Transpower NZ Ltd
System Operator Industry Seminar
13/15 September 2006

Pricing of the 17:30 Trading Period 19th June 2006

TRANSPOWER

19 June 2006 – Pricing

System Operator Industry Seminar
Murray Henderson and Derrick Westenra
Market Services
13/15 September 2006

The objective function

SPD solves to the lowest total cost possible to meet **Physical network requirements** for each trading period.

= Minimum (Offer $'s x Quantities cleared)

Energy Offers

Reserve Offers – IL, PLSR, TWD

The objective function

- the physical solution is the primary problem being solved by SPD at least cost
- physical network requirements include:
  - transmission network limits
  - risk reserve requirements
  - plant capability
- SPD will rearrange generation to achieve a physical outcome

Marginal prices (nodal prices)

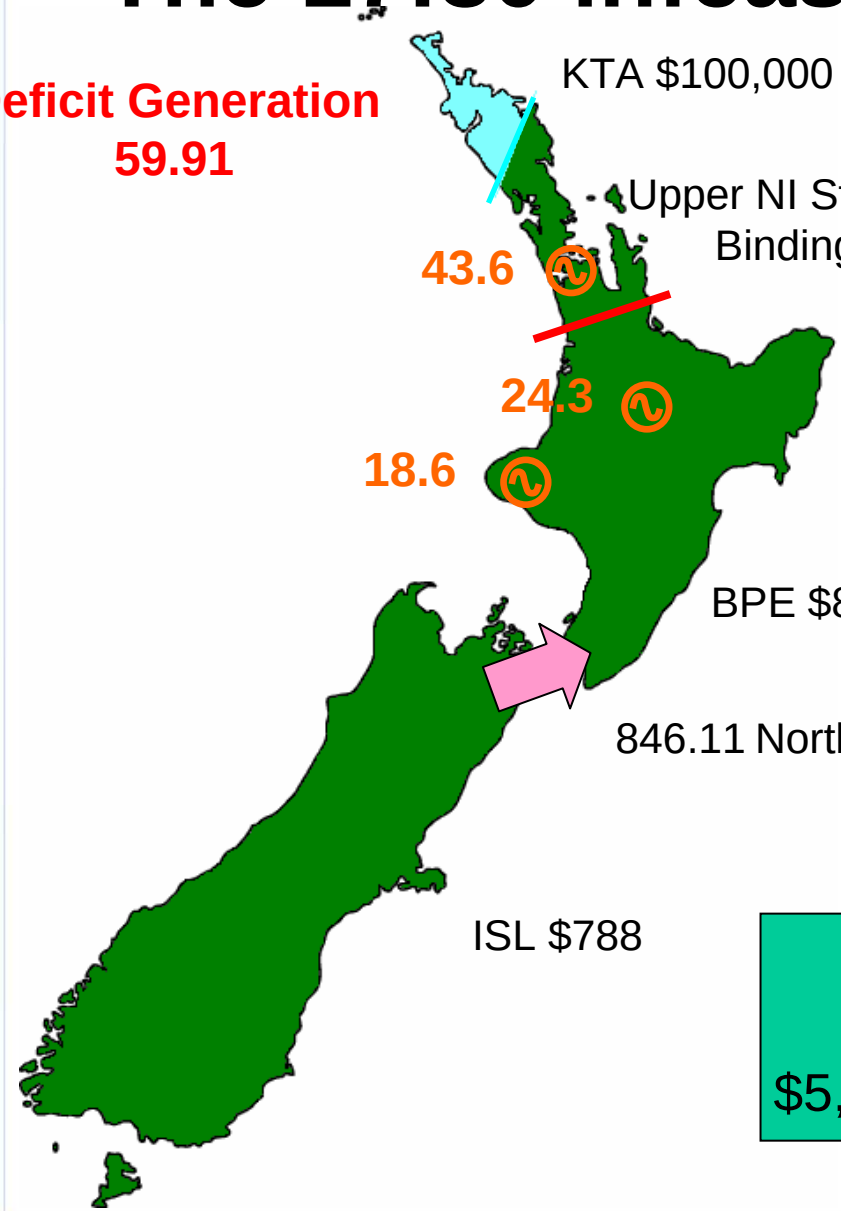
- marginal prices are the outcome to the primary physical SPD solution.
- primary problem solved at least cost, then outcome will be least cost marginal prices
- marginal prices are increment/decrement cost of unit at each bus

Resolution of infeasibilities - process

- Two primary principles are used to resolve infeasibilities:
  - according to actual network operation as far reasonably possible, subject to the EGR's Part G
  - in 1 MW increments until feasible
    - No **Discretion** in resolution approach

The 17:30 infeasible solution - I

Deficit Generation
59.91



North Island

- Uncleared ENOF
  - ARI 24.3
  - OTC 43.6
  - TCC 18.6
- Losses 135.2

South Island

- Uncleared ENOF
  - 0
- Losses 99.1

Objective Function Cost
$6,226,896
$5,990,709 CVP + $236,187 physical

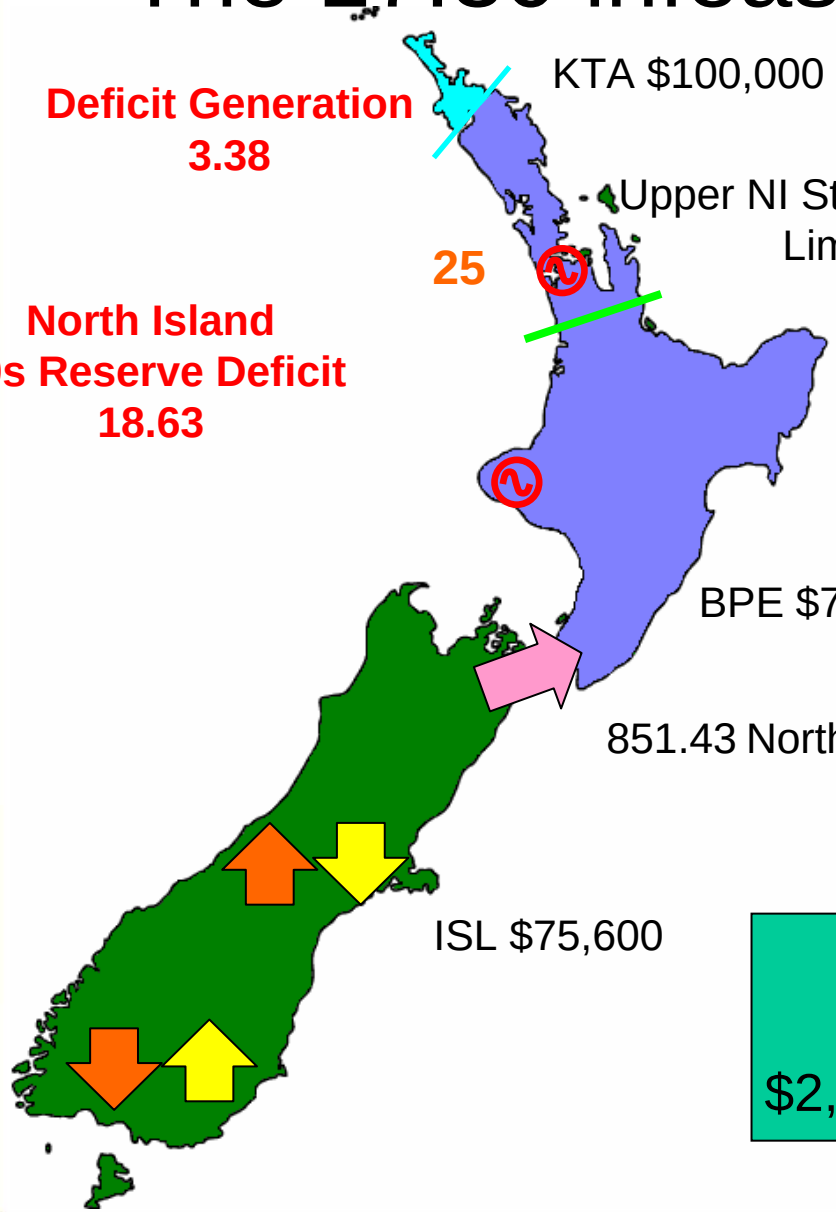
Grid Owner response – infeasibility resolution

- resolution via constraint relaxation:

  increase constraint limit in 1MWh increments, stopping once feasible solution achieved or null point achieved.

