

HELE perspectives for selected countries

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Preface

This report has been produced by IEA Clean Coal Centre and is based on a survey and analysis of published literature, and on information gathered in discussions with interested organisations and individuals. Their assistance is gratefully acknowledged. It should be understood that the views expressed in this report are our own, and are not necessarily shared by those who supplied the information, nor by our member countries.

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Abstract

In response to a request from the Minerals Council of Australia, the coal power fleet profiles have been determined and presented for the following countries: Bangladesh, China, India, Japan, Malaysia, Philippines, South Korea, Taiwan, Thailand and Vietnam. For plant currently planned, or reported as under construction post 2015 and for two recent five-year periods, the carbon dioxide emissions have been calculated for the ten countries and presented using previously reported assumptions corresponding to the three scenarios: all subcritical, “as reported” and all ultra-supercritical plant.

An inspection of the projected emissions of carbon dioxide shows that significant savings may be achieved in all cases by incorporating HELE plant over subcritical capacity. Even when comparing the “as reported” planned future coal fleet mix, relative and absolute savings may be possible in many cases, even for China which is leading the way in the use of advanced steam cycles. The most significant savings are projected for the Indian power sector where the adoption of a fully ultra-supercritical coal fleet over the planned “as reported” build profile could achieve savings of 509 Mtonnes carbon dioxide annually (over 20%). Even the Philippines’ relatively modest coal fleet could achieve absolute savings of almost 30% by adopting the most efficient plant.

Acronyms and abbreviations

| | |
|------|--|
| CFBC | Circulating fluidised bed combustion |
| CHP | Combined heat and power |
| HELE | High efficiency, low emissions |
| WEPP | (UDI) World Electric Power Plants Database |

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1 Introduction

The Minerals Council of Australia has requested (from the IEA Clean Coal Centre) a short paper that outlines the deployment of HELE coal-fired power generation technologies over time up to 2014, under construction and planned in ten countries, and the estimated and potential impact on CO₂ emissions. The countries selected for study are: Bangladesh, China, India, Japan, Malaysia, Philippines, South Korea, Taiwan, Thailand and Vietnam.

The methodology used for the study was as follows:

1. Coal fleet profile

Prepare coal fleet profiles for each of the ten countries listed using the latest Platt's data, processed and summarised as in the original IEA CCC HELE report (Barnes, 2014) in tabular and graphical formats.

2. For each country in turn:

For the portion of the coal fleet that is “planned or under construction post 2015”, estimate annual carbon dioxide emissions from this tranche of the coal fleet using assumptions on efficiency and load factor assuming that all plant is based on the subcritical plant steam cycle. Recalculate emissions for this portion of the coal fleet but this time base the calculations on a) Currently planned steam cycle technology mix, b) Current state-of-the-art plant (ultra-supercritical plant). Repeat the above for the coal fleet plant commissioned in each of the two periods: 2005 – 2009 and 2010 – 2014.

2 Results

Data on coal-fired power generation units were abstracted from the UDI World Electric Power Plants Database (WEPP) in order to prepare a profile of each country's coal fleet, setting out the installed capacity as a function of age grouped by date of commissioning and steam cycle technology. The collated data sets are presented in tabular and graphical format. The WEPP is a global inventory of electric power generating units (Platts, 2015) and contains design data for plants of all sizes and technologies operated by regulated utilities, private power companies, and industrial autoproducers (captive power). It has been licensed by the IEA Clean Coal Centre and the base dataset interrogated for the study contains up-to-date information for plants in operation, under construction, or planned as of 2015. WEPP reporting of power plant data is comprehensive, and widely used, but it should be pointed out that it is not regarded as a definitive catalogue of coal-fired power plant. The reader should note that the different steam cycle subtotals sometimes produce a figure that does not reconcile with the overall fleet size. This is primarily due to some plant being uncategorised in the Platt's database and so is “counted in” to the grand total, but is not represented in the individual steam cycle totals. Platt's claim over 95% coverage of individual countries coal fleets with the exception of China where a lower coverage is claimed. This is a consequence of the rapid transformation of China's power sector where it is reported that 1-2 new power plants are being built every week (Minchener, 2015). Chinese government policy since 2006 has been to build only

supercritical and then ultra supercritical plant for power generation, the vast majority being based on pulverised coal combustion. The only exception to this policy has been the use of subcritical pulverised coal plant for combined heat and power (CHP) applications, and the use of subcritical CFBC for burning low grade and variable quality coals, plus some waste coal. This is reflected in the database as new subcritical plant. In future, and in line with the latest policies, CHP will use supercritical steam conditions as will any CFBC sized 600MWe and over. Strong efficiency targets, which mean almost all new coal power plant will be 1000MWe ultra supercritical pulverised coal, with high efficiency and low emissions mean that Chinese carbon dioxide saving are likely to exceed those presented in this brief overview.

