Technical aspects of the Grid Investment Test

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introduction

The GIT is an economic test, with technical power systems analysis inputs, used to assess the benefits of transmission investment.

It is applied:

- by Transpower to determine proposed transmission investments for inclusion in the GUP
- by the EC to review and approve reliability and economic transmission investments, and alternatives,

Has been applied successfully, i.e., the Auckland 400 kV proposal.

introduction – II

The Government's NZ Energy Strategy:

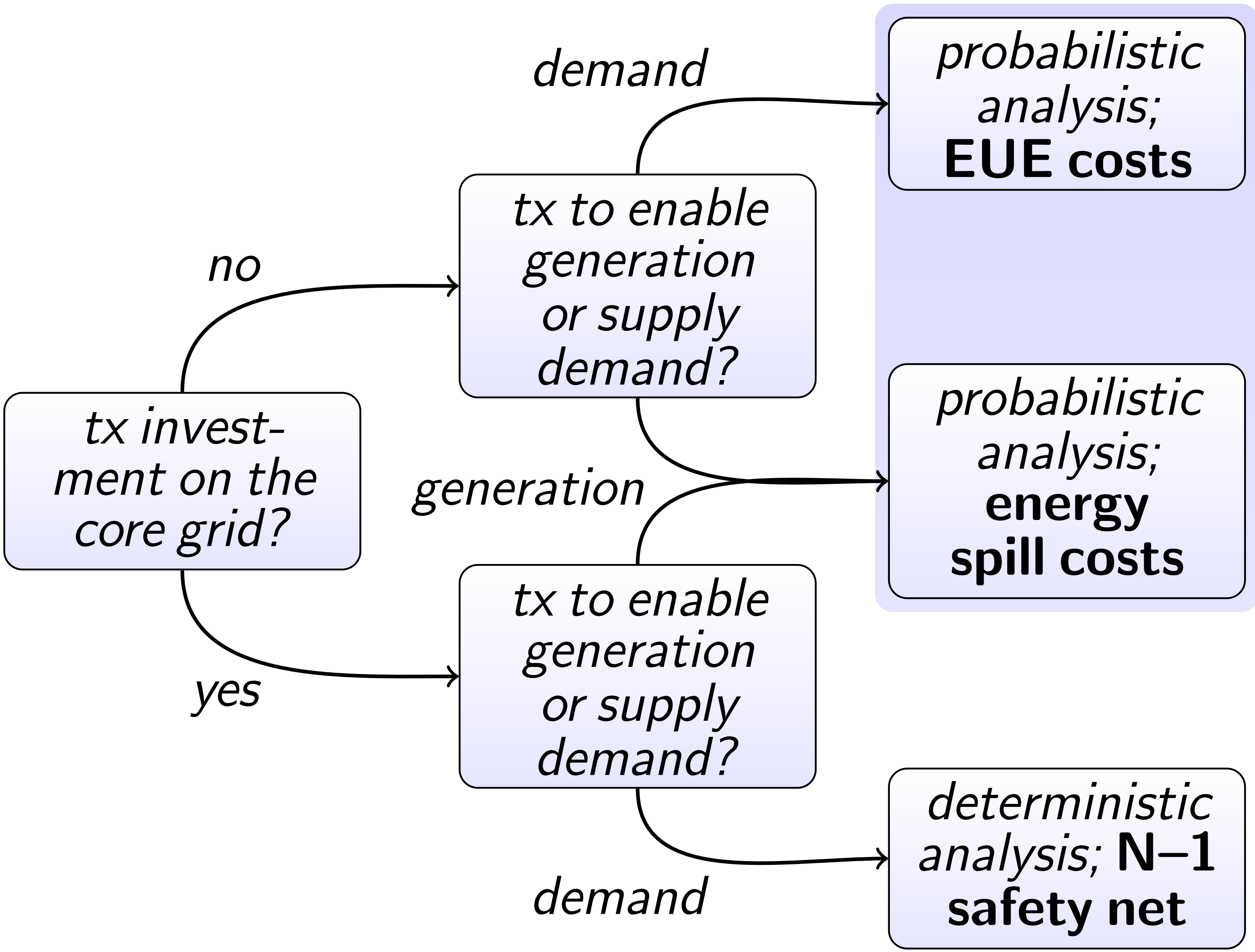
- has set a target for 90% total renewable generation by 2025
- will require rapid uptake of renewable generation

However, the GIT has yet to be applied for transmission to enable generation.

