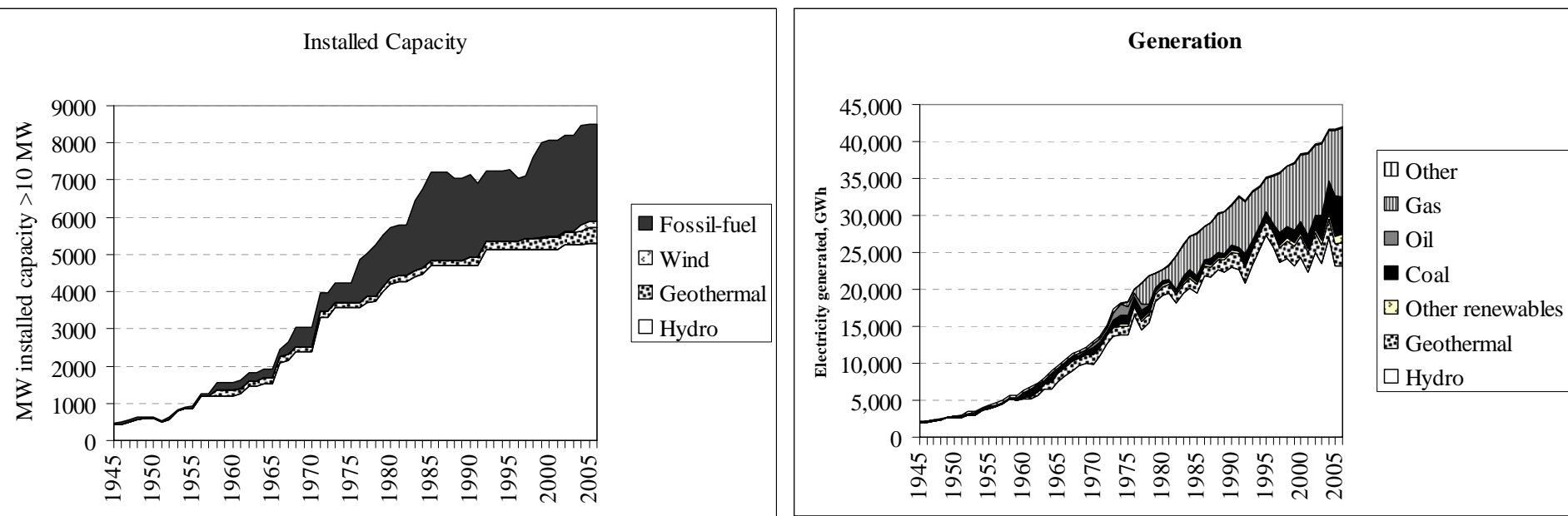


# Thinking about a 90% Renewables Target in Electricity

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26 August 2009

**Figure 1: New Zealand Electricity Installed Capacity and Generation by Fuel Type, 1945-2006**



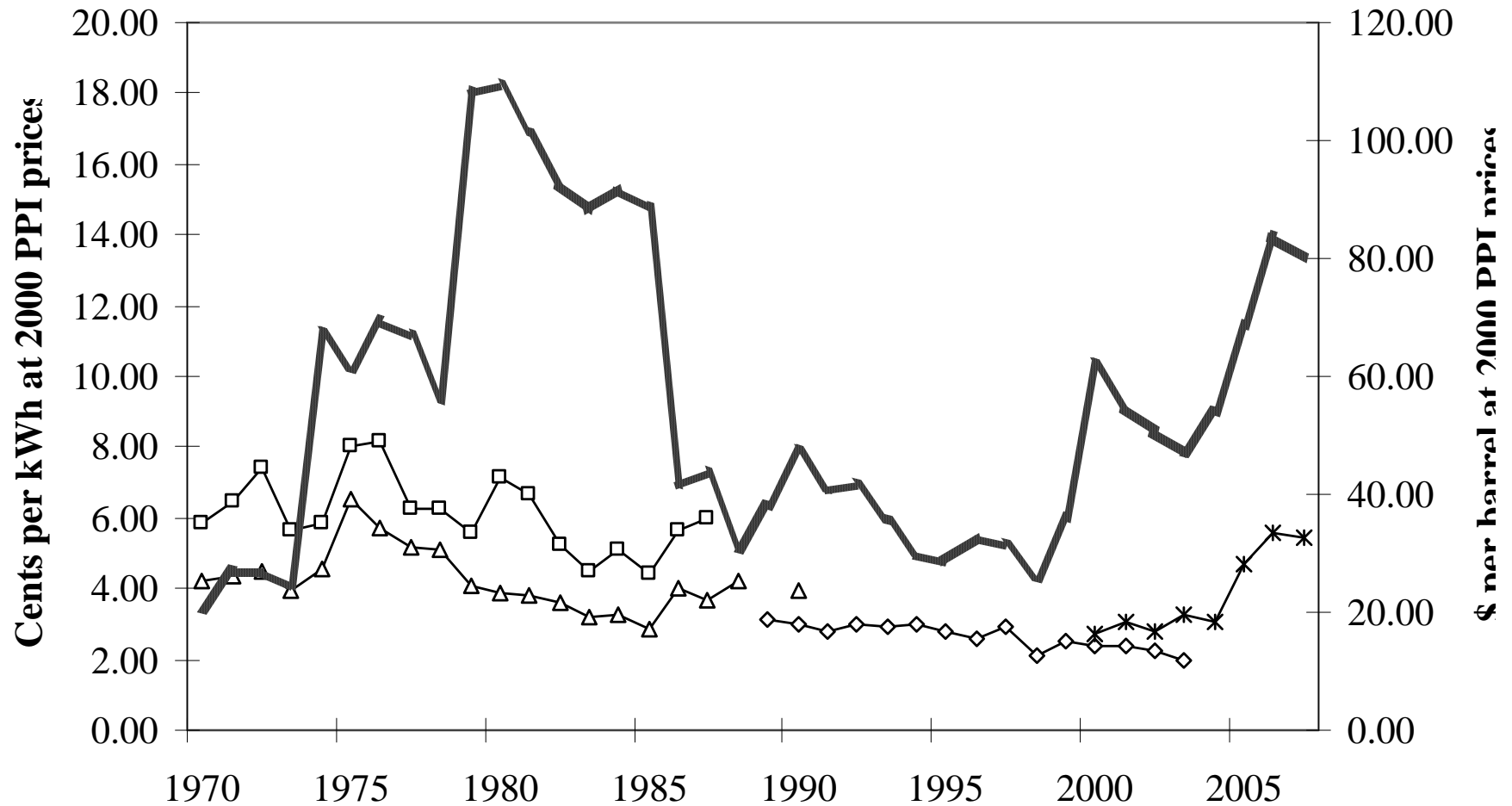
Sources: 1945-56 calculated from *Annual Reports* of the New Zealand Electricity Department 1945-1956; 1956-73 Ministry of Economic Development unpublished data; 1974-2006 from *Energy Data File* June 2008 p.100.