2.1 Coal fleet profiles

The profile of the ten candidate countries selected for study, abstracted from the WEPP is shown below in **Table 1** to **Table 10** and Figure 1 to Figure 10. Plant units are grouped by age and by steam cycle conditions (subcritical, supercritical and ultra-supercritical). Coal-fired plant planned or under construction post 2015 is highlighted with its own entry in each profile.

| Table 1 Chinese coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|---|-----------------------------------|--------------------|----------------------|----------------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 467 | 467 | 0 | 0 |
| 1960 - 69 | 375 | 375 | 0 | 0 |
| 1970 - 79 | 4816 | 4816 | 0 | 0 |
| 1980 - 89 | 36700 | 36700 | 0 | 0 |
| 1990 - 94 | 44555 | 42215 | 2340 | 0 |
| 1995 - 99 | 67959 | 65219 | 2740 | 0 |
| 2000 - 04 | 95496 | 87536 | 7760 | 0 |
| 2005 - 09 | 328605 | 192525 | 102490 | 32390 |
| 2010 - 14 | 259945 | 73859 | 86970 | 97816 |
| Subtotal less planned | 838918 | 503711 | 202300 | 130206 |
| Planned or under construction post 2015 | 483973 | 64065 | 143950 | 225338 |
| Total | 1322890 | 567776 | 346250 | 355544 |

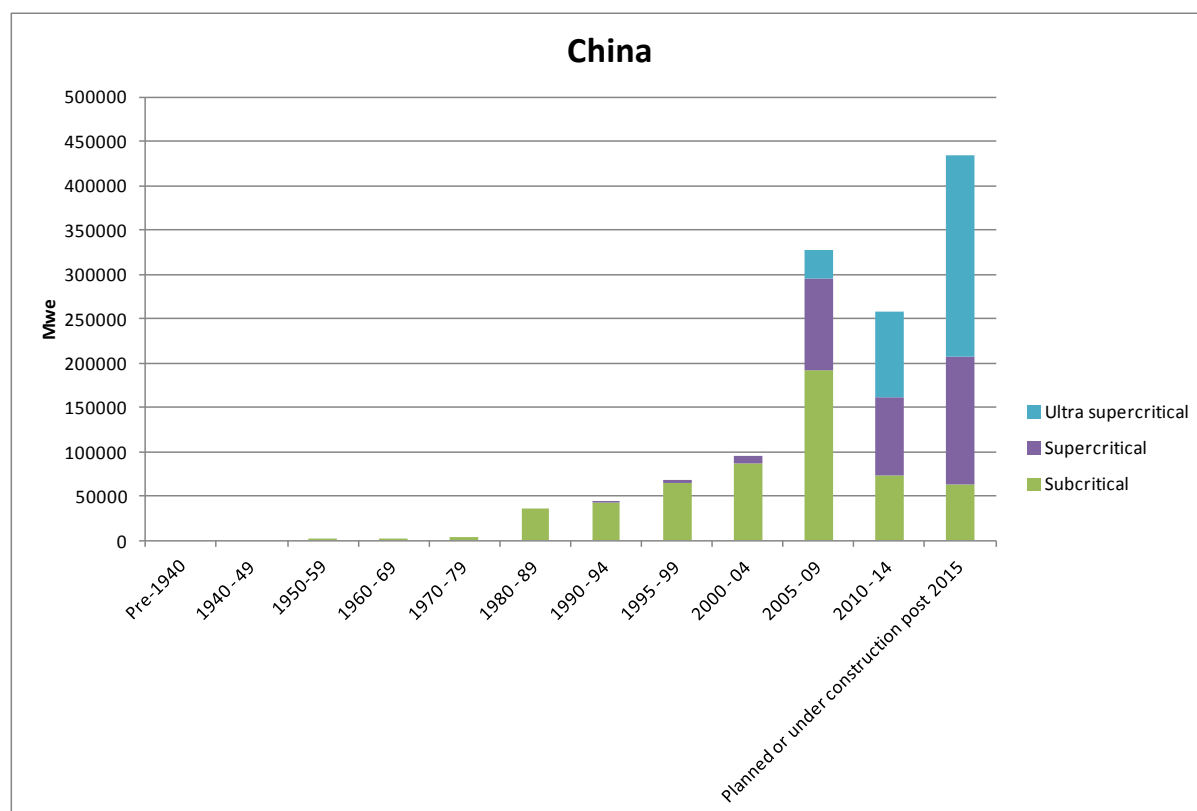


Figure 1 – Chinese coal-fired power plant by age and steam cycle conditions

| Table 2 Bangladeshi coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|--|----------------------------|-------------|---------------|---------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950 - 59 | 0 | 0 | 0 | 0 |
| 1960 - 69 | 0 | 0 | 0 | 0 |
| 1970 - 79 | 0 | 0 | 0 | 0 |
| 1980 - 89 | 0 | 0 | 0 | 0 |
| 1990 - 94 | 0 | 0 | 0 | 0 |
| 1995 - 99 | 0 | 0 | 0 | 0 |
| 2000 - 04 | 0 | 0 | 0 | 0 |
| 2005 - 09 | 250 | 250 | 0 | 0 |
| 2010 - 14 | 0 | 0 | 0 | 0 |
| Subtotal less planned | 250 | 250 | 0 | 0 |
| Planned or under construction post 2015 | 11866 | 425 | 0 | 5440 |
| Total | 12116 | 675 | 0 | 5440 |