This presentation:

- reviews GIT analysis techniques
- provides results of an analysis to enable generation (the Lower South Island)

types of GIT analysis



transmission to supply demand

- *Non core grid* – probabilistic analysis
  - economics based on EUE
  - low capex, $\rightarrow$ high EUE
  - high capex $\rightarrow$ low EUE
  - system operation can be important
- *Core grid* – deterministic analysis
  - economic analysis based on N–1 safety net
  - EUE used to select between options
  - capital costs, and,
  - Power Systems Analysis (PSA) important

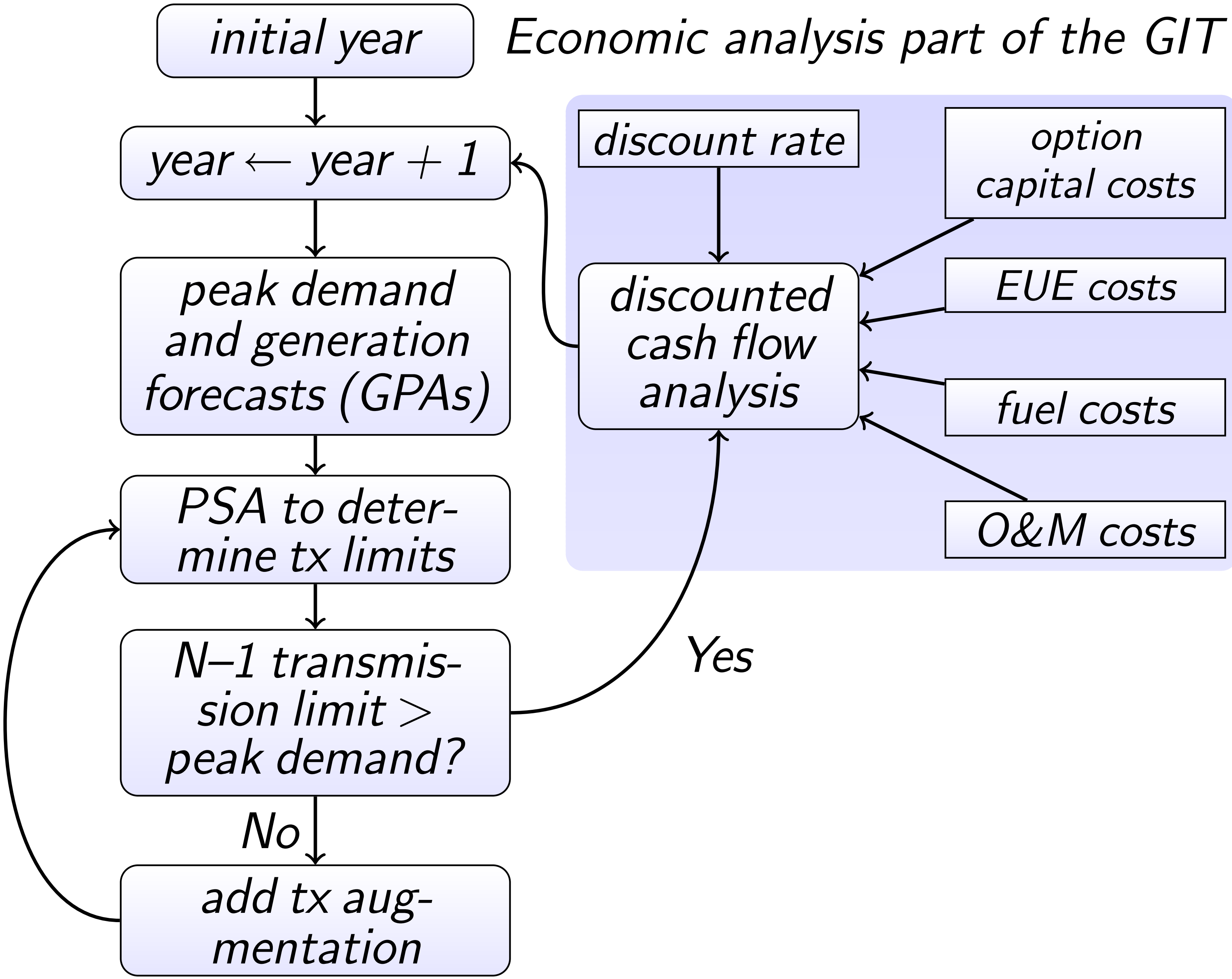
options

A GIT should identify the least cost solution among multiple options. The following transmission options could be considered:

- Option 1 - do nothing
- Option 2 - thermal upgrades (line re–tensioning)
- Option 3 - voltage support (Cap. banks or SVCs)
- Option 4 - duplexing or reconductoring circuits
- Option 5 - new line
- Option 6 - addition of a peaking plant
- Option 7 - demand side management

The most economic investment path is often a combination of options with different investment timing.

the deterministic method

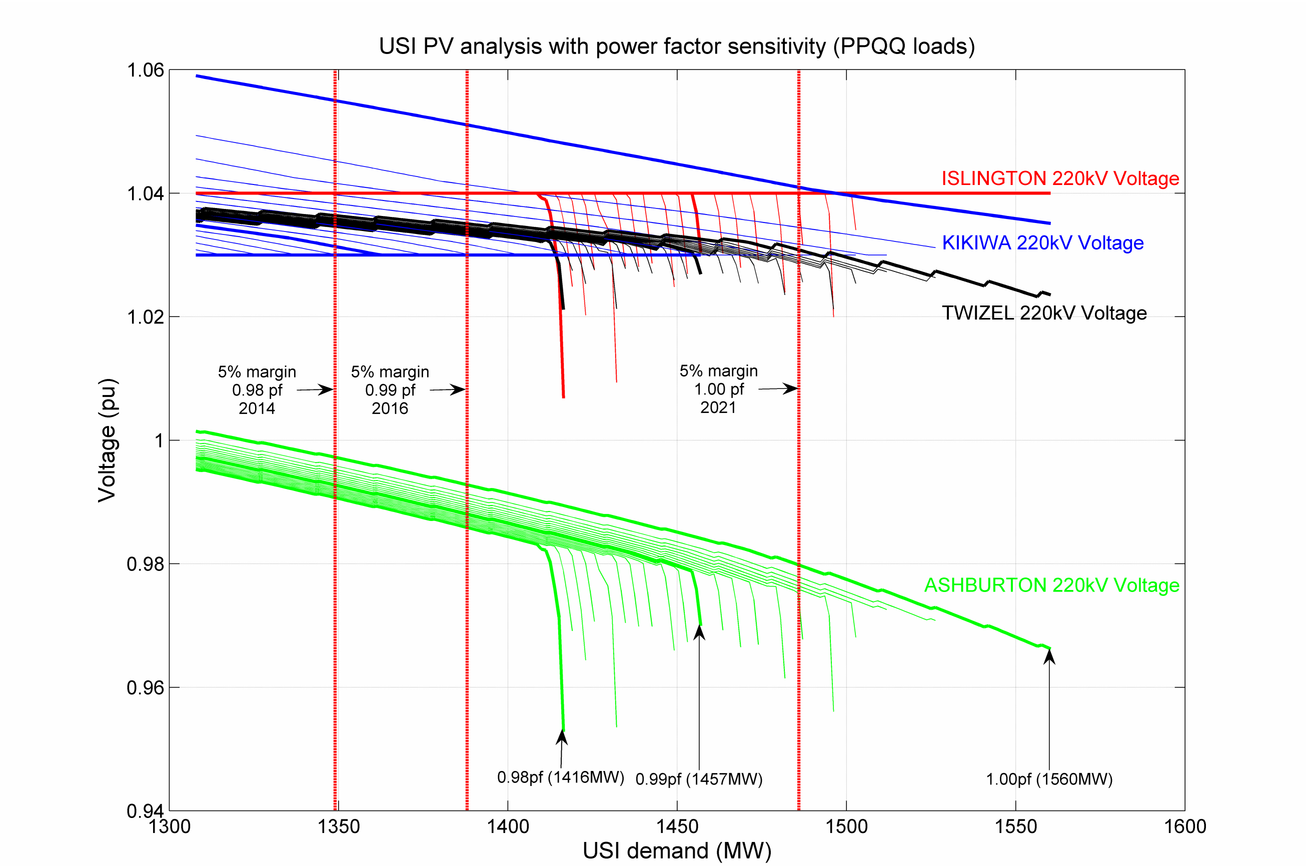


system operation effects - I

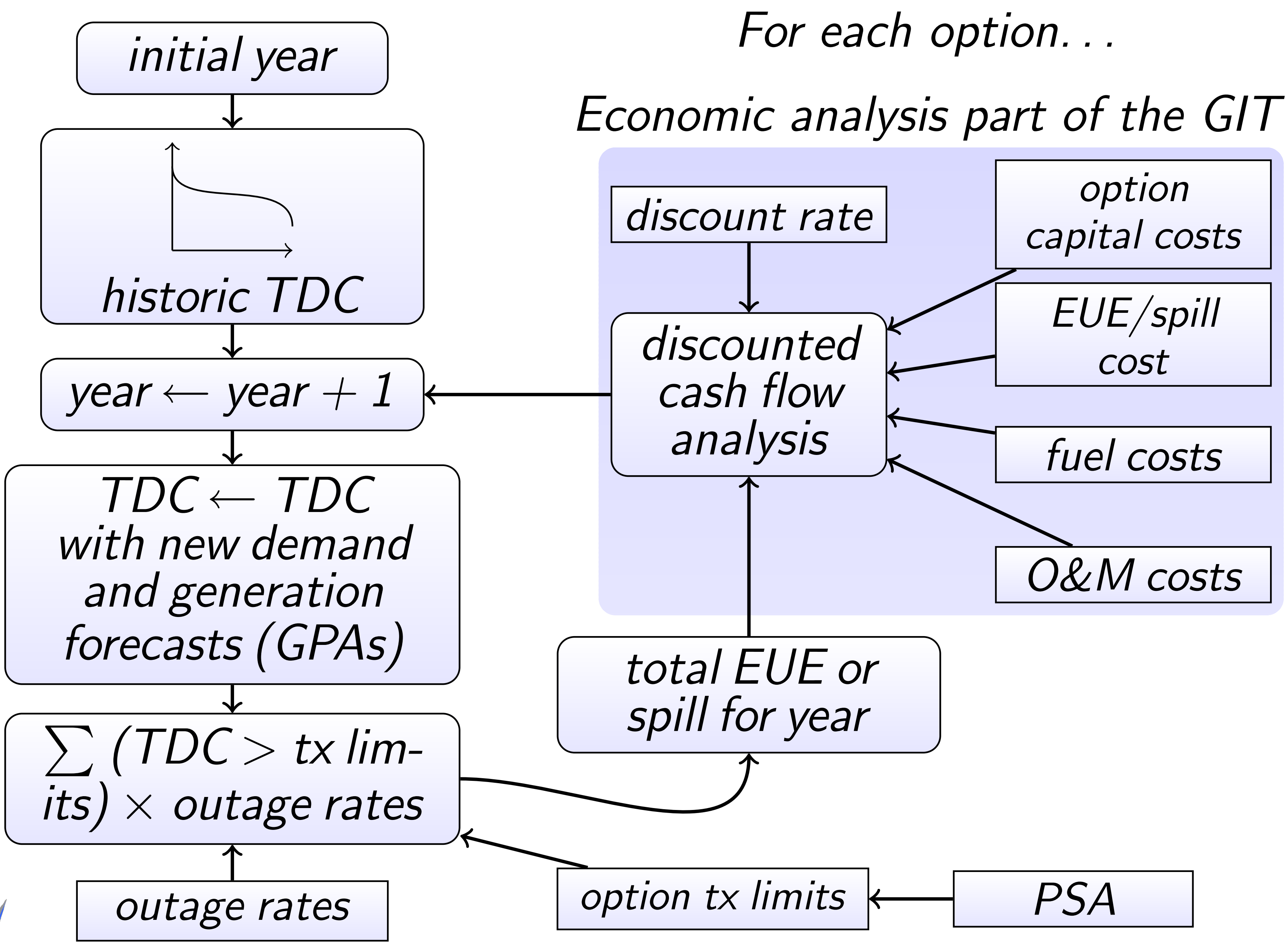
The effect of improved power factor in voltage constrained regions:

- improves transmission limits
- lower losses

USI transmission limit example:

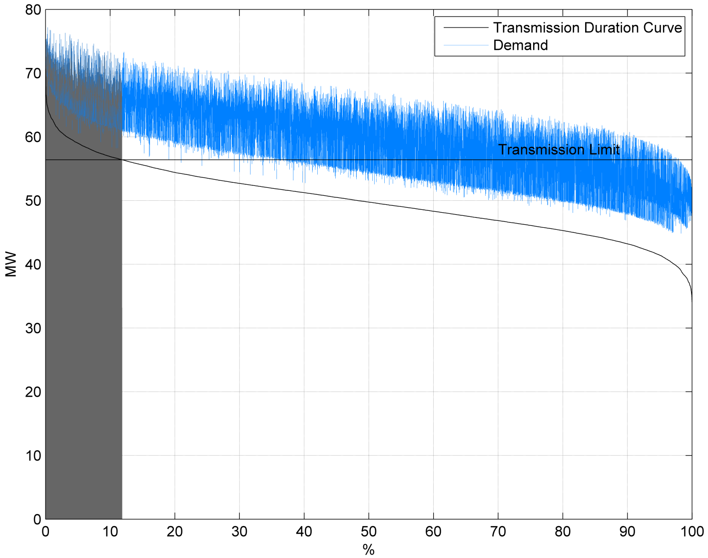


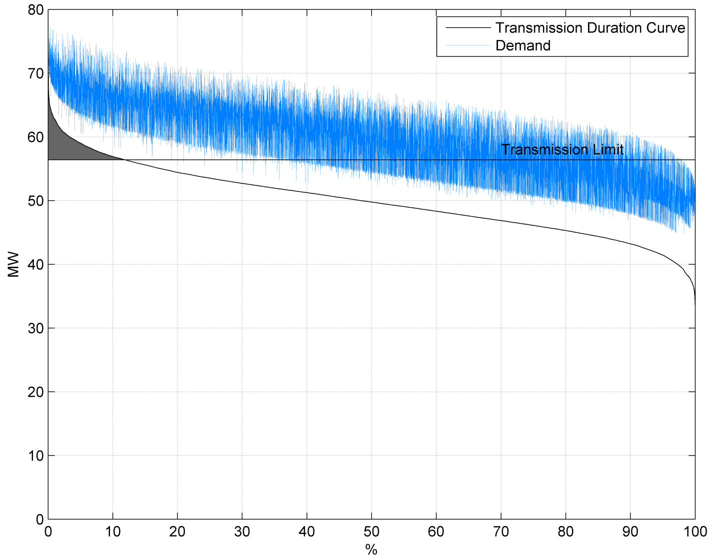
the probabilistic method



system operation effects - II

- EUE dependent on system operation following a contingent event
- loss of an entire region (no SPS), vs,
- loss of only a small portion of the region (with SPS)





transmission to enable generation

Fundamental differences in developing transmission to enable generation, rather than to supply demand:

- demand areas fixed geographically
- renewable generation opportunities (wind/hydro) scattered across the country

How does low cost generation far from demand compare with high cost generation near demand?

the TTER project

The government, through the NZES, has set a target of 90% of new electrical generation to be developed by primary renewable sources by 2025.

In response, the EC initiated a project *"Transmission to Enable Renewables (TTER)"* which is split into two parts:

- identify plausible future renewable generation
- identify areas where transmission constraints, or lack of any transmission at all, may limit future renewable generation development

wind resource study

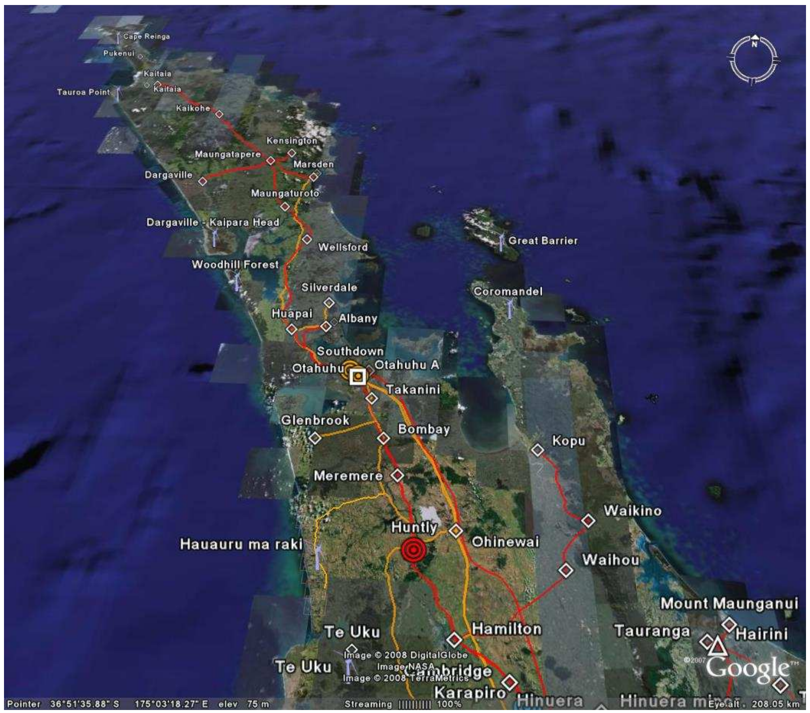
Connell Wagner identified large amounts of potential wind resource
Three tranches identified, based on resource quality:

- Tranche 1 : 40% cap. factor, $80/MWh
- Tranche 2 : 35% cap. factor, $95/MWh
- Tranche 3 : 30% cap. Factor, $110/MWh

Region	**Capacity** (MW)	**Annual Energy** (GWh)
North Island (T1)	**8900**	**31000**
(T2)	**8850**	**27000**
(T3)	**8600**	**23000**
South Island (T1)	**5600**	**20000**
(T2)	**5000**	**15000**
(T3)	**4300**	**11500**
New Zealand	**41000**	**126000**

UNI vs LSI wind?

UNI	LSI
>5000MW identified	>3500MW identified
Tranche 2 & 3	Tranche 1
>500MW planned	>1000MW planned or consenting
high connection costs	low connection costs
low grid upgrade costs	high grid upgrade costs
lower losses	higher losses



LSI analysis – I

Many generators have identified a low cost wind resource in the LSI.

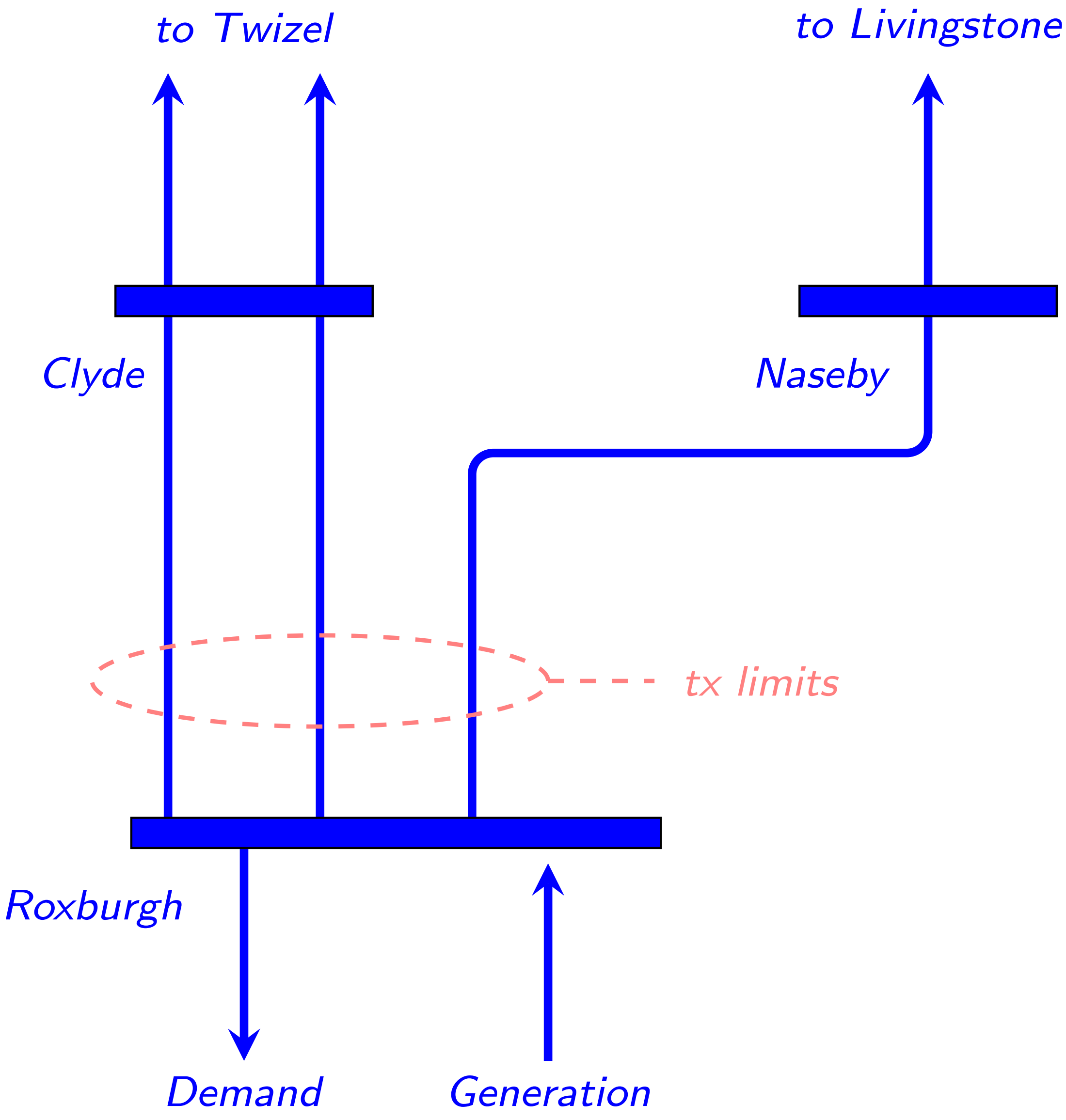
the pros...