**Table 1: Fuel Shares of NZ Electricity Generated for the Grid, 1945-2007**  
**Five-year averages, GWh per year**

|         | Geo-thermal | Hydro  | Wind | Bio-mass | Coal and Oil | Gas   | Cogen | Other | Total  | Renewables % |
|---------|-------------|--------|------|----------|--------------|-------|-------|-------|--------|--------------|
| 1945-49 | 0           | 2,322  | 0    | 0        | 111          | 0     | 0     | 39    | 2,472  | 94           |
| 1950-54 | 0           | 3,204  | 0    | 0        | 171          | 0     | 0     | 241   | 3,616  | 89           |
| 1955-59 | 27          | 4,720  | 0    | 0        | 319          | 0     | 0     | 297   | 5,363  | 89           |
| 1960-64 | 716         | 6,136  | 0    | 0        | 825          | 0     | 0     | 319   | 7,995  | 86           |
| 1965-69 | 1,204       | 9,240  | 0    | 0        | 770          | 0     | 0     | 346   | 11,561 | 90           |
| 1970-74 | 1,215       | 13,027 | 0    | 63       | 1,986        | 42    | 0     | 299   | 16,632 | 86           |
| 1975-79 | 1,243       | 16,035 | 0    | 357      | 1,498        | 2,303 | 0     | 0     | 21,436 | 82           |
| 1980-84 | 1,194       | 19,300 | 0    | 403      | 613          | 3,276 | 0     | 0     | 24,787 | 84           |
| 1985-89 | 1,314       | 21,633 | 0    | 442      | 697          | 5,123 | 0     | 0     | 29,209 | 80           |
| 1990-94 | 2,176       | 23,067 | 1    | 488      | 758          | 6,177 | 0     | 0     | 32,667 | 79           |
| 1995-99 | 2,244       | 24,791 | 17   | 494      | 1,318        | 7,227 | 0     | 0     | 36,089 | 76           |
| 2000-04 | 2,669       | 24,427 | 182  | 513      | 2,598        | 9,132 | 63    | 0     | 39,585 | 70           |
| 2005-07 | 1,896       | 13,901 | 431  | 415      | 2,690        | 5,849 | 26    | 0     | 25,208 | 66           |

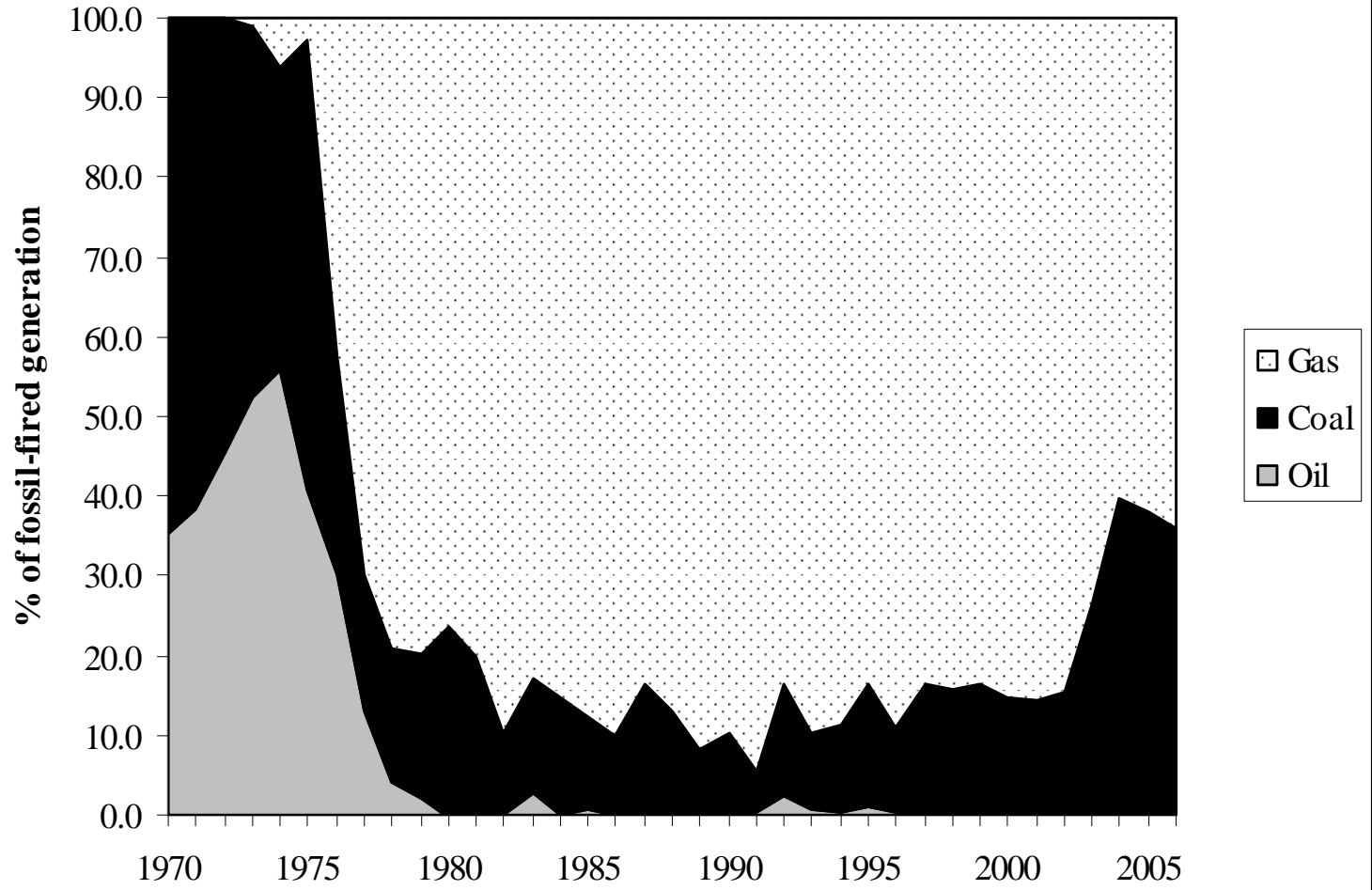
*Sources:* as for Figure 3

# Figure 2: Real Fuel Cost of Fossil-fired Generation in New Zealand Compared with World Oil Price Trends

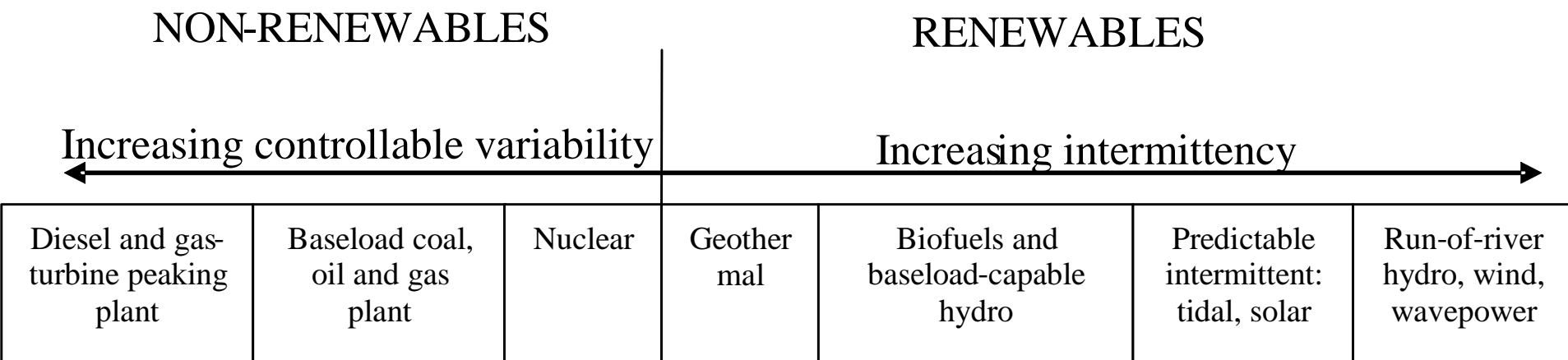


- Working cost of NZED thermals c/kWh
- △— Fuel cost of NZED thermals c/kWh
- ◇— ECNZ's Maui gas cost per kWh
- \*— Industrial gas price cost per kWh
- — Brent crude in NZ\$ (RH scale)