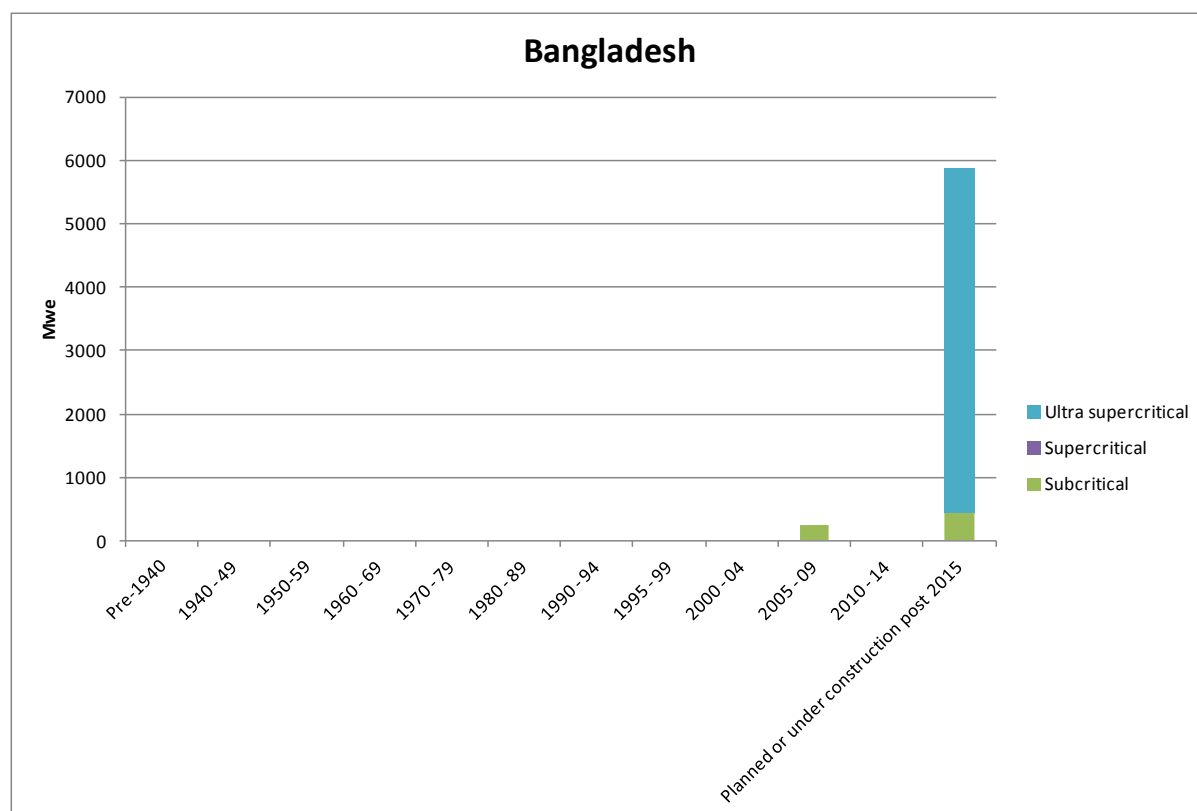


Figure 2 – Bangladeshi coal-fired power plant by age and steam cycle conditions

| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
|---|----------------------------|-------------|---------------|---------------------|
| Pre-1940 | 6 | 6 | 0 | 0 |
| 1940 - 49 | 4 | 4 | 0 | 0 |
| 1950-59 | 58 | 58 | 0 | 0 |
| 1960 - 69 | 2999 | 2999 | 0 | 0 |
| 1970 - 79 | 7838 | 7838 | 0 | 0 |
| 1980 - 89 | 27185 | 27185 | 0 | 0 |
| 1990 - 94 | 10948 | 10948 | 0 | 0 |
| 1995 - 99 | 10695 | 10695 | 0 | 0 |
| 2000 - 04 | 7756 | 7756 | 0 | 0 |
| 2005 - 09 | 23255 | 23255 | 0 | 0 |
| 2010 - 14 | 81795 | 57260 | 24535 | 0 |
| Subtotal less planned | 172535 | 148000 | 24535 | 0 |
| Planned or under construction post 2015 | 391698 | 79178 | 221065 | 16900 |
| Total | 564234 | 227179 | 245600 | 16900 |

