100 percent Renewable Energy Rotorua

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Acknowledgement

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Objectives

- Explore implications for Rotorua adopting a 100% renewable energy culture.
- Chart pathway towards this objective.
- Commence implementing pathway with community partners.

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Why Rotorua?

- Home of Forest Research.
- Has a base of renewable energy resources.
- Has pollution problems with both air and lake water.
- A compact, tourist oriented city, so Green issues are important.

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Overview of strategy

- Assess renewable and non-renewable energy resources available.
- Assess energy demand by both source and end use.
- Build a model of how transformation may be achieved.
- Build portfolio of energy savings and energy sources.

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Initial scope of project

- Confined to non-transport energy use.
- Domestic and commercial energy use is initial target.
- Way shown by similar projects in Denmark and Scotland.

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Current situation

- 50,000 inhabitants in Rotorua.
- Bioenergy supplies 50% of total.
- Climate change policy.
- National energy efficiency and conservation strategy.
- Loans for solar water heaters.

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Renewable energy sources

- Geothermal
- Bio-energy for space and water heating.
- Hydro electricity
- Solar energy for water heating
- Solar energy for photovoltaics
- Wind? - Not considered viable in many places in Rotorua.

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Non-renewable energy sources

- Natural gas
- Electricity from fossil fuel fired generators

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Modelling factors from here to there

- Expansion of population
- Increase in energy-using appliances
- Improvement in conversion efficiency
- Implementation of conservation measures.
- Transition from non-renewable to renewable sources.

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Three transition scenarios modelled

- Business as usual
  – slow change
- Green
  - moderate efforts to change
- Super green
  - serious change as a result of major effort

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Technology diffusion model – the logistic S curve

- Based on information theory
- Slow initial introduction then acceleration
- More rapid uptake as technology becomes accepted
- Slowing uptake when nearing full implementation with mature technology

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The logistic curve adopted

$$y = \frac{e^z}{1 - e^z}$$

$$z = T \ln\left(\frac{p}{1-p}\right) \times \frac{\frac{t}{T} - 1}{t_p - T}$$

y is the level of implementation
t_p, years, is time taken to reach a given percentage, p %, of the target.
p % is the percentage of the target achieved at time, t_p
T years, is the time taken, to reach 50% of the target value.

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Energy allocation tables

Current situation 2005

Current Allo. Pattern	Demand	Energy Source. Current end use % age						
End Use	% age	Hydro Elect	Fossil Elec	N. Gas	Geothermal	Wood	Solar	Totals
Water Heating	29.0	45	38	9	2	5	1	100
Space conditioning	22.0	25	20	15	20	20	0	100
Lighting	11.0	55	45	0	0	0	0	100
Refrigeration	10.0	55	45	0	0	0	0	100
Cooking	8.0	40	35	25	0	0	0	100
Miscellaneous electrical	20.0	55	45	0	0	0	0	100
	100							

Future Super Green situation 2030

Future Target Pattern	Demand	Energy Source. Future end use % age						
End Use	% age	Hydro Elect	Fossil Elec	N. Gas	Geothermal	Wood	Solar	Totals
Water Heating	30	40	0	0	25	10	25	100
Space conditioning	10	20	0	0	35	30	15	100
Lighting	20	100	0	0	0	0	0	100
Refrigeration	10	90	0	0	0	0	10	100
Cooking	10	90	0	0	0	10	0	100
Miscellaneous electrical	20	100	0	0	0	0	0	100
	100							