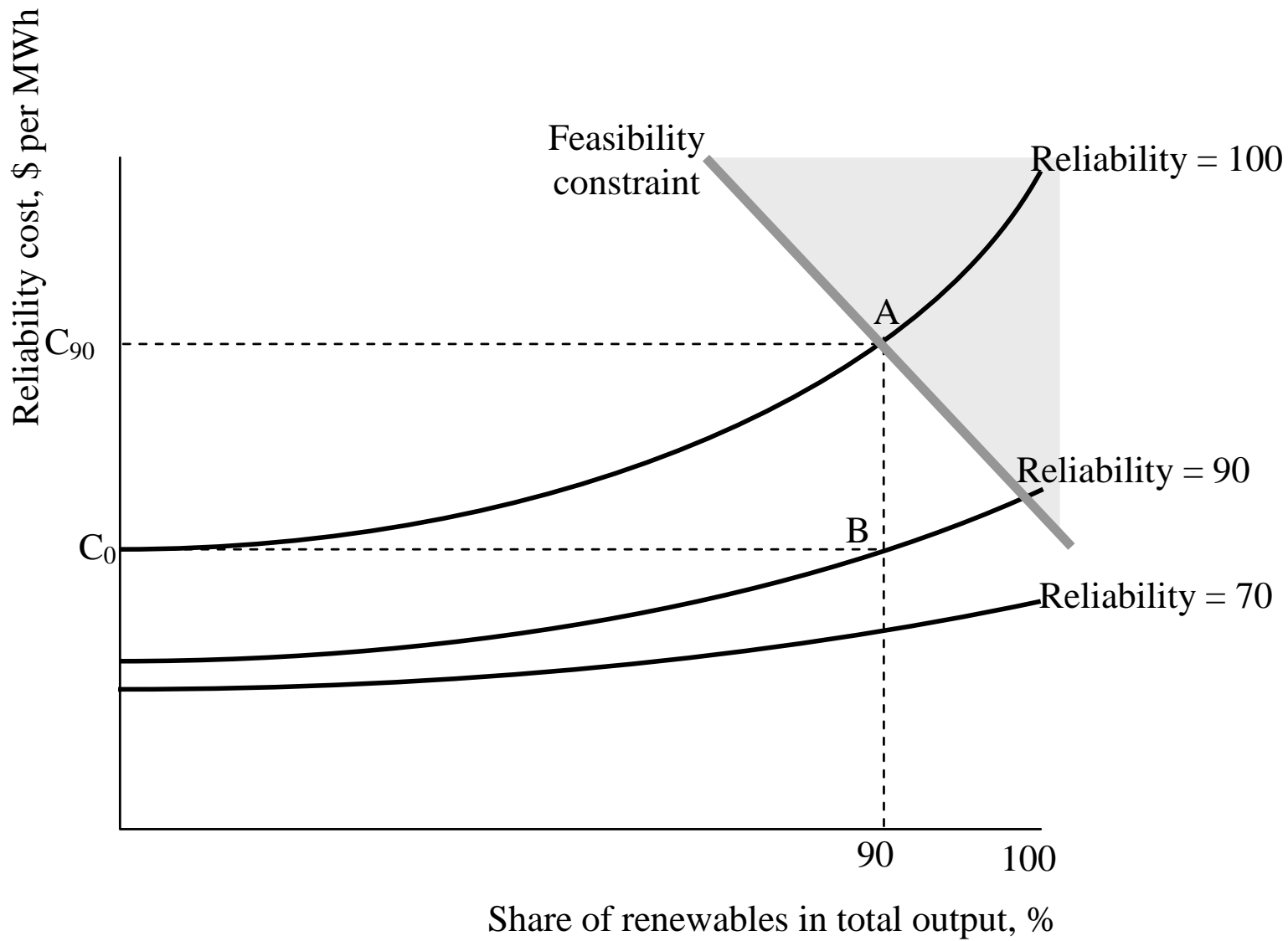
# Figure 3: New Zealand's Switch to Gas in Thermal Generation



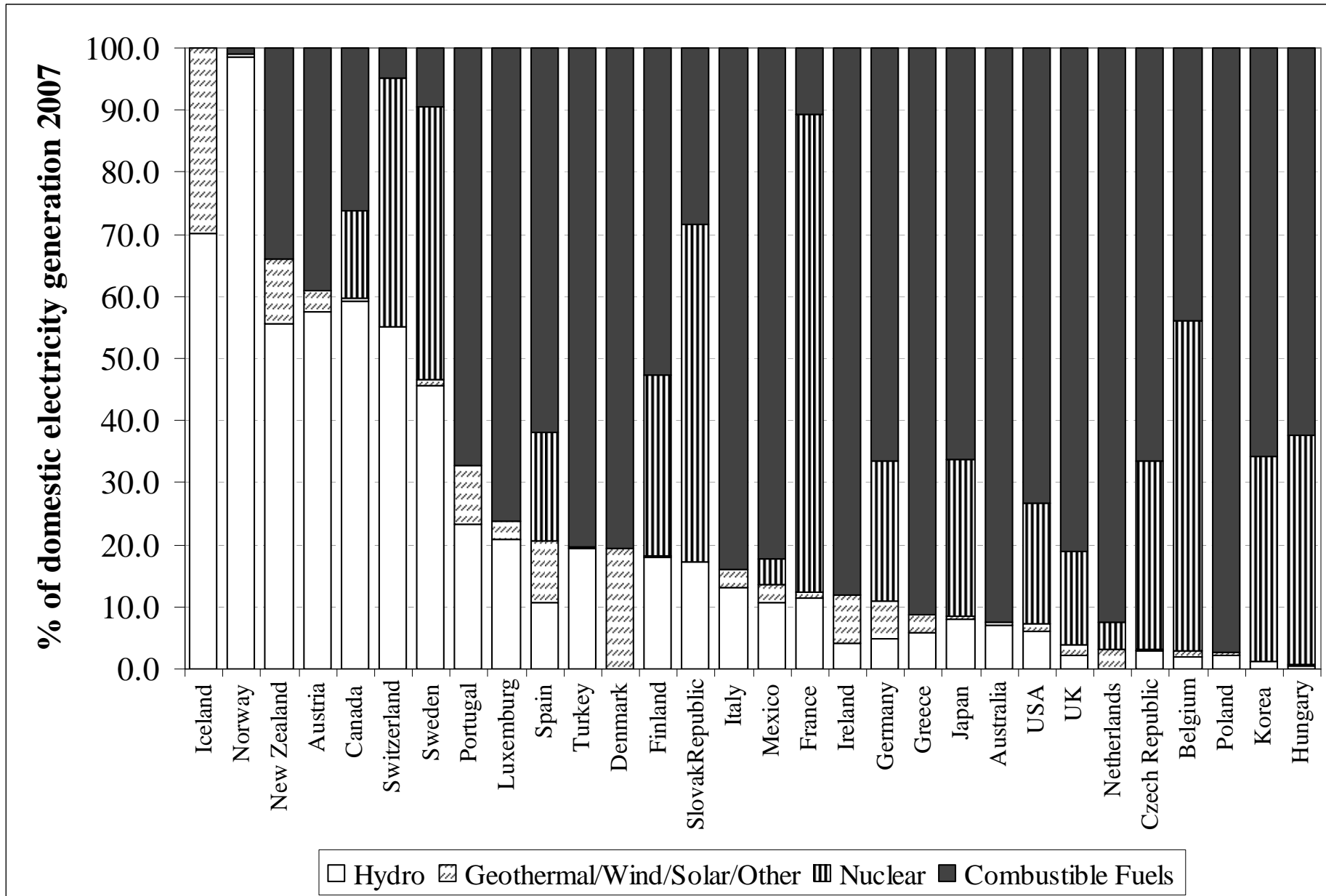
**Figure 4: Schematic Comparison of Renewable and Nonrenewable Technologies**