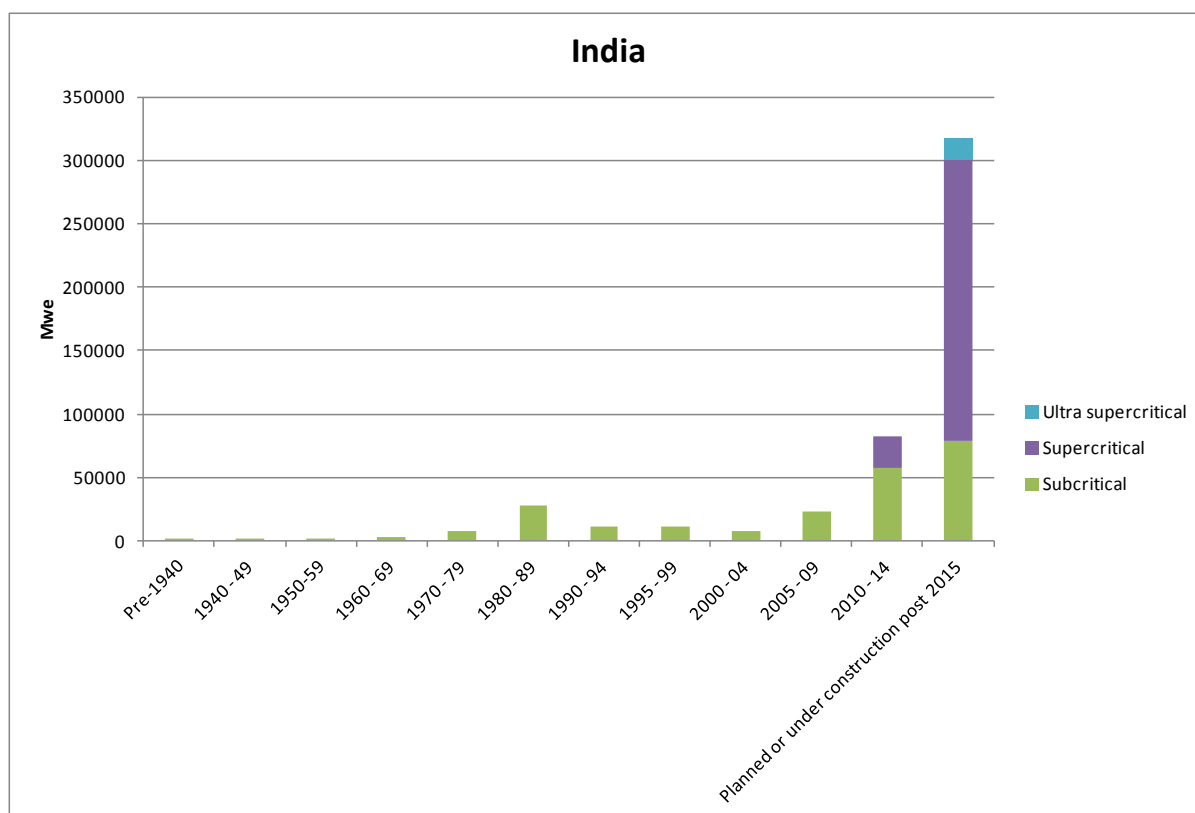


Figure 3 – Indian coal-fired power plant by age and steam cycle conditions

| Table 4 Japanese coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|---|----------------------------|-------------|---------------|---------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 75 | 75 | 0 | 0 |
| 1960 - 69 | 1990 | 1990 | 0 | 0 |
| 1970 - 79 | 2625 | 2625 | 0 | 0 |
| 1980 - 89 | 6561 | 1961 | 4600 | 0 |
| 1990 - 94 | 6436 | 636 | 4500 | 1300 |
| 1995 - 99 | 7903 | 1003 | 3200 | 3700 |
| 2000 - 04 | 13488 | 1798 | 3790 | 7900 |
| 2005 - 09 | 2129 | 1022 | 507 | 600 |
| 2010 - 14 | 2516 | 16 | 0 | 2500 |
| Subtotal less planned | 43722 | 11125 | 16597 | 16000 |
| Planned or under construction post 2015 | 11116 | 826 | 400 | 7290 |
| Total | 54838 | 11951 | 16997 | 23290 |

