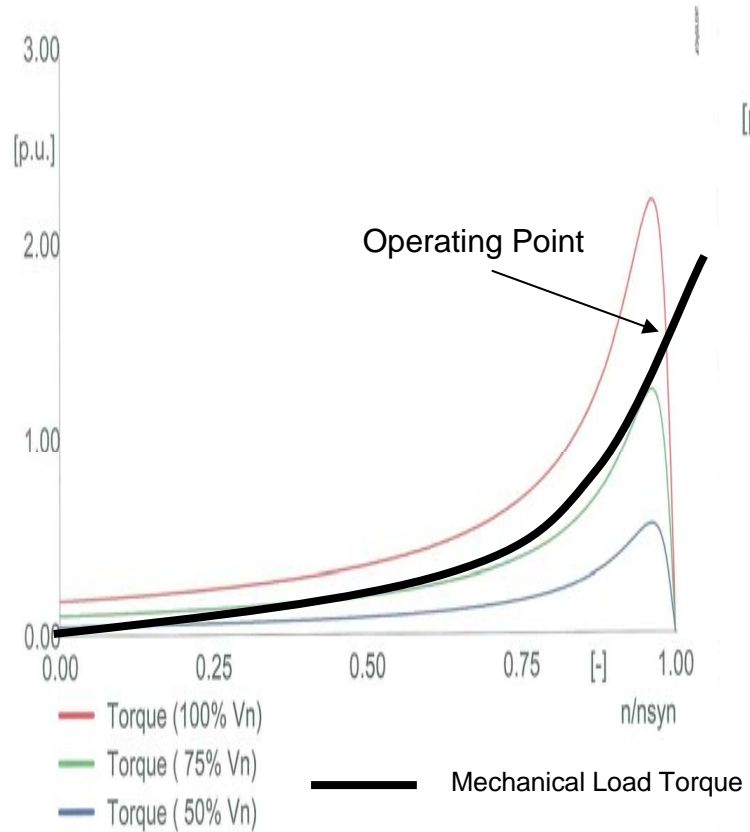


# Motors with Contactors – Group 1

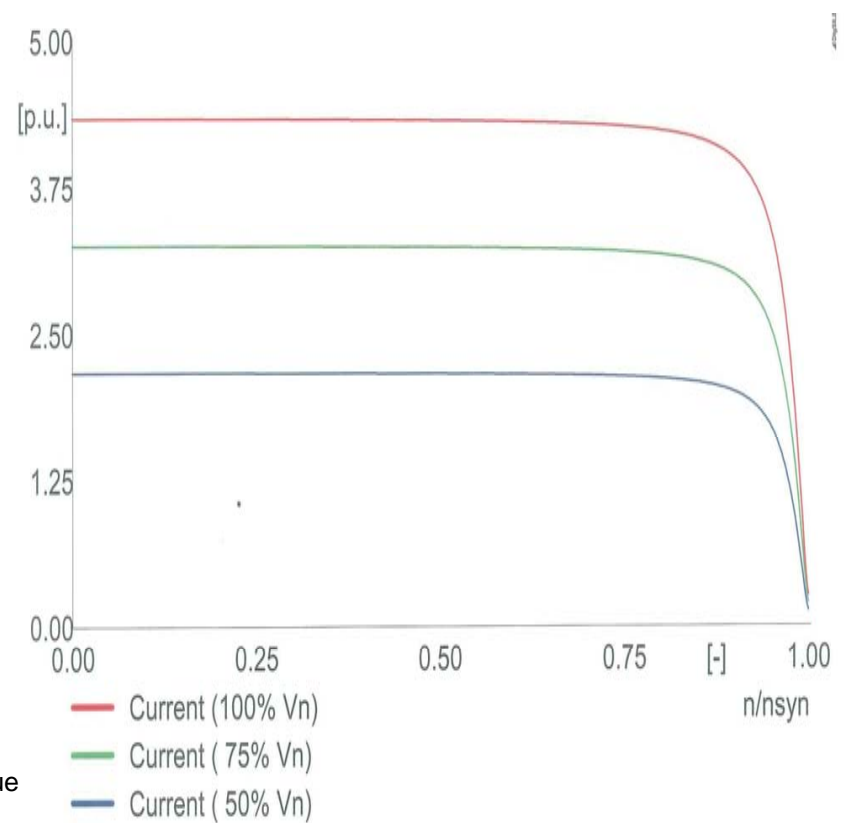


- Disconnect for momentary voltage dips [ typically  $V < 0.5\text{p.u}$  ]
- Group 1 motors have big impact on system voltage recovery, therefore sensitivity analysis applied