- UNI Stability Constraint Limit not binding in dispatch/actual and infeasible in final pricing

The 17:30 infeasible solution - II



North Island

- Uncleared ENOF
  OTC 25
- Losses 145

South Island

- Uncleared ENOF
  0
- Losses 93.8

Objective Function Cost
$3,224,796
$2,945,983 CVP + $278,813 physical

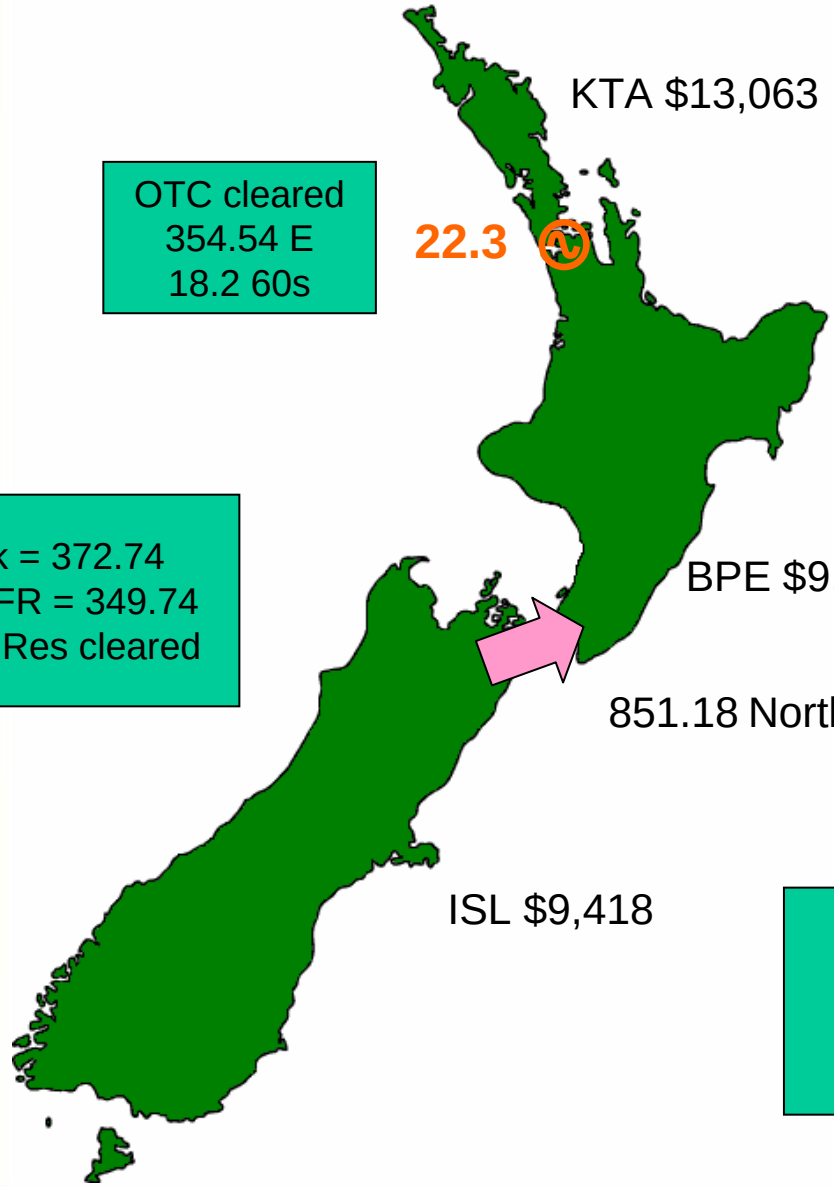
Grid Owner response – infeasibility resolution

- resolution via addition of North Island 60s Net Free Reserve:

  increase 60s Net Free Reserve in 1MWh increments stopping once feasible solution achieved or null position reached.

- only resolution approach possible to obtain a feasible Final Price

The 17:30 **feasible** solution = final prices



OTC cleared
354.54 E
18.2 60s

Risk = 372.74
-23 NFR = 349.74
= 60s Res cleared

North Island

- Uncleared ENOF
  OTC 22.3
- Losses 145.82

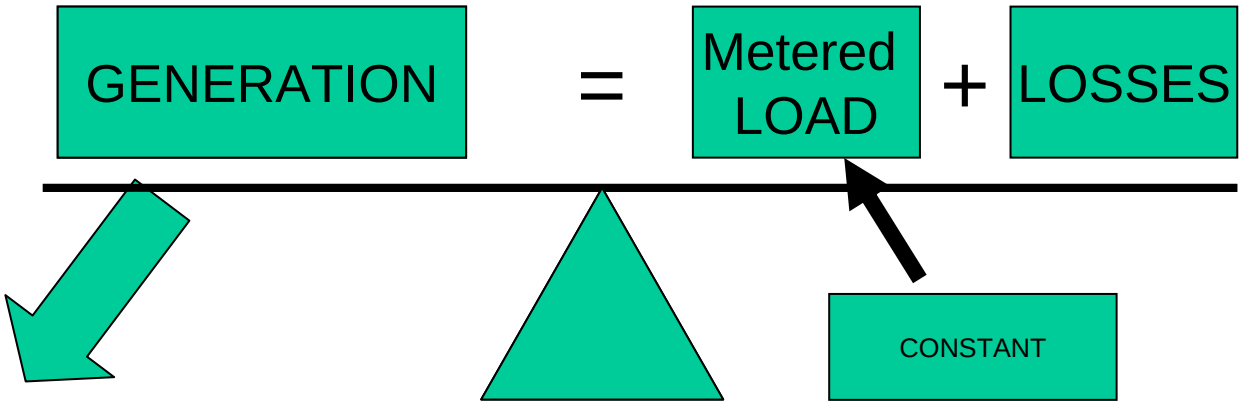
South Island

- Uncleared ENOF
  0
- Losses 94.1

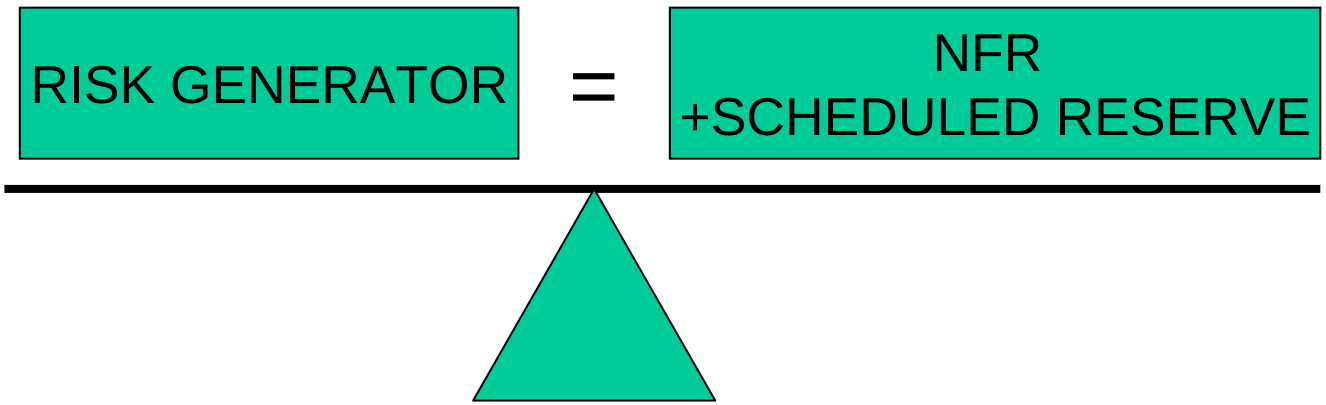
Objective Function Cost
$275,597 physical