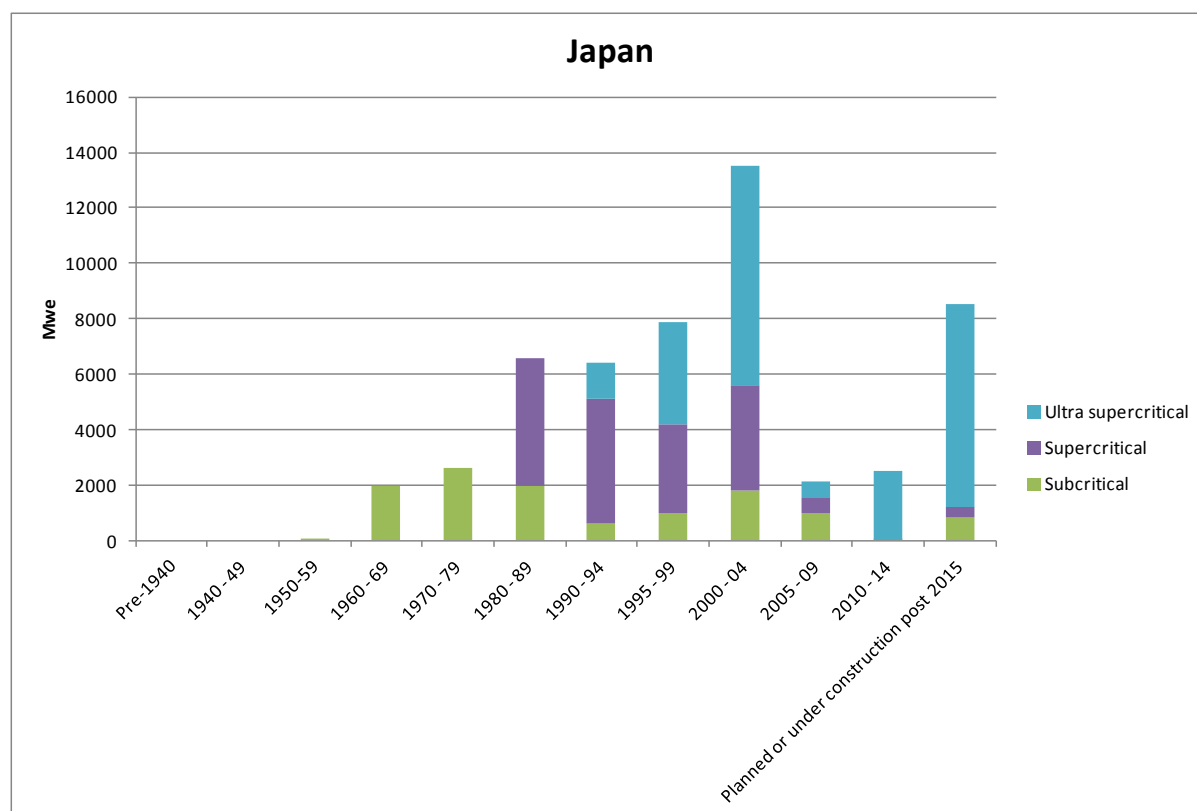


Figure 4 – Japanese coal-fired power plant by age and steam cycle conditions

| Table 5 Malaysian coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|--|----------------------------|-------------|---------------|---------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 0 | 0 | 0 | 0 |
| 1960 - 69 | 0 | 0 | 0 | 0 |
| 1970 - 79 | 0 | 0 | 0 | 0 |
| 1980 - 89 | 600 | 600 | 0 | 0 |
| 1990 - 94 | 0 | 0 | 0 | 0 |
| 1995 - 99 | 100 | 100 | 0 | 0 |
| 2000 - 04 | 3210 | 3210 | 0 | 0 |
| 2005 - 09 | 4019 | 4019 | 0 | 0 |
| 2010 - 14 | 0 | 0 | 0 | 0 |
| Subtotal less planned | 7929 | 7929 | 0 | 0 |
| Planned or under construction post 2015 | 6880 | 1800 | 1000 | 4080 |
| Total | 14809 | 9729 | 1000 | 4080 |

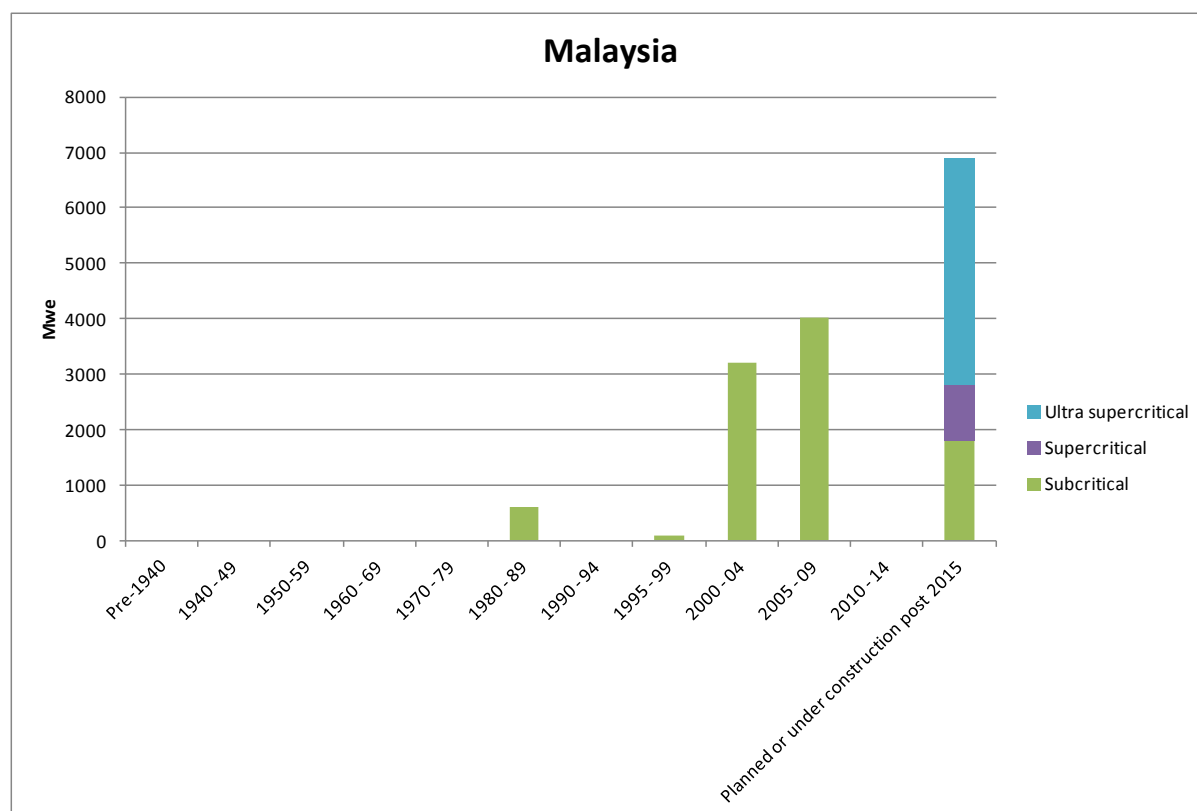


Figure 5 – Malaysian coal-fired power plant by age and steam cycle conditions

| Table 6 Philippine coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|---|----------------------------|-------------|---------------|---------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 0 | 0 | 0 | 0 |
| 1960 - 69 | 15 | 15 | 0 | 0 |
| 1970 - 79 | 26 | 26 | 0 | 0 |
| 1980 - 89 | 472 | 472 | 0 | 0 |
| 1990 - 94 | 0 | 0 | 0 | 0 |
| 1995 - 99 | 2989 | 2989 | 0 | 0 |
| 2000 - 04 | 511 | 511 | 0 | 0 |
| 2005 - 09 | 308 | 308 | 0 | 0 |
| 2010 - 14 | 1298 | 1298 | 0 | 0 |
| Subtotal less planned | 5619 | 5619 | 0 | 0 |
| Planned or under construction post 2015 | 13589 | 12789 | 500 | 0 |
| Total | 19208 | 18408 | 500 | 0 |