# Figure 5: Framework for the Integration of Renewables into a Hypothetical Electricity System



**Figure 6: Electricity Generation by Primary Energy Source, OECD Countries**

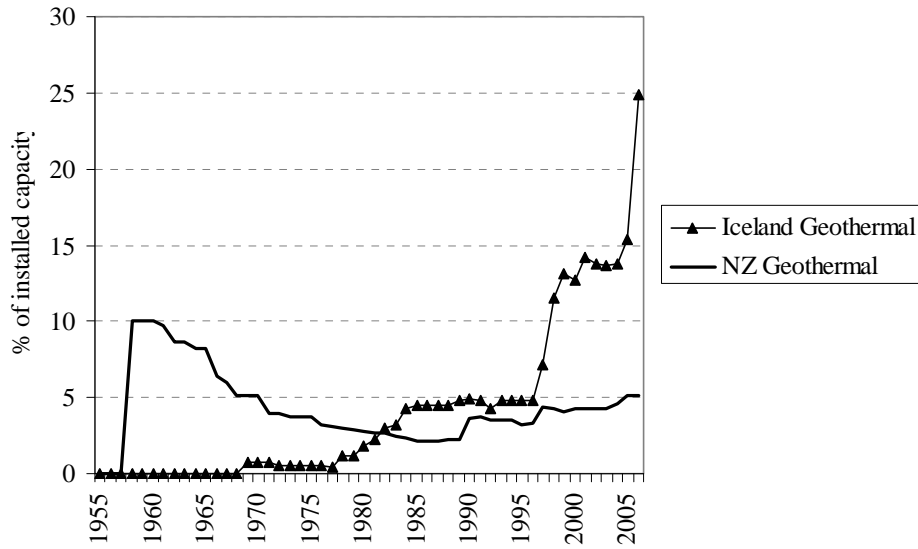


## Table 2 New Zealand and Iceland Compared

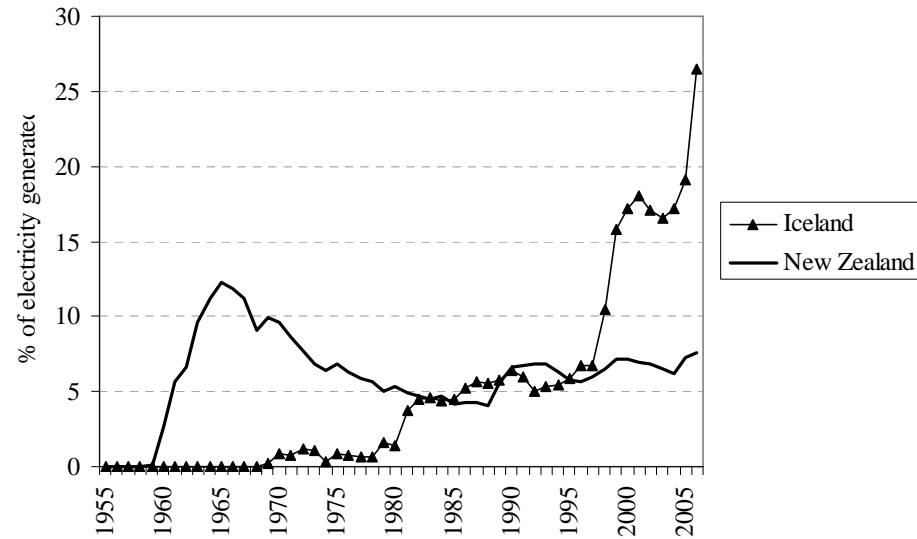
|                                     | Iceland      |     |              |      | New Zealand   |      |               |     |
|-------------------------------------|--------------|-----|--------------|------|---------------|------|---------------|-----|
|                                     | 1970         |     | 2006         |      | 1970          |      | 2006          |     |
|                                     |              | %   |              | %    |               | %    |               | %   |
| Population, 000                     | 204          |     | 304          |      | 2,852         |      | 4,173         |     |
| Generation per capita, MWh          | 7.2          |     | 33           |      | 4.5           |      | 10            |     |
| <b>Electricity generated, GWh</b>   | <b>1,460</b> |     | <b>9,925</b> |      | <b>12,926</b> |      | <b>42,056</b> |     |
| of which hydro                      | 1,413        | 97  | 7,289        | 73.4 | 9,889         | 76.5 | 23,220        | 55  |
| geothermal                          | 12           | 1   | 2,631        | 26.5 | 1,243         | 9.6  | 3,210         | 8   |
| wind                                | 0            | 0   | 0            | 0.0  | 0             | 0.0  | 617           | 2   |
| fossil-fired                        | 35           | 2   | 5            | 0.0  | 1,471         | 11.4 | 14,322        | 34  |
| <b>Generation capacity 2006, MW</b> | <b>334</b>   |     | <b>1,698</b> |      | <b>3,040</b>  |      | <b>8,517</b>  |     |
| of which hydro                      | 244          | 17  | 1,163        | 12   | 2,373         | 18.4 | 5,283         | 13  |
| geothermal                          | 2.6          | 0.2 | 422          | 4    | 157           | 1.2  | 435           | 1   |
| wind                                | 0            | 0   | 0            | 0    | 0             | 0    | 171           | 0.4 |
| fossil-fired                        | 88           | 6   | 113          | 1    | 510           | 3.9  | 2,628         | 6   |