The network energy balance

- The balance equations can be represented thus:



- Subject to:



The 17:30 price sensitivity – marginal prices

GENERATION = Metered LOAD + LOSSES

RISK = RESERVE

The 17:30 price sensitivity – marginal prices

GENERATION = Metered LOAD + LOSSES

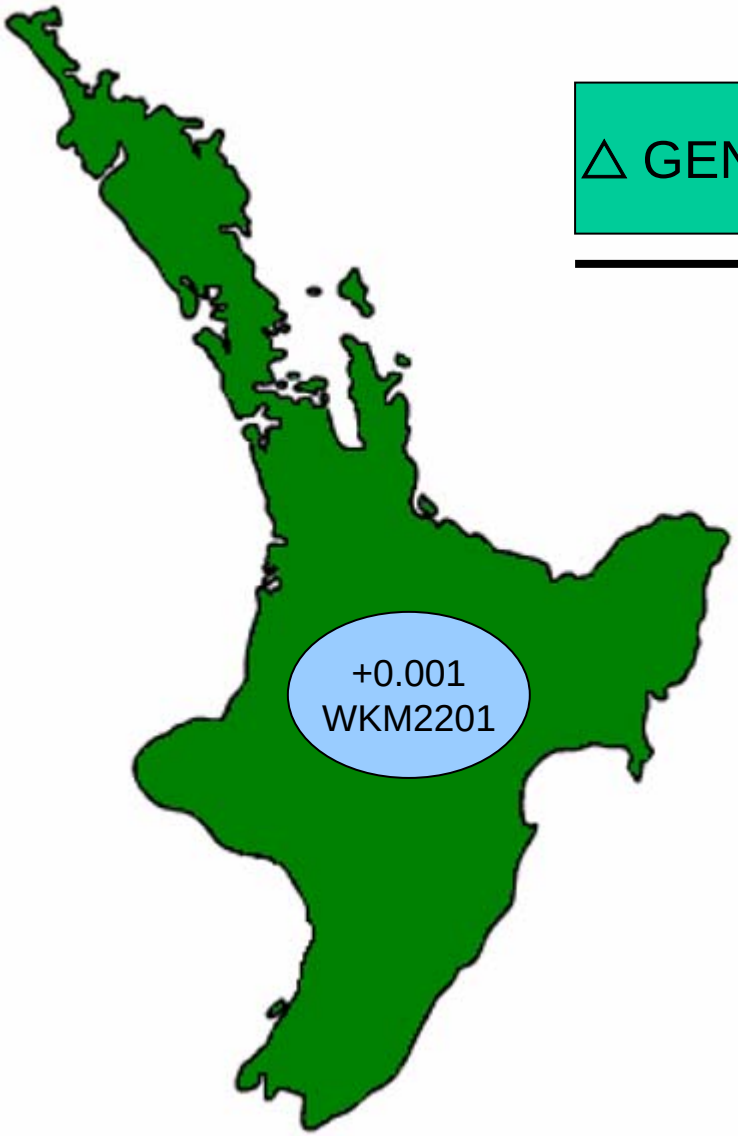
RISK = RESERVE

The 17:30 price sensitivity – marginal prices

GENERATION = +0.001 WKM2201 + LOSSES

RISK = RESERVE

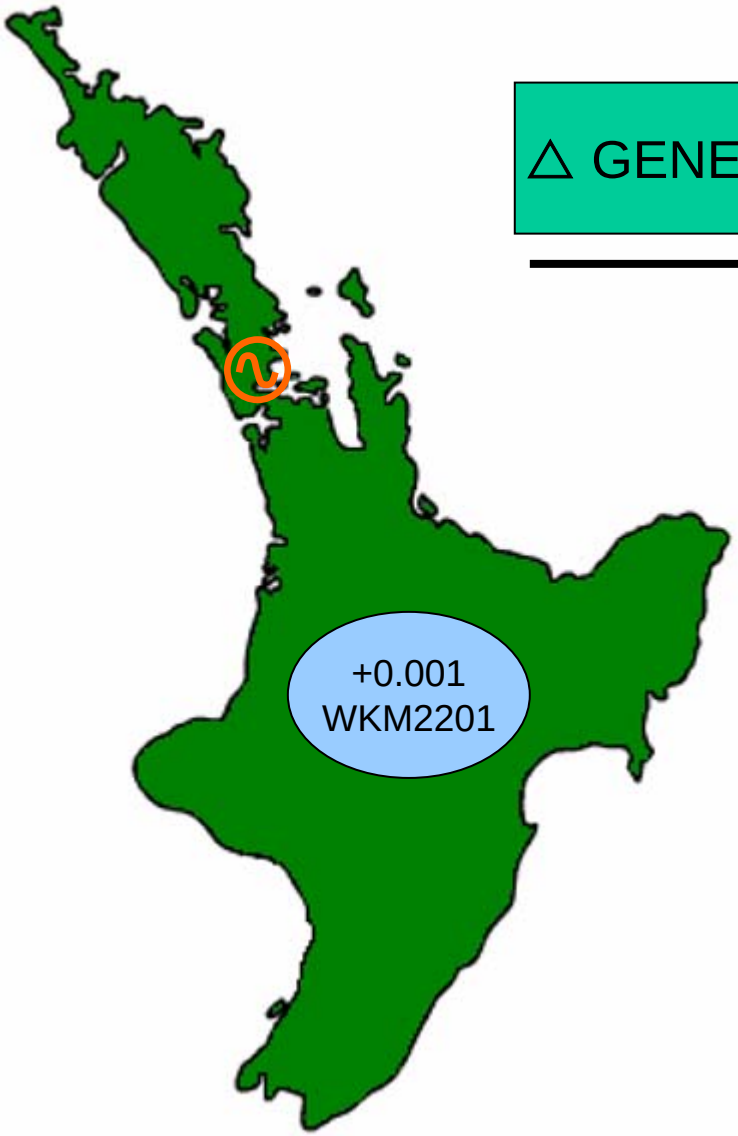
The 17:30 price sensitivity – marginal prices