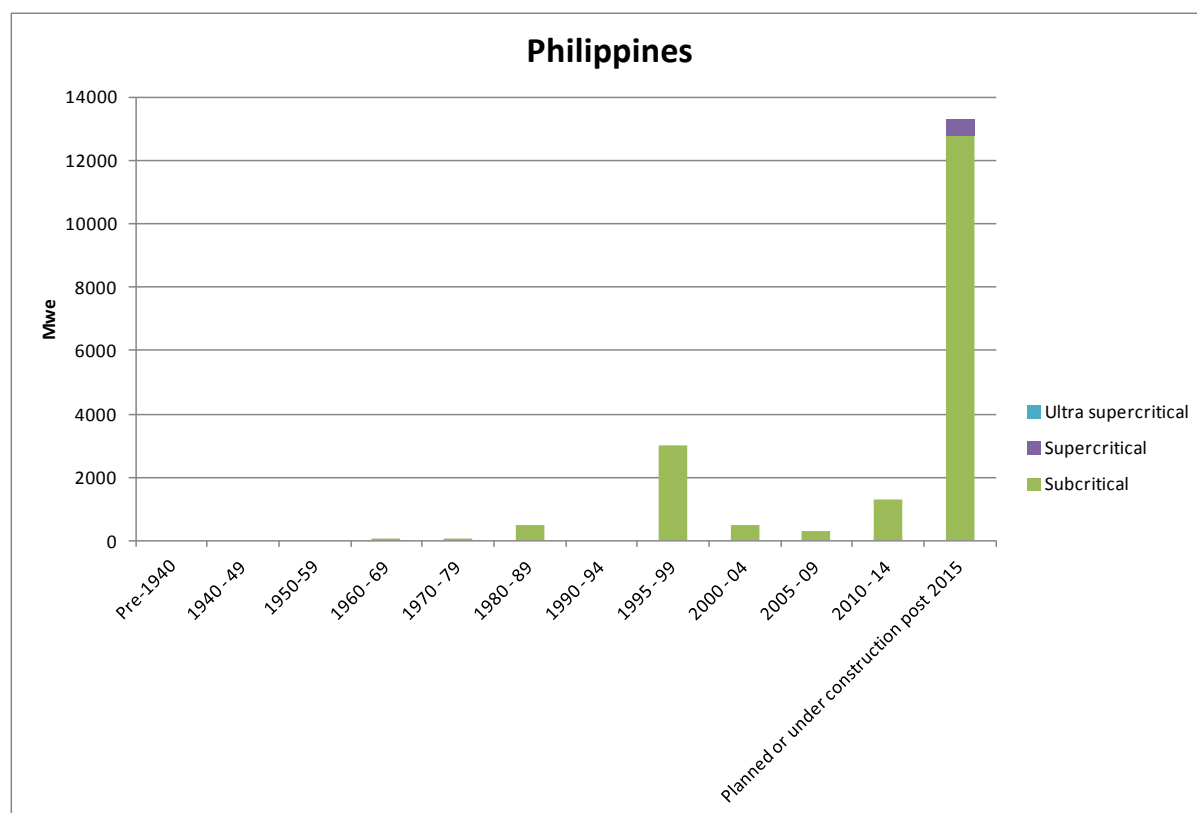


Figure 6 – Philippine coal-fired power plant by age and steam cycle conditions

| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
|---|----------------------------|-------------|---------------|---------------------|
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 0 | 0 | 0 | 0 |
| 1960 - 69 | 80 | 80 | 0 | 0 |
| 1970 - 79 | 1520 | 1520 | 0 | 0 |
| 1980 - 89 | 2613 | 2613 | 0 | 0 |
| 1990 - 94 | 3514 | 1514 | 2000 | 0 |
| 1995 - 99 | 6758 | 758 | 6000 | 0 |
| 2000 - 04 | 4675 | 75 | 4600 | 0 |
| 2005 - 09 | 6915 | 100 | 0 | 6815 |
| 2010 - 14 | 2467 | 727 | 1740 | 0 |
| Subtotal less planned | 28542 | 7387 | 14340 | 6815 |
| Planned or under construction post 2015 | 17618 | 1288 | 1290 | 15040 |
| Total | 46161 | 8675 | 15630 | 21855 |