- good resource has been identified
- close to existing transmission grid $\longrightarrow$ low connection cost

the cons...

- far from demand:
  - $\frac{2}{3}$ demand in the NI, $\frac{1}{3}$ in Auckland/Northland
  - requires transmission investment on the main grid $\longrightarrow$ high network costs
  - requires transmission north $\longrightarrow$ high electrical I^2R losses

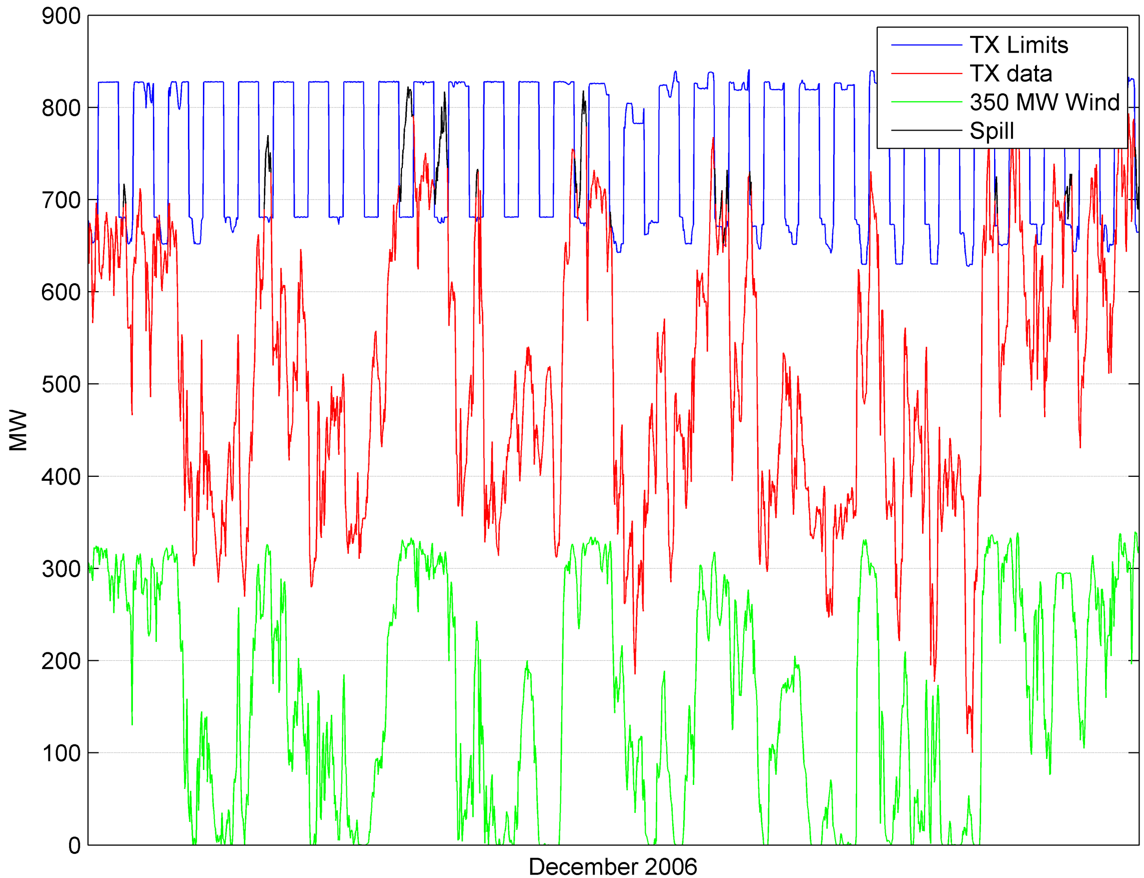
LSI analysis – II



LSI analysis – III

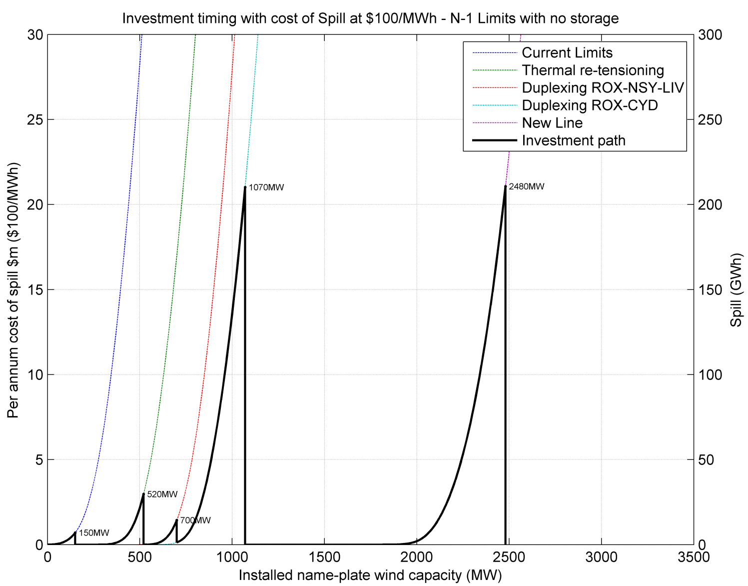
Example of time–domain data used for probabilistic analysis

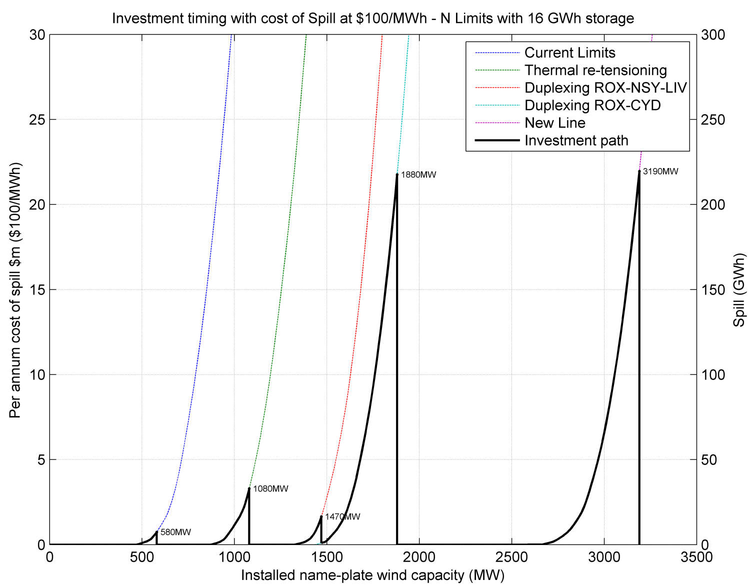
- December 2006, half–hourly data from CDS
- Fictitious 350 MW wind generator (scaled Te Apiti data)



LSI analysis – IV

	N–1, no storage, (MW)	N, 16GWh (MW)
Current limits	150	580
Thermal re–tensioning	520	1080
Duplex ROX–NSY–LIV	700	1470
Duplex ROX–CYD	1070	1880
New Line	2480	3190





summary

Reviewed technical analysis techniques for performing the GIT:

- deterministic N–1 technique for *core grid* investments, and,
- probabilistic techniques for *non core grid* investments and to enable generation

Lower South Island used as an example of the probabilistic technique for transmission investment to enable generation.

going where we've not been before...

and taking care of our environmental footprint...

Thank you