**Figure 7: Geothermal shares of capacity and generation, New Zealand and Iceland**

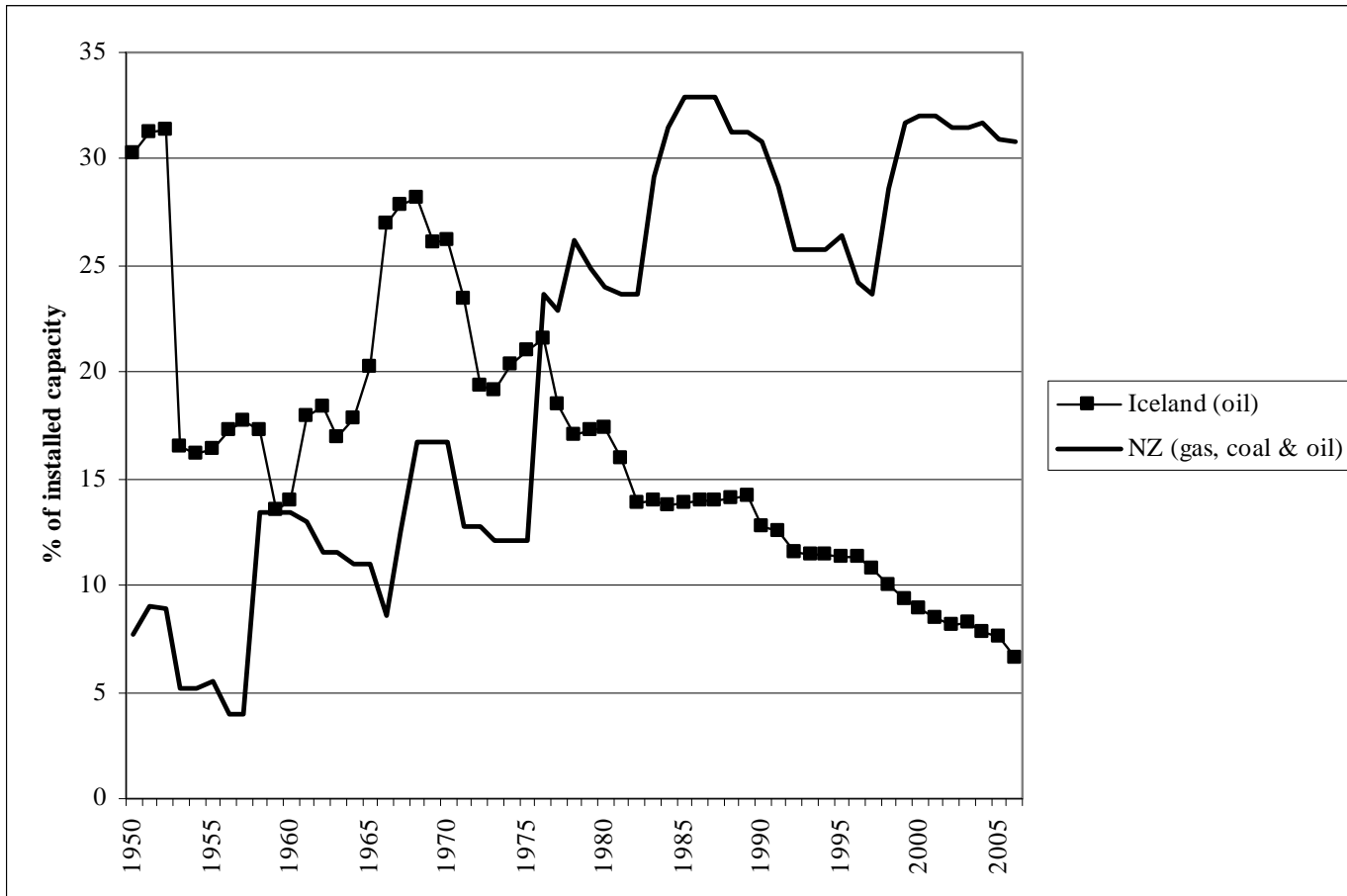
Share of total generation capacity



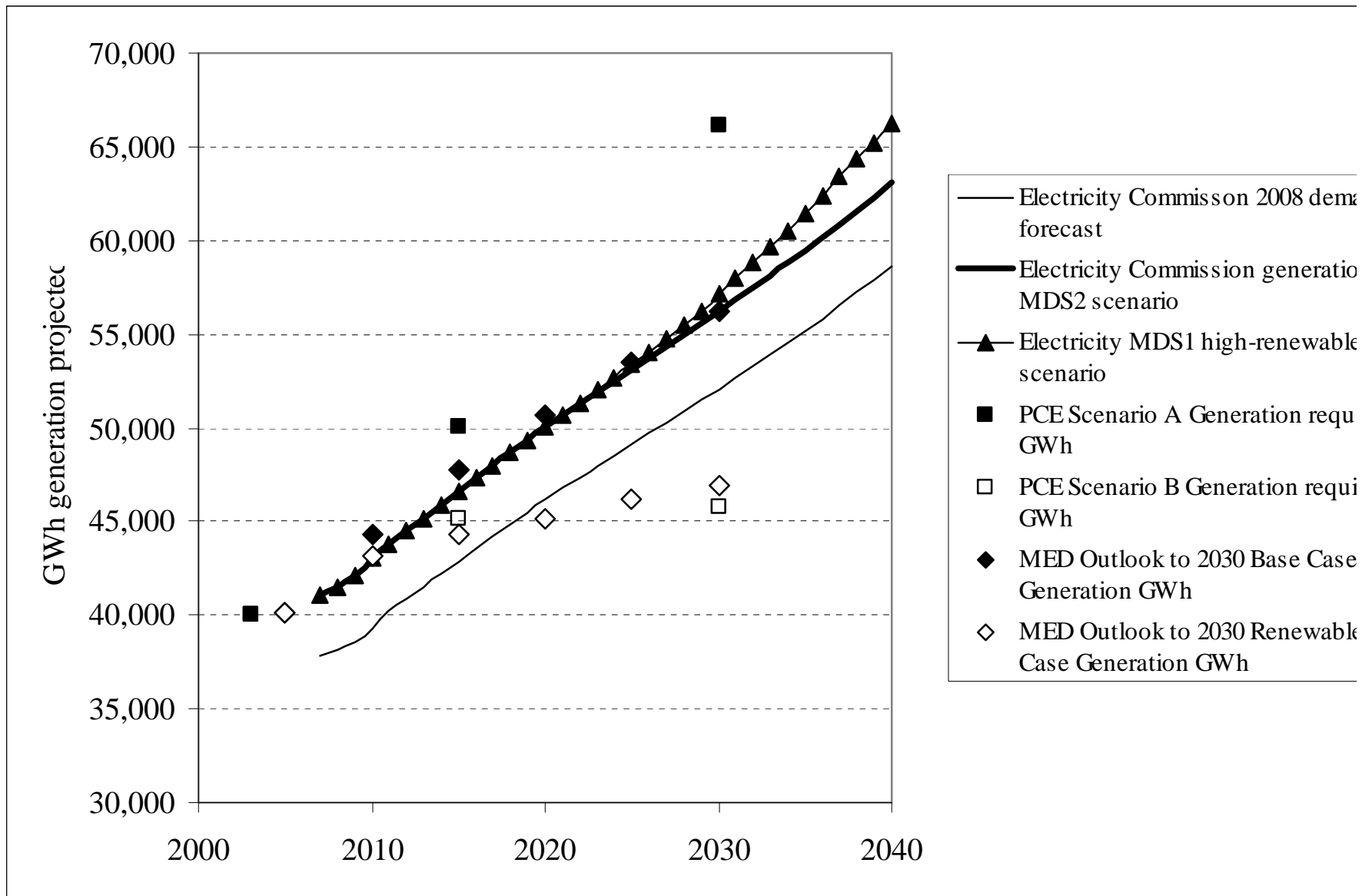
Share of total electricity generated



# Figure 8: Non-renewables share of installed capacity



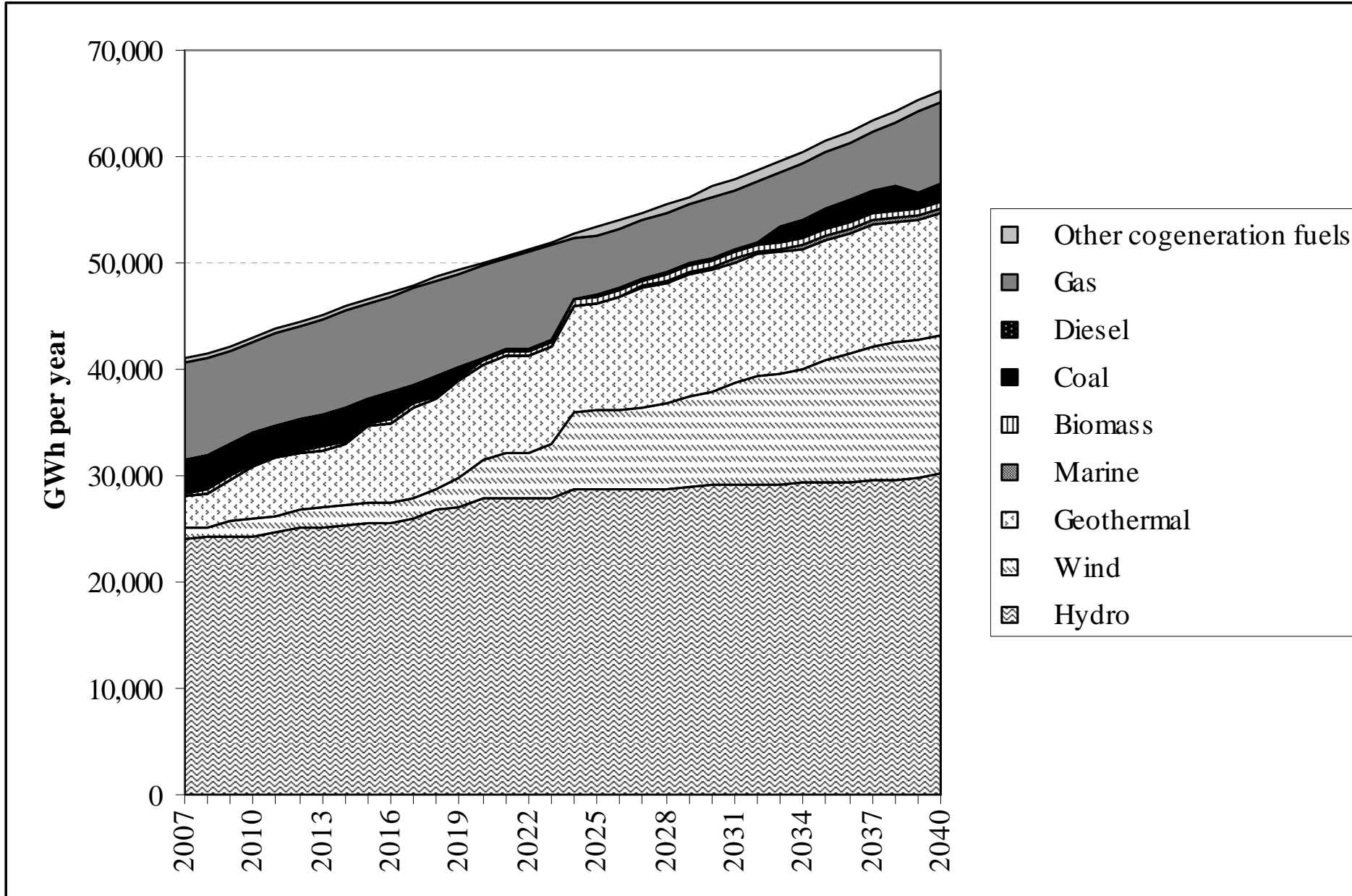
# Figure 10: Projections of Electricity Demand and Generation