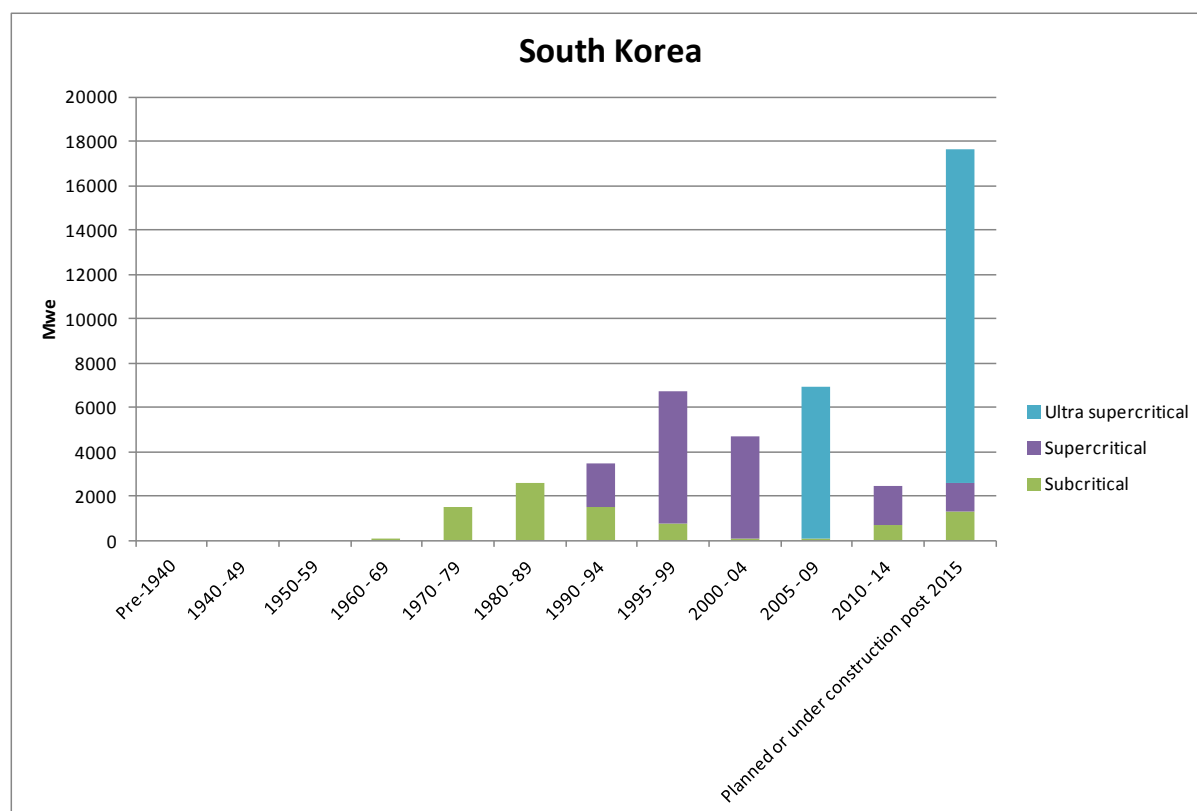


Figure 7 – South Korean coal-fired power plant by age and steam cycle conditions

| Table 8 Taiwanese coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|--|----------------------------|-------------|---------------|---------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 0 | 0 | 0 | 0 |
| 1960 - 69 | 1044 | 1044 | 0 | 0 |
| 1970 - 79 | 1930 | 1930 | 0 | 0 |
| 1980 - 89 | 2400 | 2400 | 0 | 0 |
| 1990 - 94 | 2839 | 2839 | 0 | 0 |
| 1995 - 99 | 3946 | 2746 | 1200 | 0 |
| 2000 - 04 | 5452 | 2452 | 3000 | 0 |
| 2005 - 09 | 1100 | 1100 | 0 | 0 |
| 2010 - 14 | 50 | 50 | 0 | 0 |
| Subtotal less planned | 18762 | 14562 | 4200 | 0 |
| Planned or under construction post 2015 | 16940 | 0 | 0 | 8800 |
| Total | 35702 | 14562 | 4200 | 8800 |