△ GENERATION = +0.001 WKM2201 + LOSSES

RISK = RESERVE

The 17:30 price sensitivity – marginal prices



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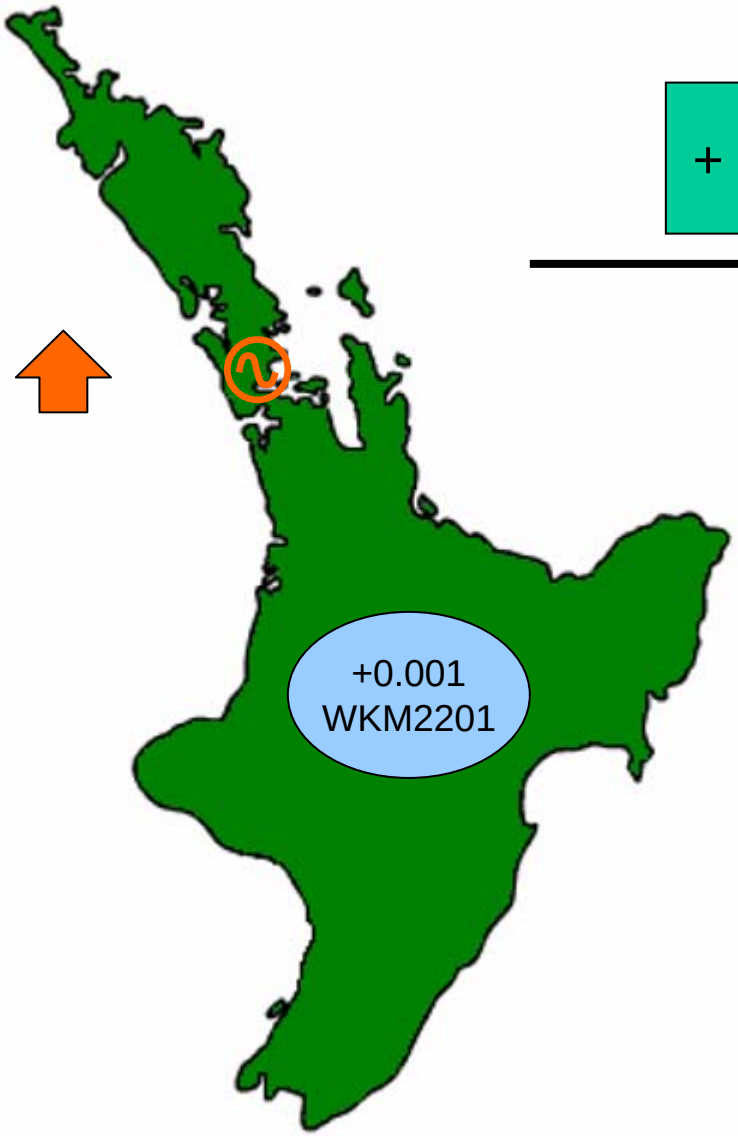
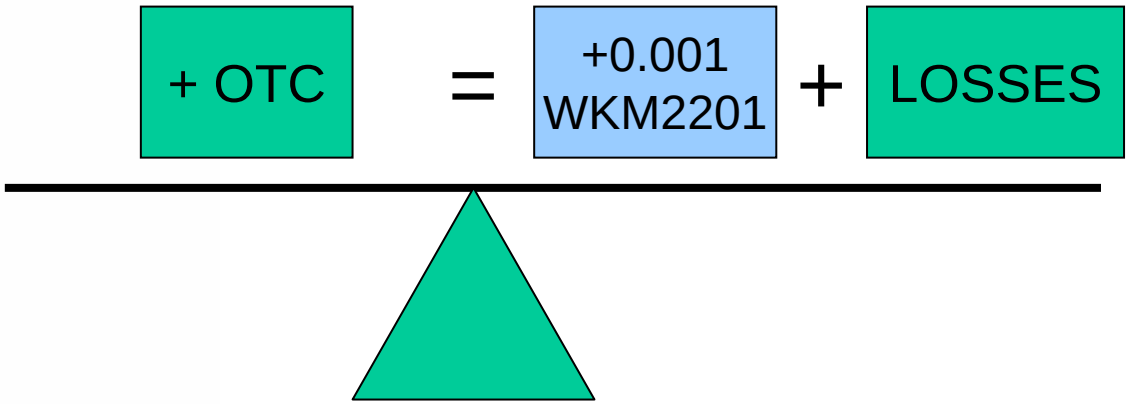
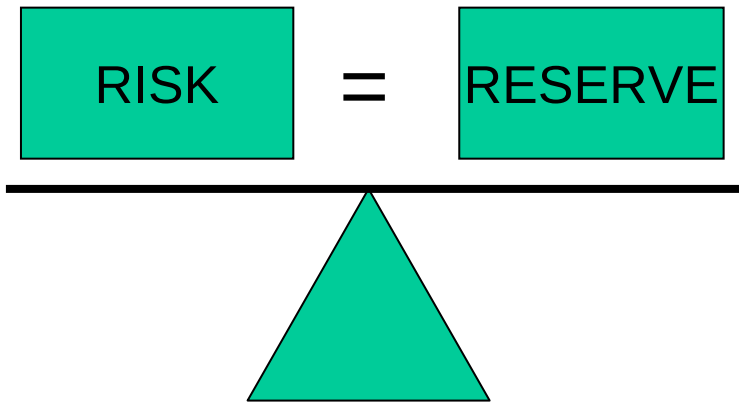
The 17:30 price sensitivity – marginal prices







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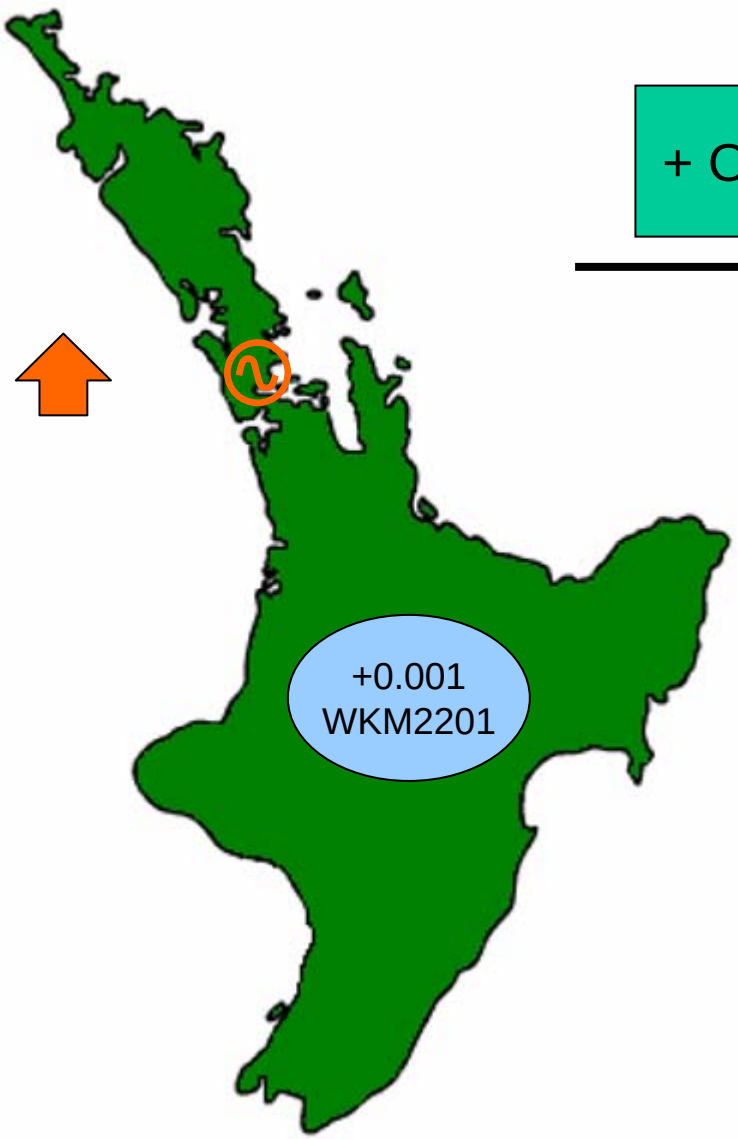