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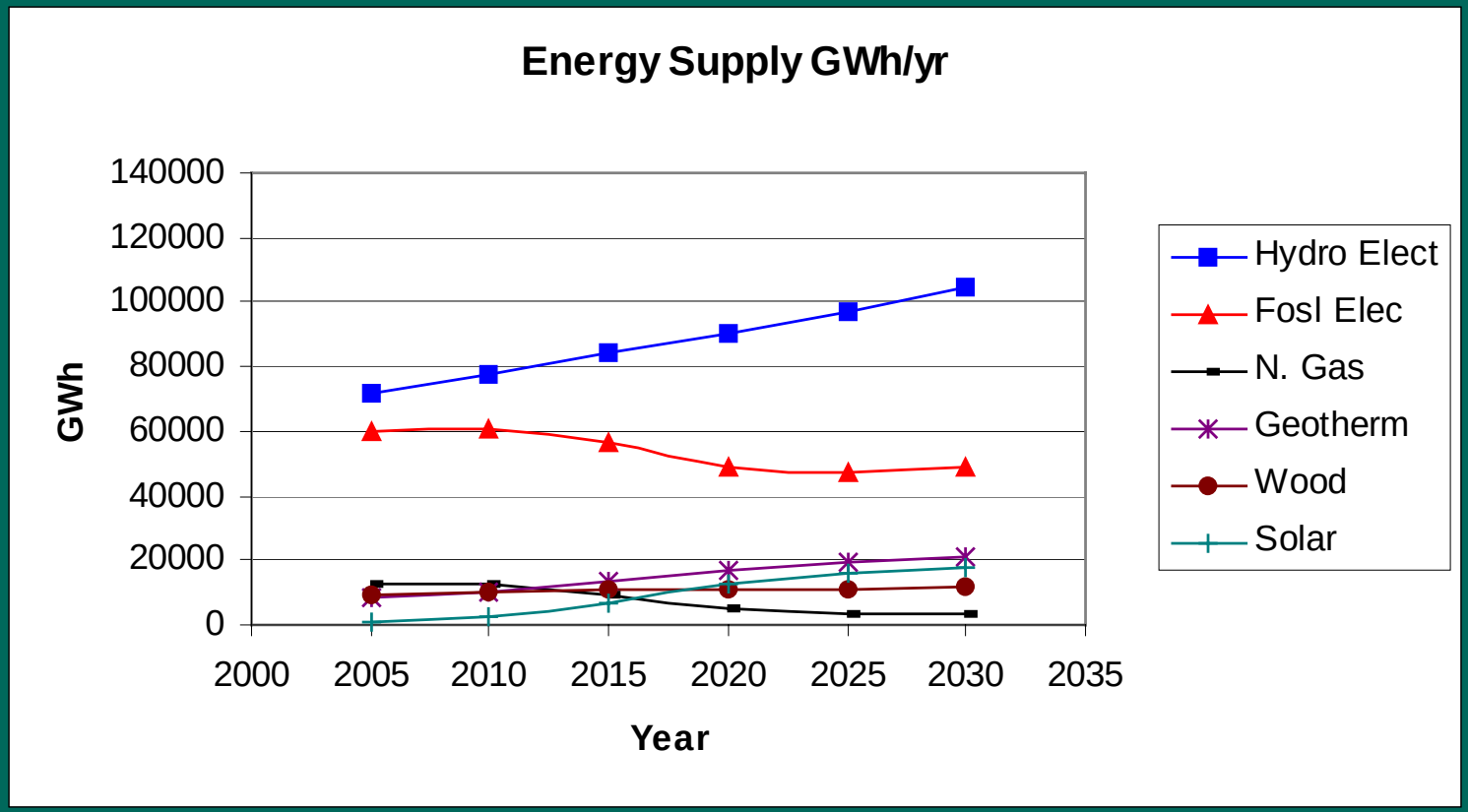
Predicted energy supply curves – Green scenario