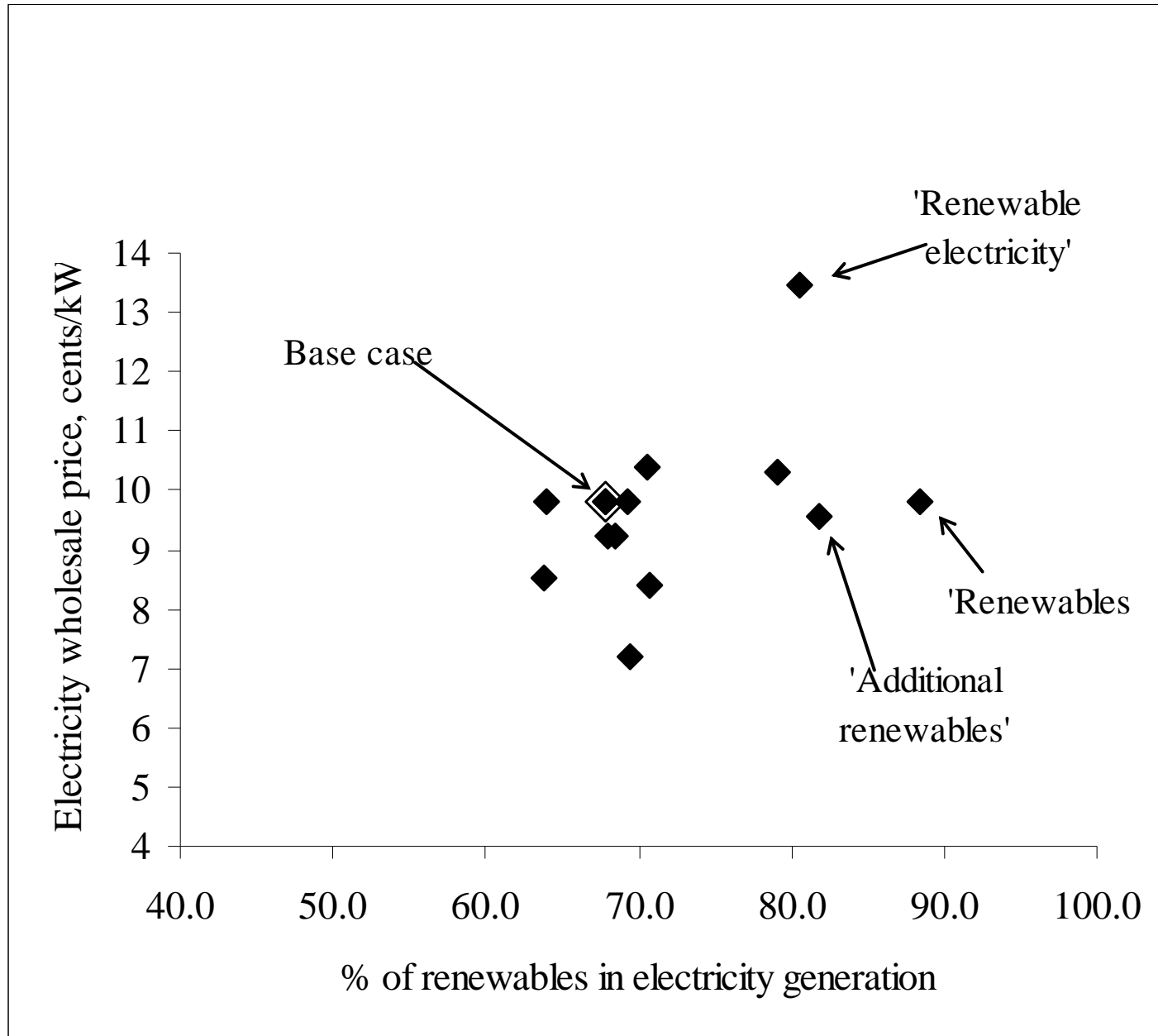
**Table 3: NZ Electricity Commission Scenarios at June 2008**

|      |                          | Scenarios                     |                                      |                                |   |                                 |
|------|--------------------------|-------------------------------|--------------------------------------|--------------------------------|---|---------------------------------|
|      |                          | MDS1<br>“Sustainable<br>Path” | MDS2<br>“South<br>Island<br>Surplus” | MDS3<br>“Medium<br>Renewables” | MDS4<br>“Demand<br>Side<br>Participation” | MDS5<br>“High Gas<br>Discovery” |
| 2007 | Installed capacity MW    | 8,553                         | 8,553                                | 8,553                          | 8,553                                     | 8,553                           |
|      | Modelled generation GWh  | 41,079                        | 41,069                               | 43,067                         | 41,075                                    | 43,074                          |
| 2025 |                          |                               |                                      |                                |   |                                 |
|      | Total MW                 | 12,488                        | 12,481                               | 10,899                         | 10,934                                    | 10,934                          |
|      | of which renewable       | 9,935                         | 9,161                                | 7,317                          | 7,164                                     | 7,084                           |
|      | <i>renewable share %</i> | <i>79.6%</i>                  | <i>73.4%</i>                         | <i>67.1%</i>                   | <i>65.5%</i>                              | <i>64.8%</i>                    |
|      | Total GWh                | 53,393                        | 53,133                               | 51,513                         | 53,288                                    | 55,051                          |
|      | of which renewable       | 46,832                        | 42,729                               | 37,496                         | 35,868                                    | 35,737                          |
|      | <i>renewable share %</i> | <i>87.7%</i>                  | <i>80.4%</i>                         | <i>72.8%</i>                   | <i>67.3%</i>                              | <i>64.9%</i>                    |
|      |                          |                               |                                      |                                |   |                                 |
| 2030 |                          |                               |                                      |                                |   |                                 |
|      | Total MW                 | 13,532                        | 13,286                               | 11,239                         | 11,916                                    | 11,459                          |
|      | of which renewable       | 10,899                        | 9,676                                | 7,692                          | 7,244                                     | 7,285                           |
|      | <i>renewable share %</i> | <i>80.5%</i>                  | <i>72.8%</i>                         | <i>68.4%</i>                   | <i>60.8%</i>                              | <i>63.6%</i>                    |
|      | Total GWh                | 57,147                        | 56,187                               | 53,035                         | 56,991                                    | 58,103                          |
|      | of which renewable       | 50,239                        | 44,705                               | 38,349                         | 34,957                                    | 37,566                          |
|      | <i>renewable share %</i> | <i>87.9%</i>                  | <i>79.6%</i>                         | <i>72.3%</i>                   | <i>61.3%</i>                              | <i>64.7%</i>                    |
|      |                          |                               |                                      |                                |   |                                 |
| 2040 |                          |                               |                                      |                                |   |                                 |
|      | Total MW                 | 15,988                        | 14,328                               | 12,559                         | 13,081                                    | 13,247                          |
|      | of which renewable       | 12,500                        | 9,676                                | 8,467                          | 8,209                                     | 7,855                           |
|      | <i>renewable share %</i> | <i>78.2%</i>                  | <i>67.5%</i>                         | <i>67.4%</i>                   | <i>62.8%</i>                              | <i>59.3%</i>                    |
|      | Total GWh                | 66,223                        | 63,066                               | 59,917                         | 65,826                                    | 65,029                          |
|      | of which renewable       | 55,662                        | 45,106                               | 42,116                         | 39,875                                    | 39,854                          |
|      | <i>renewable share %</i> | <i>84.1%</i>                  | <i>71.5%</i>                         | <i>70.3%</i>                   | <i>60.6%</i>                              | <i>61.3%</i>                    |