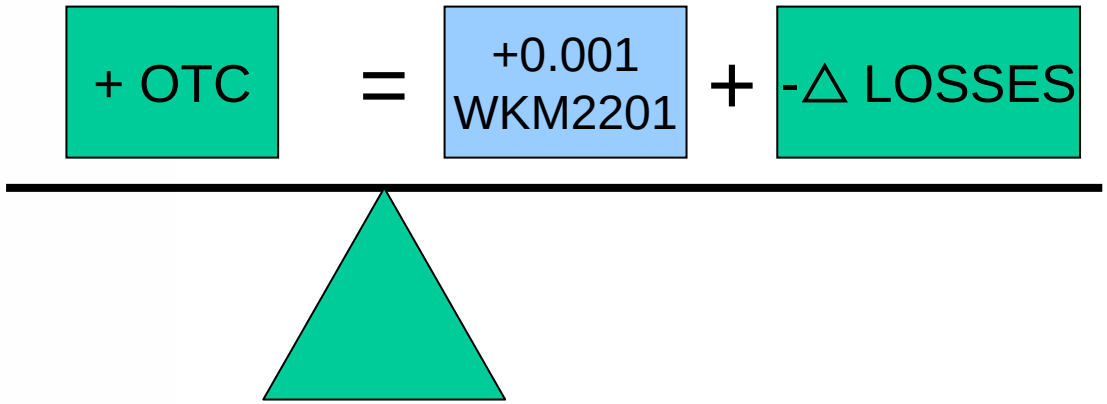

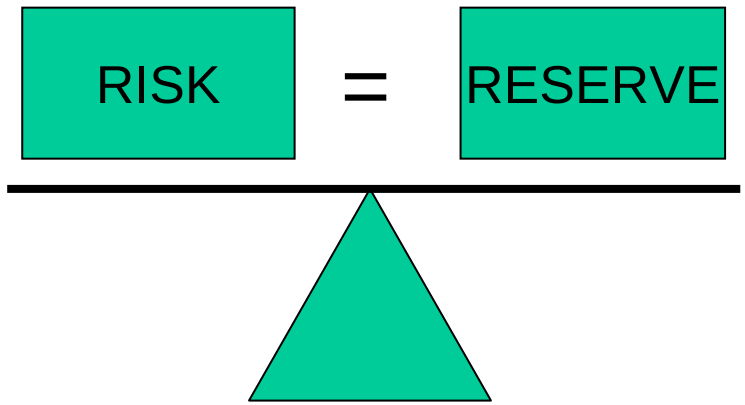

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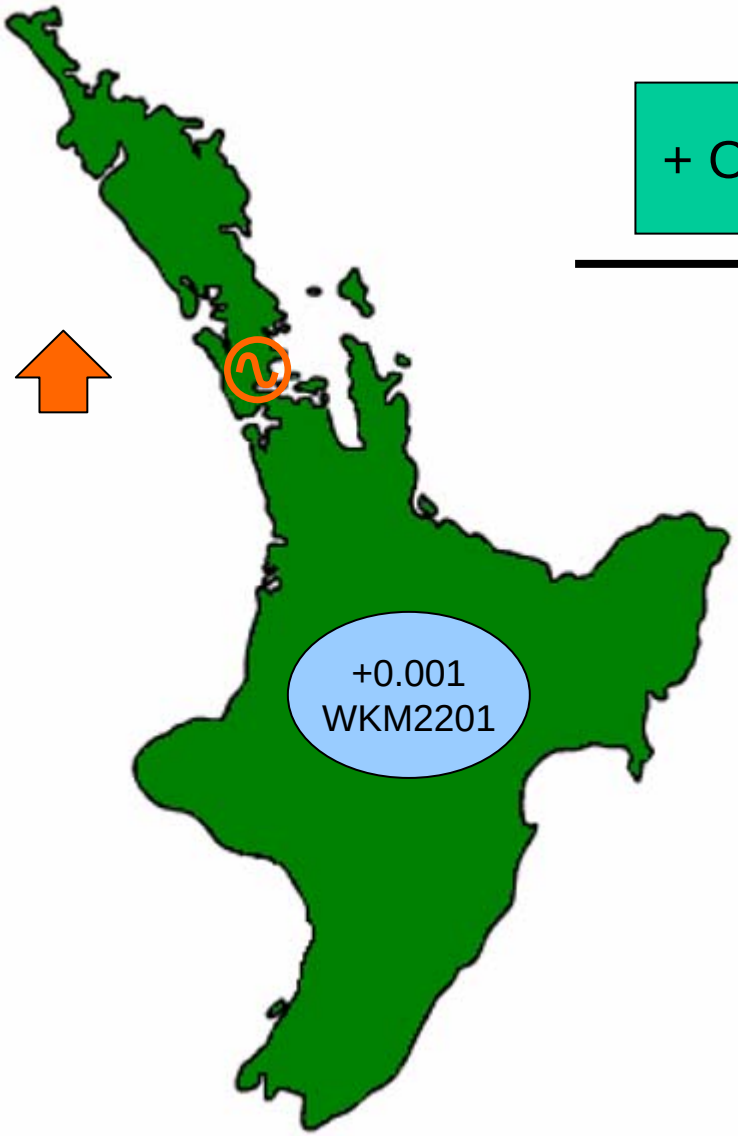