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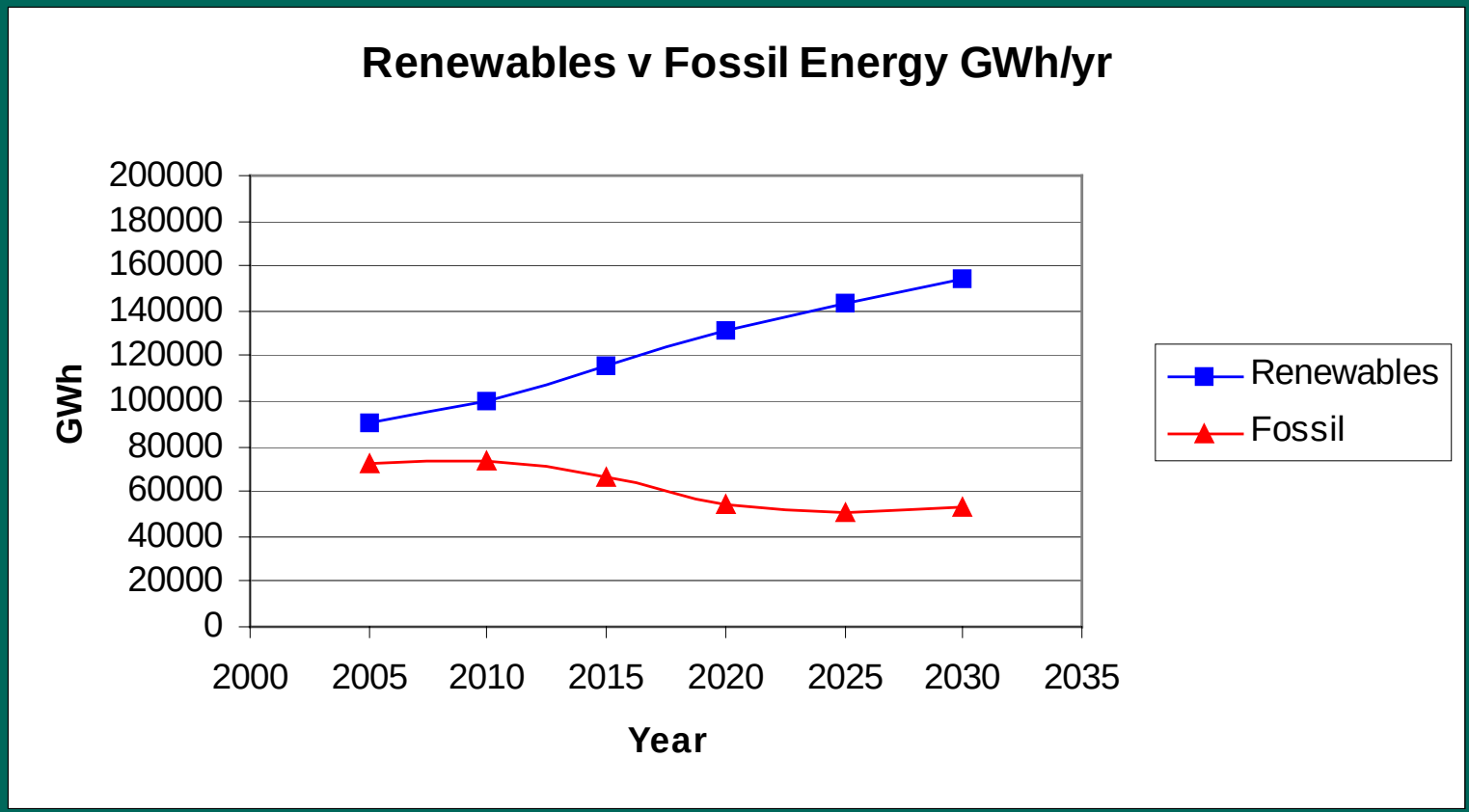
Total Renewables and Fossil fuel supply - Green scenario



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Additional factors incorporated in model

- Time to 50% implementation. Uses S curve.
- Increase in efficiency of appliances. Uses S curve.
- Population growth, % per year.
- Growth in energy consuming appliances per household, % pa.