# Induction Motor Stalling/Acceleration Mechanisms



Torque vs Speed



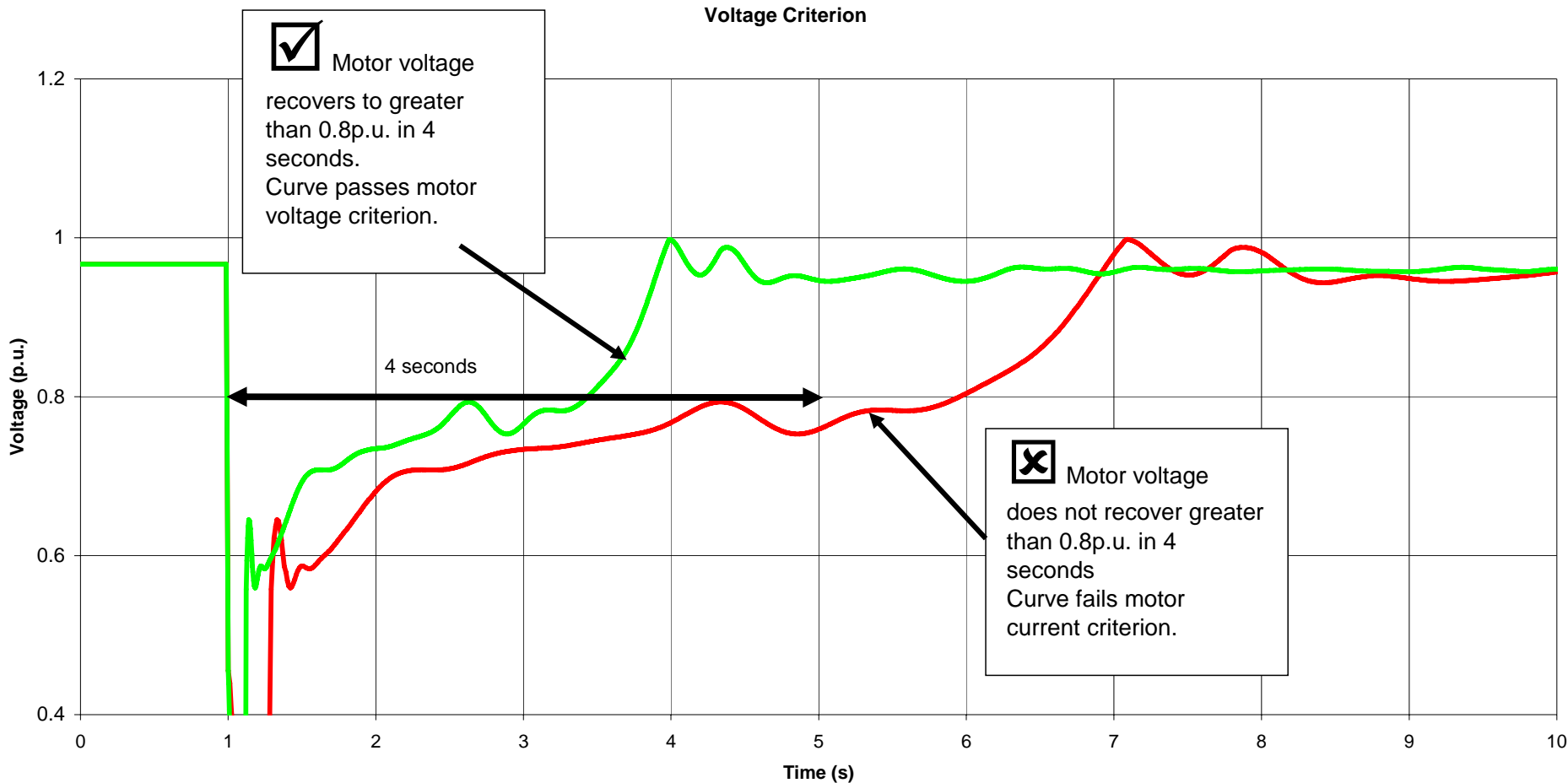
Current vs Speed

# Dynamic Performance Criteria

Criteria	Reason
Load bus voltage should not transiently dip below 0.5 pu for equipment outage (without a fault)	Avoid unnecessary loss of motor load by contactor action
Load voltage recovers to 0.8 pu within 4 sec	Avoid loss of motor load by under-voltage relay operation
Peak over-voltage < 1.3 pu, limited quickly < 1.1 pu	Prevent equipment damage, avoid triggering of over voltage protection relays
Motor current not >6 pu for more than 3 sec, not > 3 pu for more than 8 sec	Avoid loss of motor load by over-current relay operation