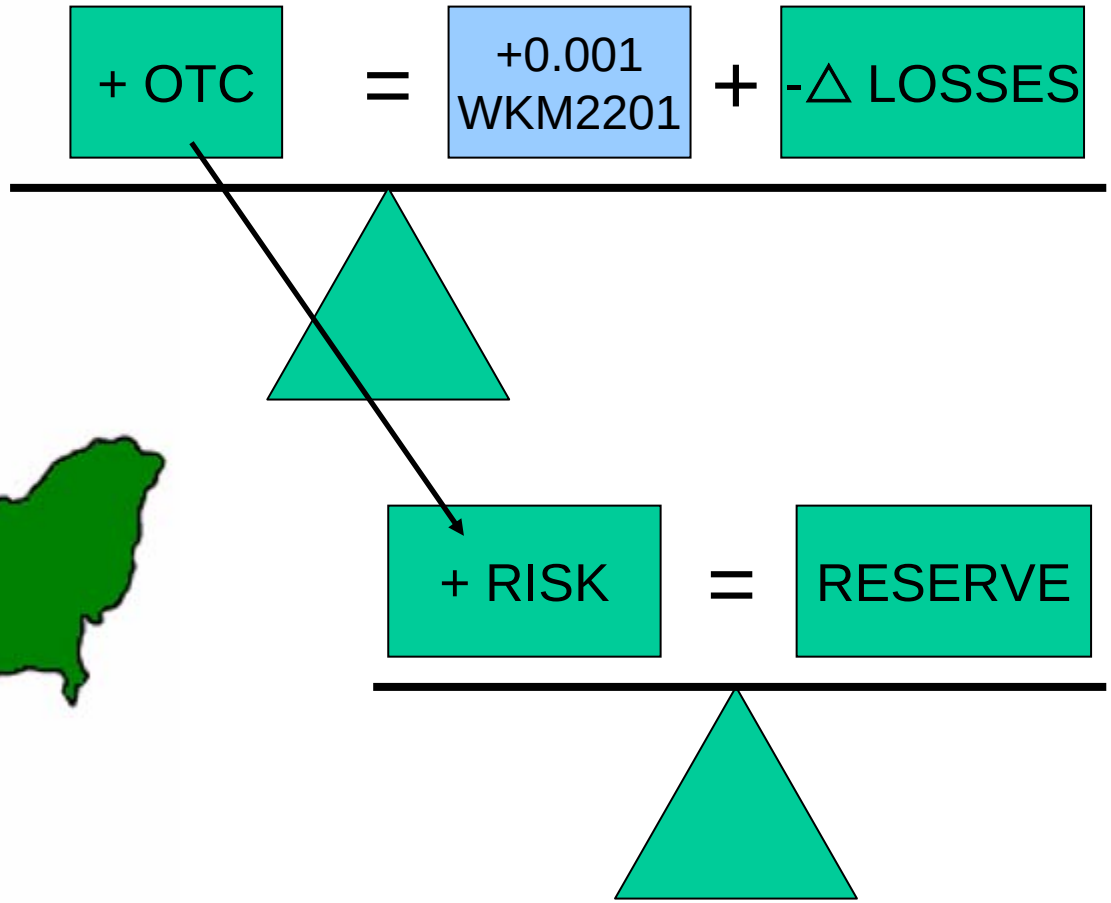

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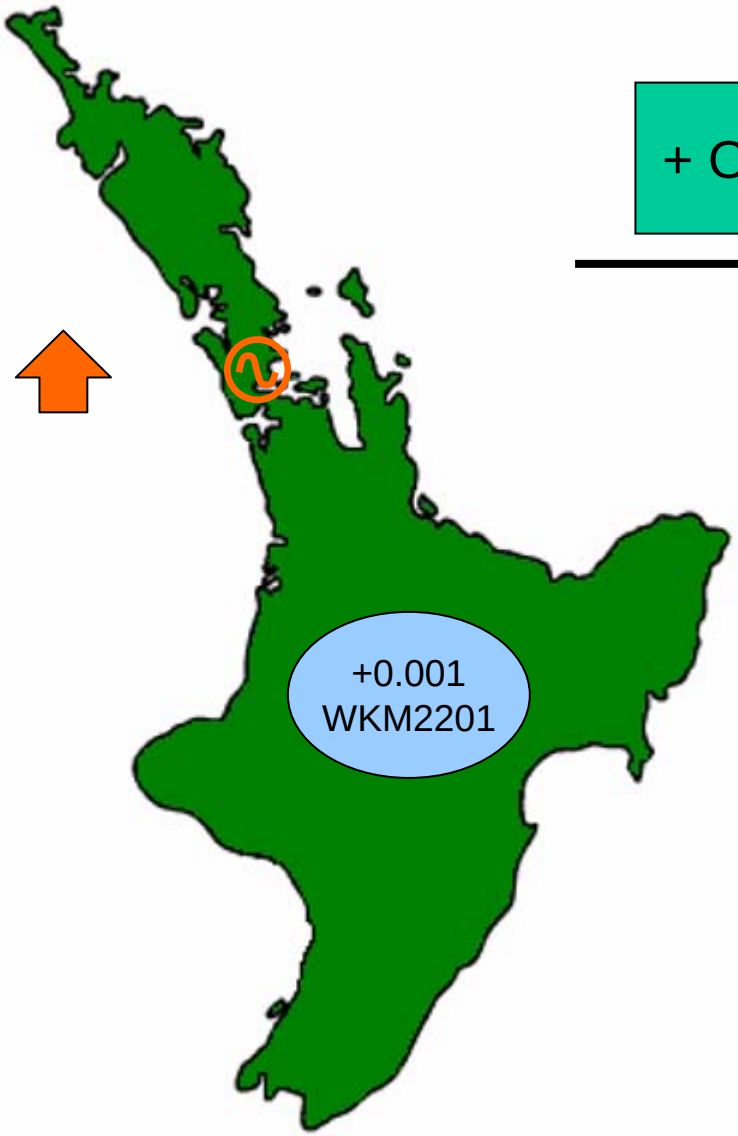

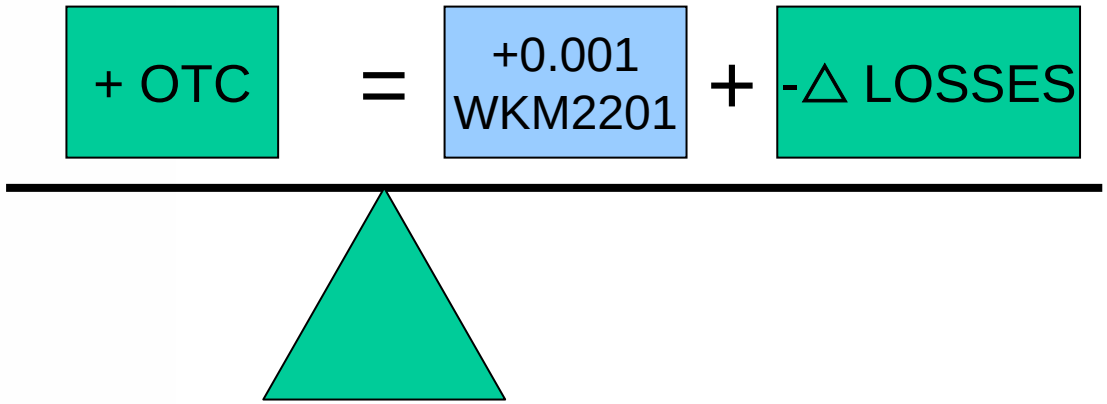

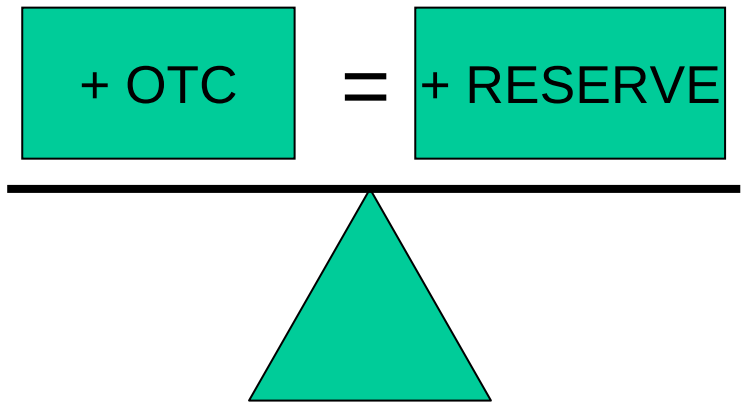

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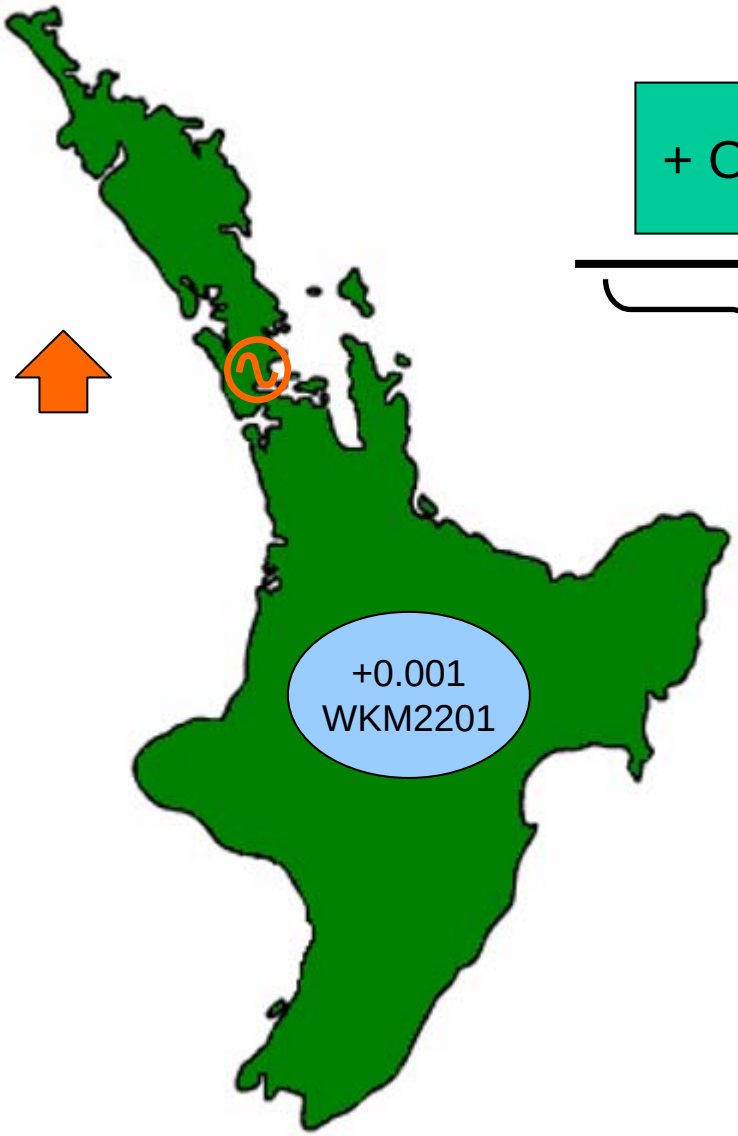