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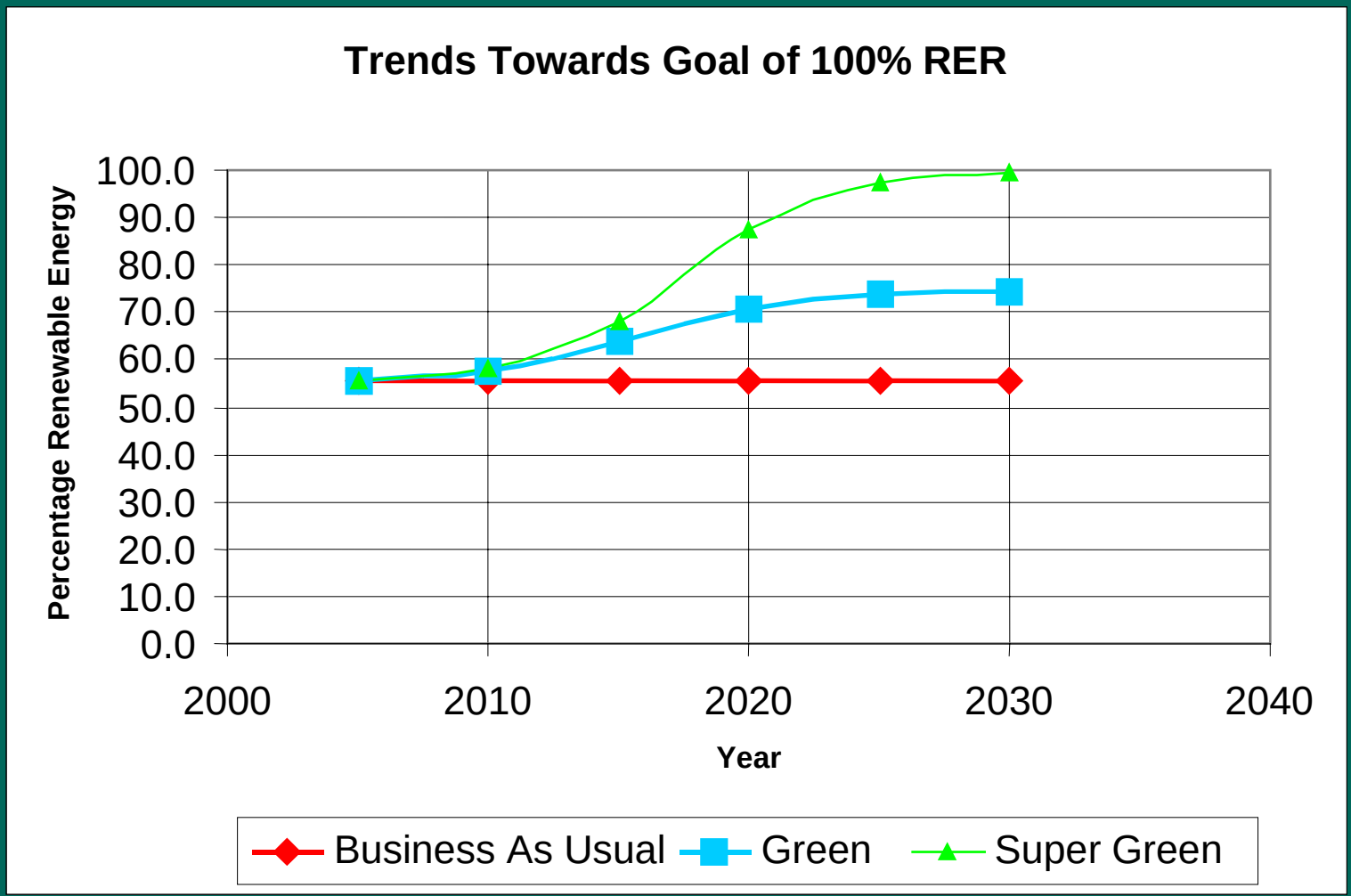
Trend towards goal for each scenario