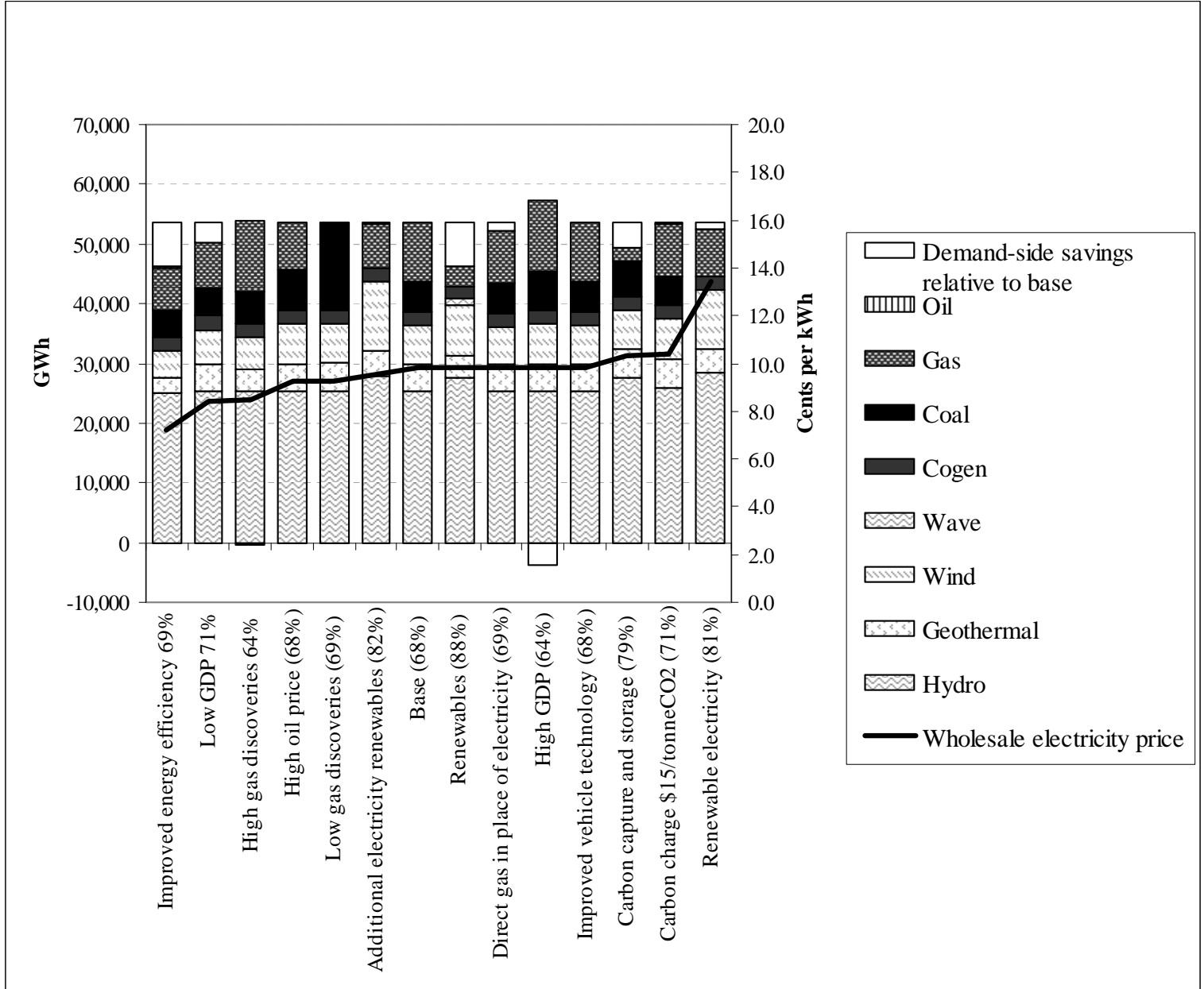
**Figure 11: Generation by Fuel, Electricity Commission Scenario MDS1**