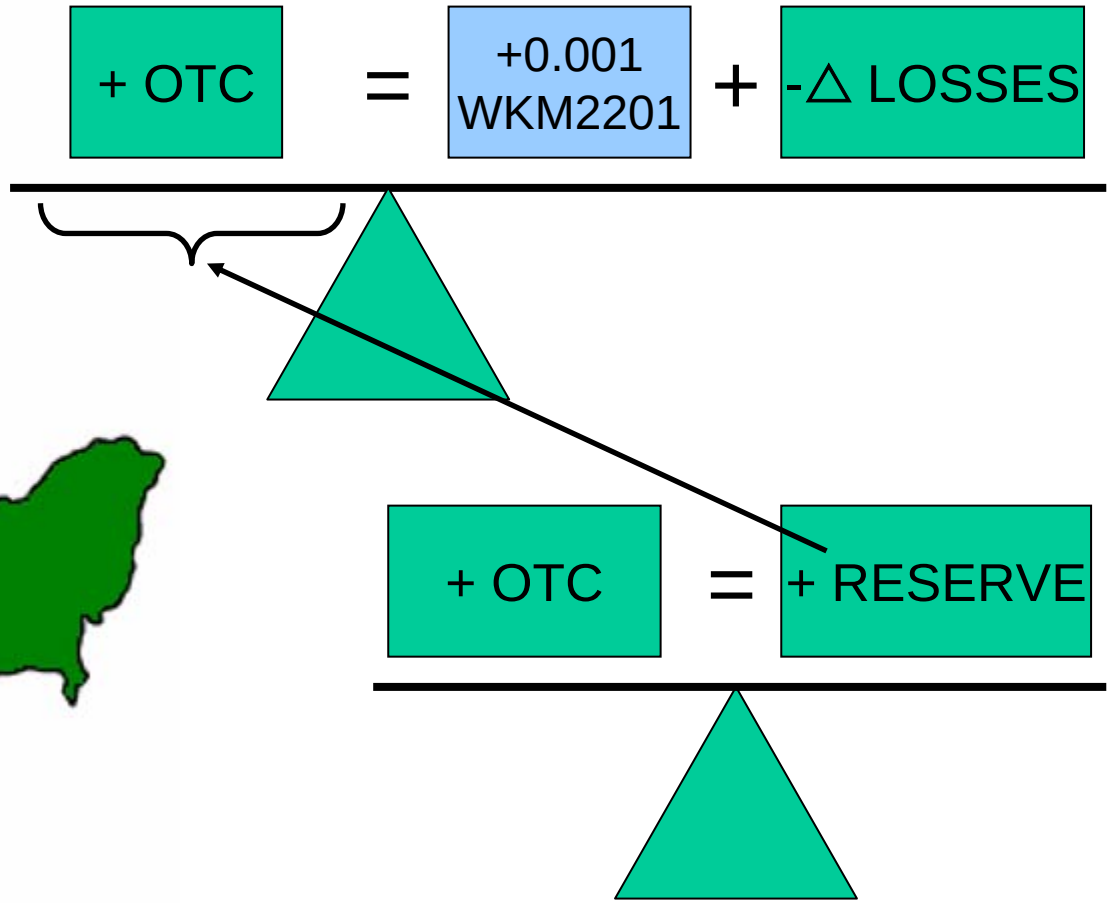

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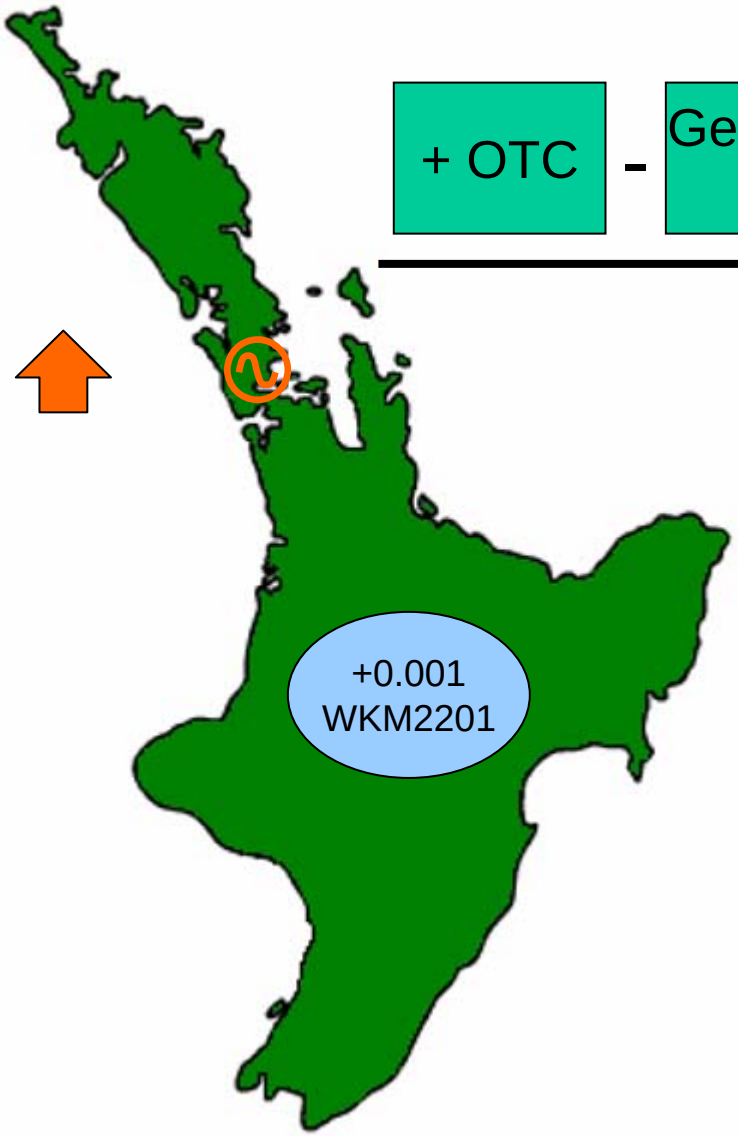
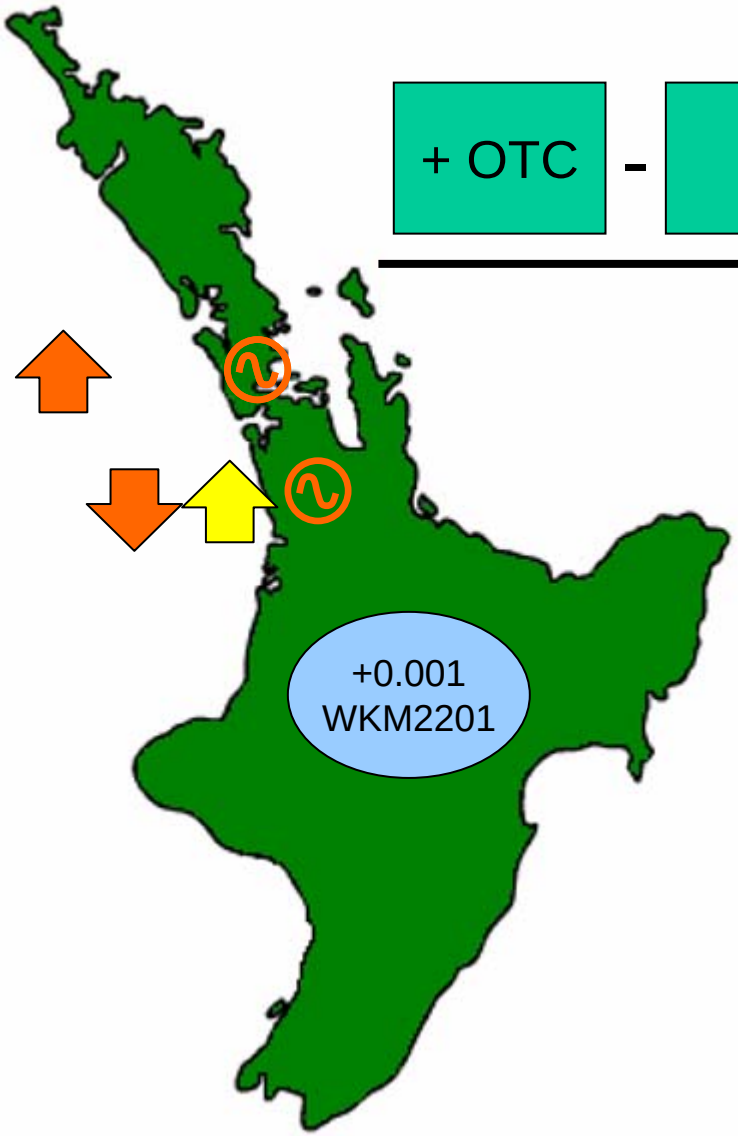