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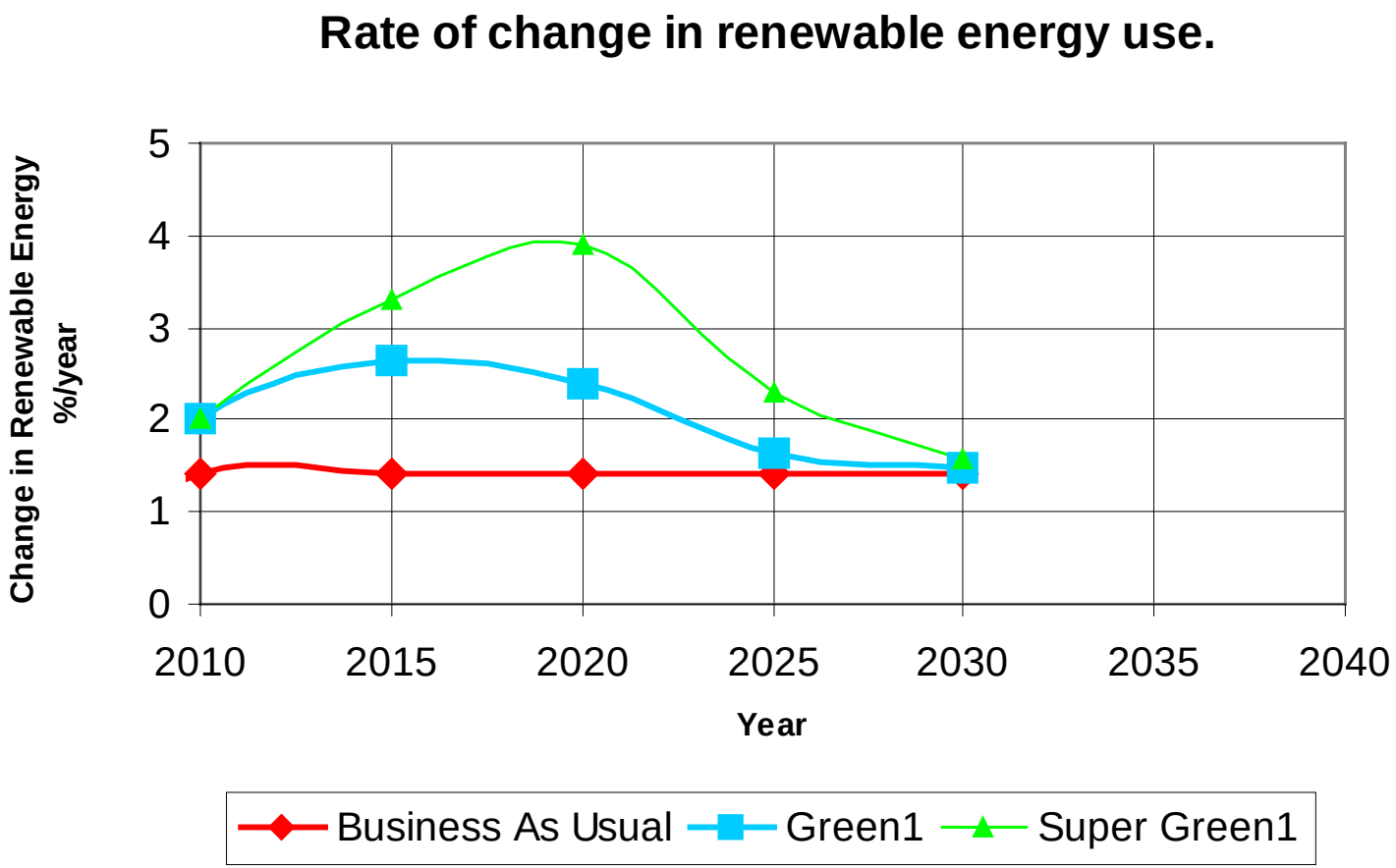
Rate of change in renewable energy use from 2010 to 2030



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Decoupling energy consumption from economic and population growth

- Pressures to use more energy from:
  - Population growth
  - Growth of existing industry
  - Introduction of new industries
  - More appliances
  - More activity

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Decoupling energy consumption from economic and population growth (2)

- Counteracted by:
  - Conservation - use less
  - Match energy source to end use
  - Use renewables
  - Reduce waste
  - Increased efficiency of use
  - Change in business mix towards service industries

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Next Steps

- Prepare Technology Catalogue
- Include economic analyses
- Include industrial and commercial sectors

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Conclusions

- At 1% overall demand growth, must achieve 1.2% growth in renewables just to stand still at 55% share.
- For Green must achieve rates of change of 2.5% pa to achieve objective.
- For Super Green must achieve rates of change of 4% pa to achieve objective.
- Challenge is to find most economic way to achieve 100% RER

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