**Figure 12: Renewables Share and Wholesale Price: MED 2006 Scenarios at 2025**

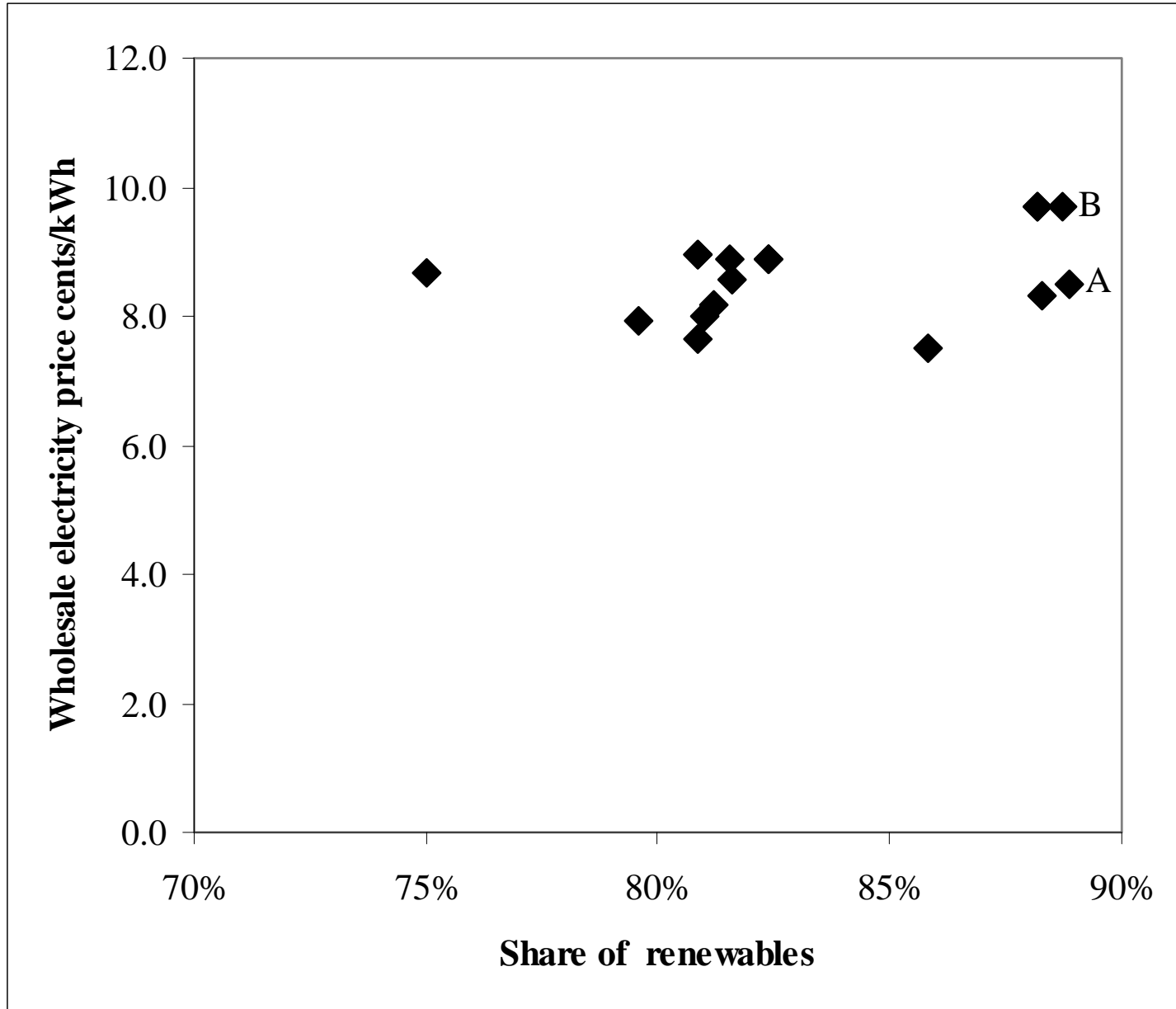


**Figure 13: MED (2007) Generation Scenarios for 2025 Ranked in Order of Wholesale Electricity Price**



**Figure 14**

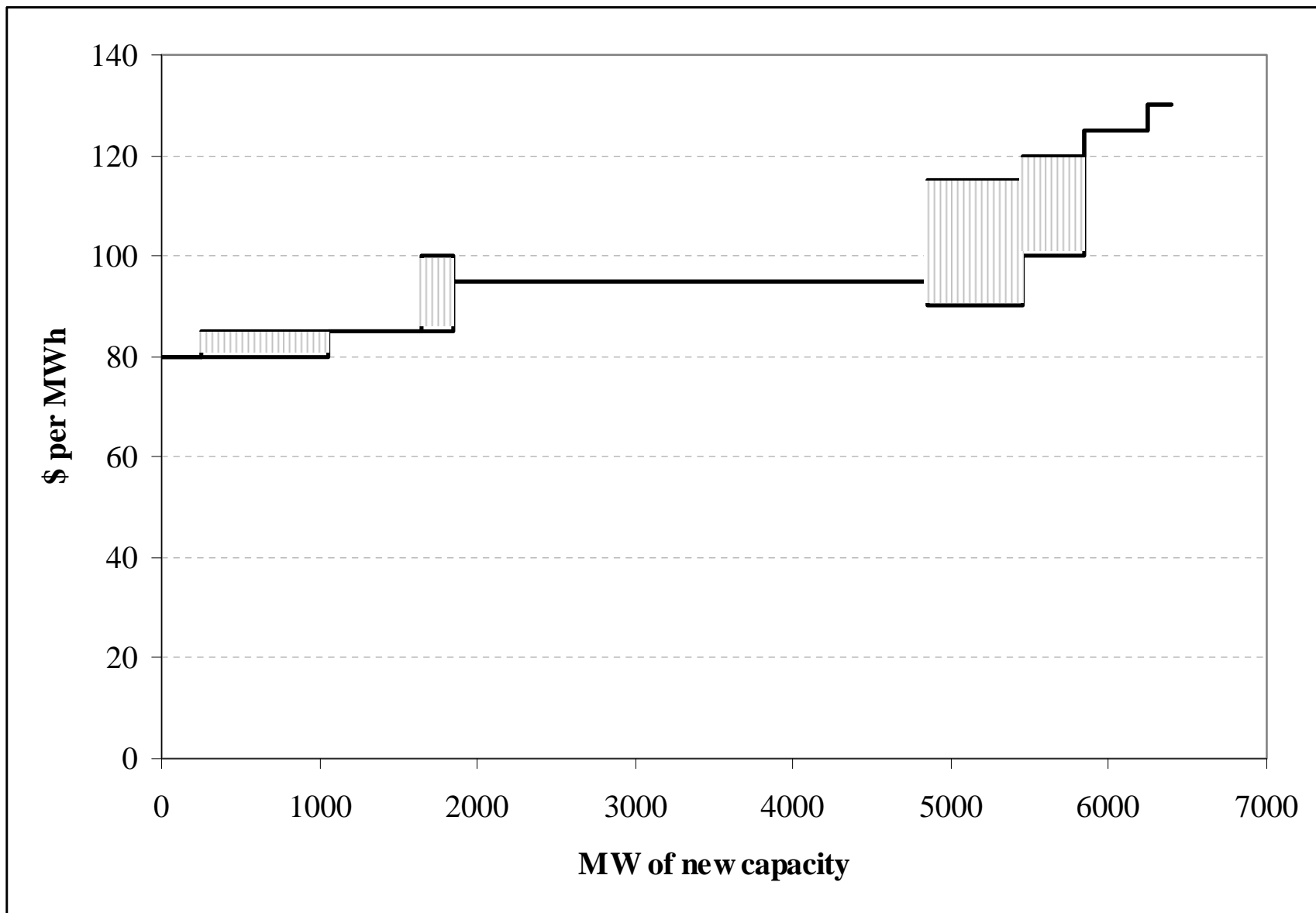
**Renewables Share and Wholesale Price, MED 2007 Scenarios at 2025**



**Table 4: Scope of Feasible Renewable Projects**

| \$/MWh        | 80      | 80-85 | 85  | 85-100 | 95    | 90-115 | 100-120 | 125 | 130 | Total       | Other         | Total potential |
|---------------|---------|-------|-----|--------|-------|--------|---------|-----|-----|-------------|---------------|-----------------|
| Geothermal    | 250-300 |       | 400 |        |       |        |         |     |     | 650-700     | 56-106        | 756             |
| Wind          |         | 800   |     |        | 3,000 |        |         |     |     | 3800        | 12,590        | 16,390          |
| Hydro         |         |       | 200 | 200    |       | 600    | 400     |     |     | 1400        | 537           | 1,937           |
| Biomass cogen |         |       |     |        |       |        |         |     | 150 | 150         |               | 150             |
| Marine        |         |       |     |        |       |        |         | 400 |     | 400         |               | 300             |
|               |         |       |     |        |       |        |         |     |     |             |               |                 |
| Total MW      | 250-300 | 800   | 600 | 200    | 3,000 | 600    | 400     | 400 | 150 | 6,400-6,450 | 13,183-13,233 | 19,533          |

**Figure 15: Estimated Renewables Supply Curve from Electricity Commission Database**



# Conclusions

- 85%+ renewable electricity is easy
- 90% is pushing the envelop but looks feasible
- Beyond 90% you have to look closely at the denominator of any calculation
- The analysis by MED and the Electricity Commission has ignored small-scale DG and demand-side innovation
- A big push towards renewables does not make sense in isolation from (i) a price on carbon, and (ii) serious attention to the gaps in the electricity market, especially on the demand side