+ OTC - Generator 2 = +0.001 WKM2201 + -△ LOSSES

+ OTC = + RESERVE

The 17:30 price sensitivity – marginal prices

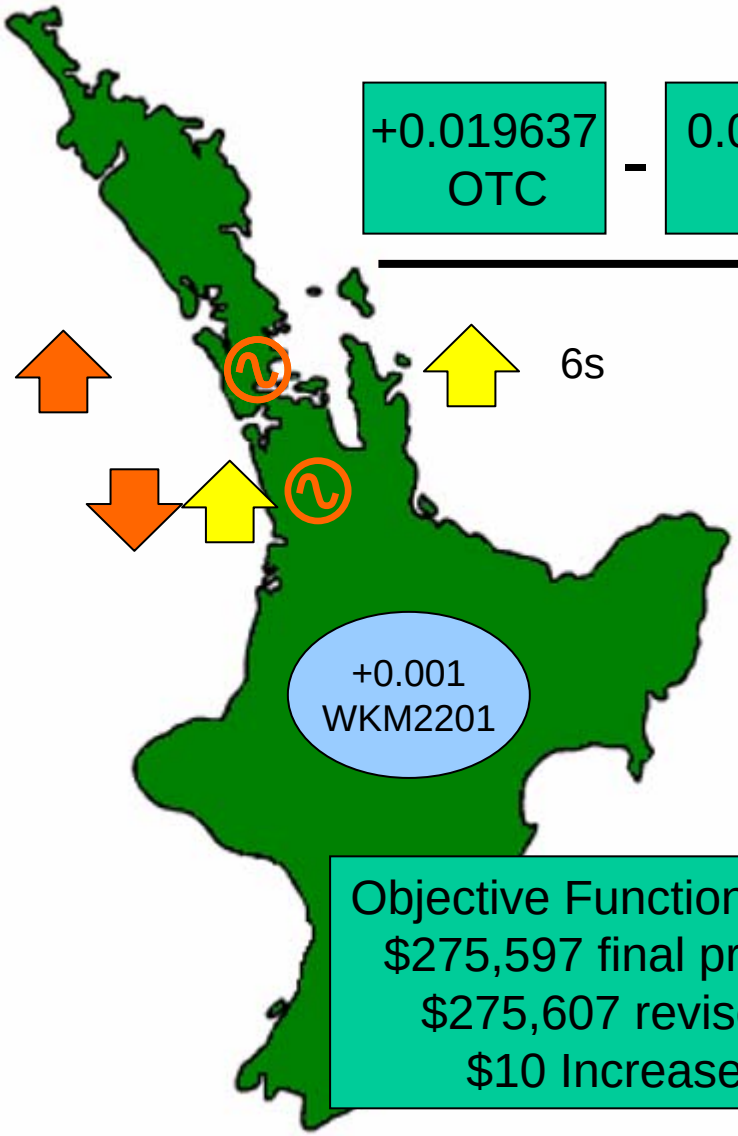


+ OTC - HLY = +0.001 WKM2201 + -△ LOSSES

60s Reserve

+ OTC = + HLY

The 17:30 price sensitivity – marginal prices



+0.019637 OTC - 0.019637 HLY = +0.001 WKM2201 + -0.001

6s

60s Reserve

+0.019637 OTC = +0.019637 HLY

Objective Function Cost
$275,597 final prices
$275,607 revised
$10 Increase

The marginal price calculation

- change in Energy costs

OTC	+(0.019637 x 1,000) x $420.00	$8,247.74
HLY	-(0.019637 x 1,000) x $55.04	-$1,080.85

- change in Reserve costs

IL	6s	+(0.019637 x 1,000) x $130.00	$2,552.87
HLY	60s	+(0.019637 x 1,000) x $0.24	$4.71

- change in Total costs $9,724.47

  = Change in Objective Function (x 1,000)

  = Nodal Price @ WKM2201

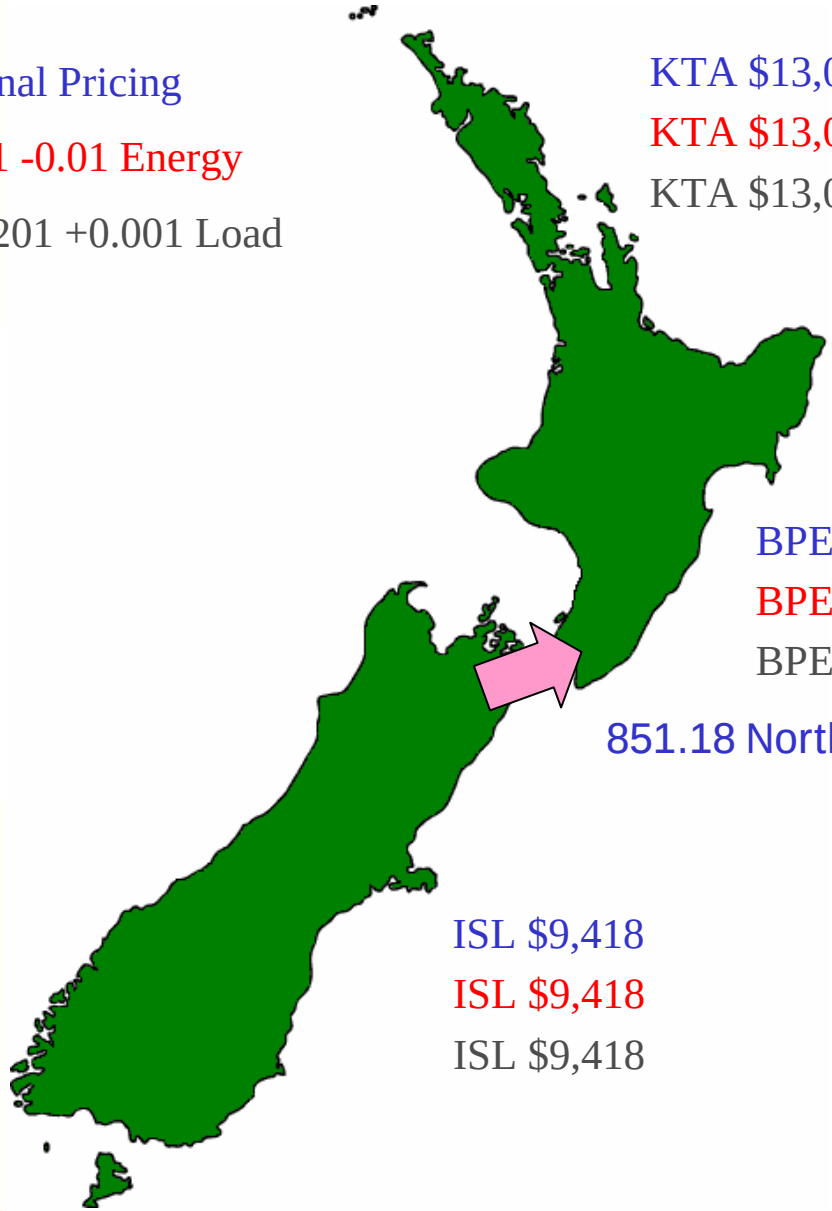
Summary

Final Pricing

HLY1 -0.01 Energy

WKM2201 +0.001 Load

KTA $13,063
KTA $13,063
KTA $13,063



BPE $9,636
BPE $9,636
BPE $9,636

851.18 North

ISL $9,418
ISL $9,418
ISL $9,418

Objective Function Costs

$275,597
$275,698
$275,607