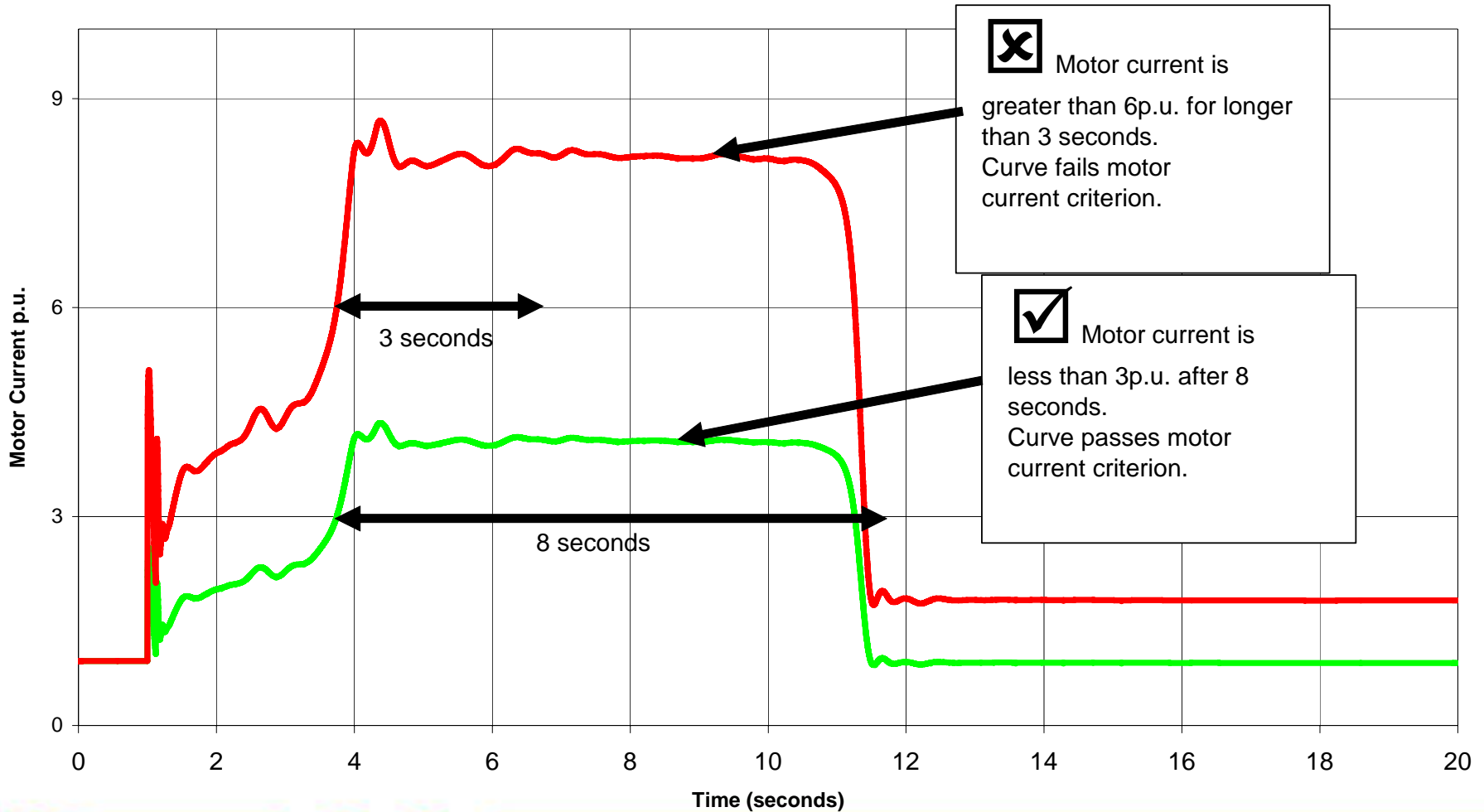
# Dynamic criteria – Load Bus Voltage



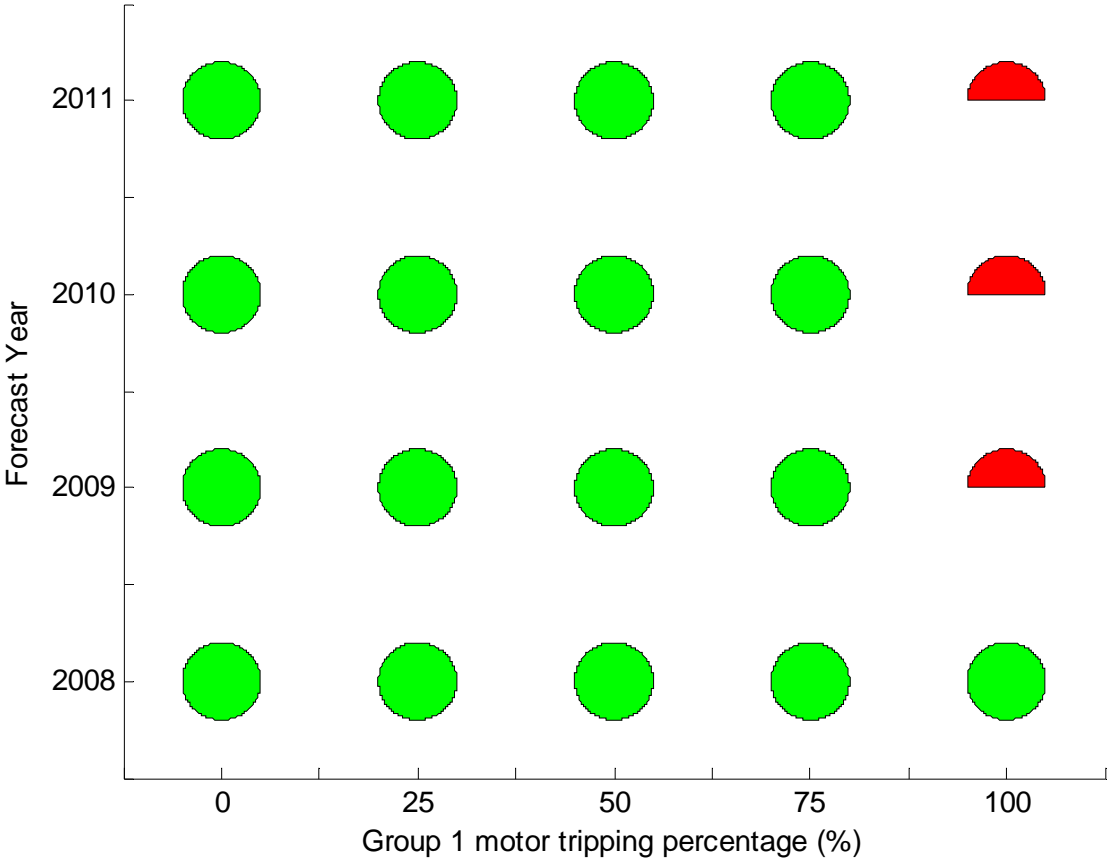
# Dynamic criteria – Induction Motor

## Currents

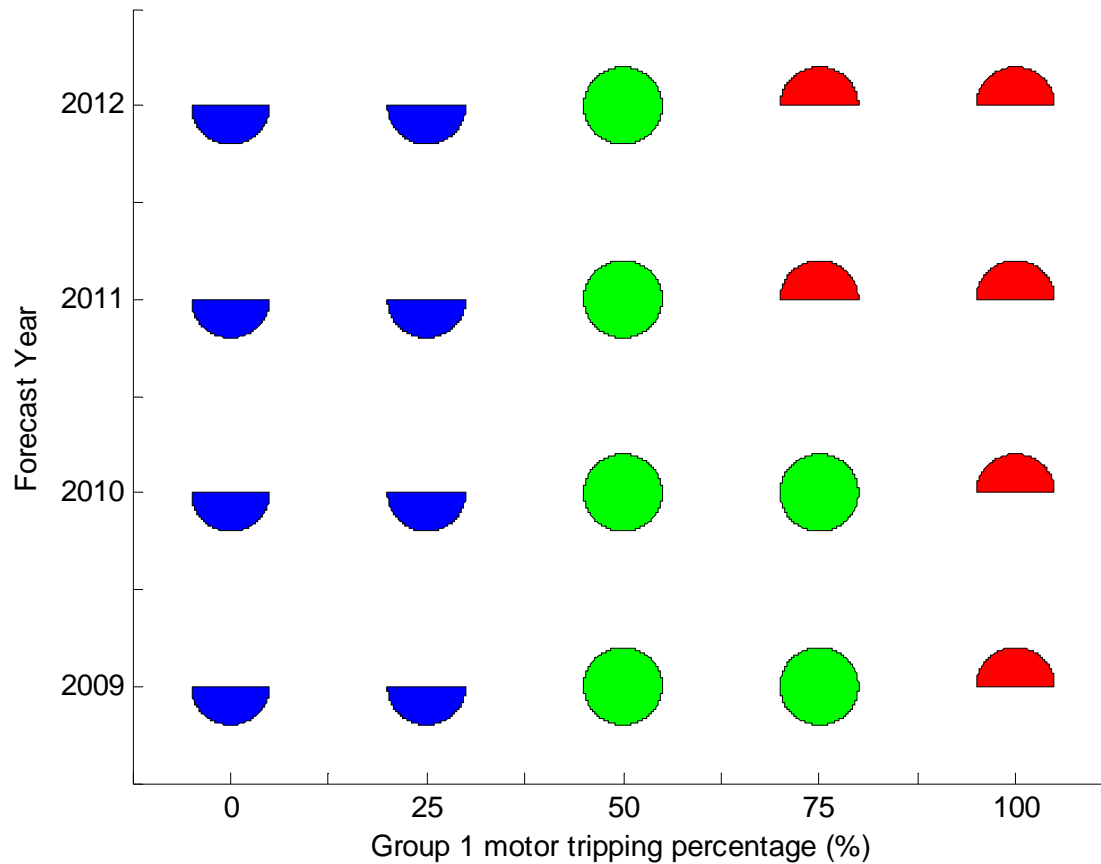
Motor Current Criterion



# Need Analysis – Winter – N-1



# Need-Analysis – Summer – N-1



# UNI reactive planning – solutions

- Presently considering combinations of
  - Capacitor banks
  - Voltage support GSC
  - SVC / Statcom
  - Low impedance transformers



# Process

- Consultation document posted on 1 June 2009
- Consultation now closes on 7<sup>th</sup> July 2009
- Consulting on assumptions and potential solutions
  - (including RFI of non-transmission solutions)
- Identify long list - 17<sup>th</sup> July 2009
- Select short list - 31<sup>st</sup> July 2009
- Submit GUP - 31<sup>st</sup> October 2009
- Target commissioning date – as soon as possible



# Questions ?