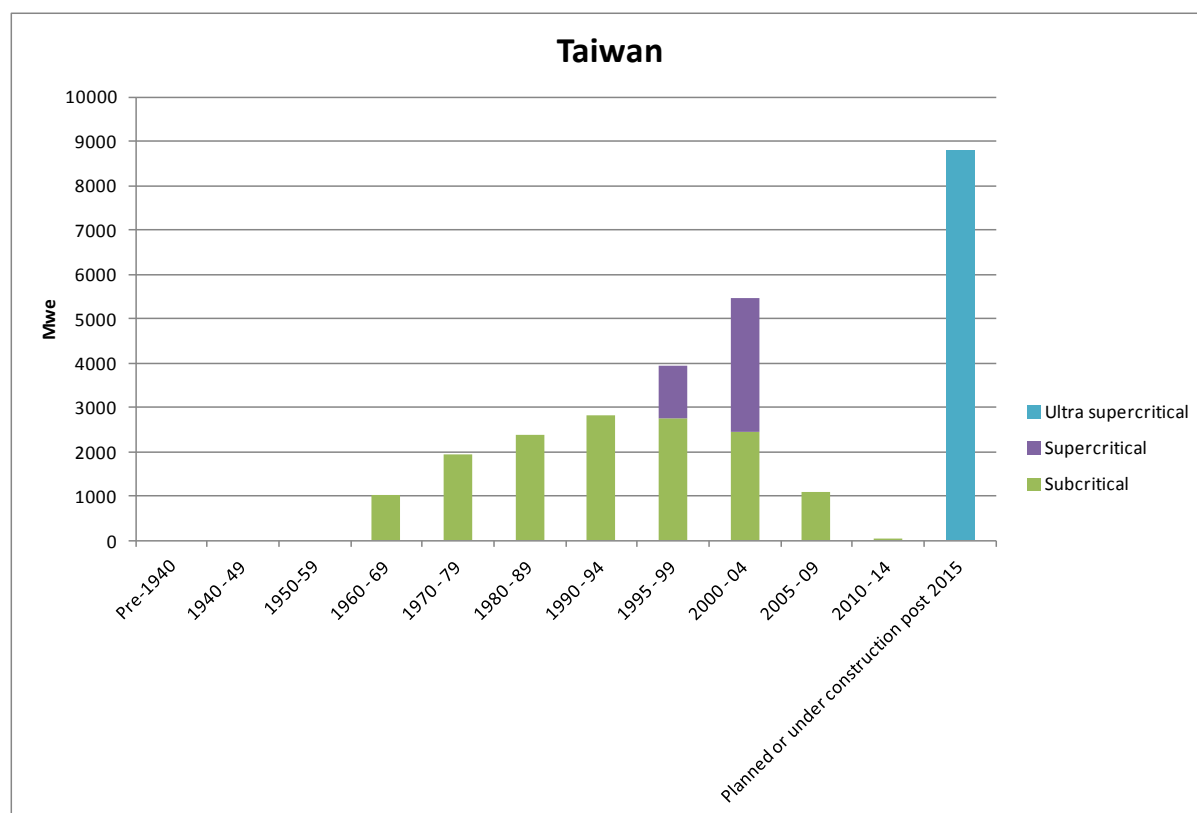


Figure 8 – Taiwanese coal-fired power plant by age and steam cycle conditions

| Table 9 Thai coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|---|----------------------------|-------------|---------------|---------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 0 | 0 | 0 | 0 |
| 1960 - 69 | 0 | 0 | 0 | 0 |
| 1970 - 79 | 0 | 0 | 0 | 0 |
| 1980 - 89 | 624 | 624 | 0 | 0 |
| 1990 - 94 | 1405 | 1405 | 0 | 0 |
| 1995 - 99 | 1283 | 1283 | 0 | 0 |
| 2000 - 04 | 0 | 0 | 0 | 0 |
| 2005 - 09 | 1517 | 1517 | 0 | 0 |
| 2010 - 14 | 827 | 127 | 700 | 0 |
| Subtotal less planned | 5656 | 4956 | 700 | 0 |
| Planned or under construction post 2015 | 7760 | 560 | 600 | 600 |
| Total | 13416 | 5516 | 1300 | 600 |

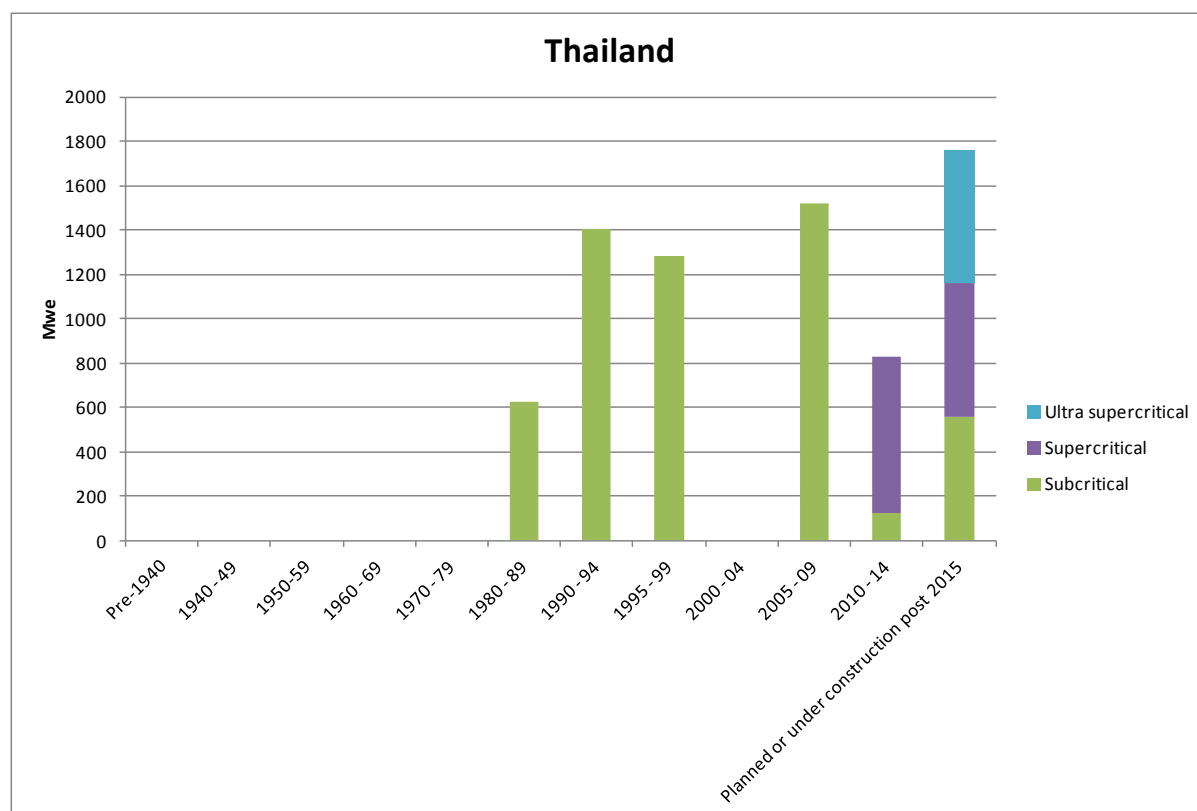


Figure 9 – Thai coal-fired power plant by age and steam cycle conditions

| Table 10 Vietnamese coal-fired power plant by age and steam cycle conditions (MWe) | | | | |
|--|----------------------------|-------------|---------------|---------------------|
| Period | All steam cycle conditions | Subcritical | Supercritical | Ultra-supercritical |
| Pre-1940 | 0 | 0 | 0 | 0 |
| 1940 - 49 | 0 | 0 | 0 | 0 |
| 1950-59 | 0 | 0 | 0 | 0 |
| 1960 - 69 | 55 | 55 | 0 | 0 |
| 1970 - 79 | 275 | 275 | 0 | 0 |
| 1980 - 89 | 468 | 468 | 0 | 0 |
| 1990 - 94 | 0 | 0 | 0 | 0 |
| 1995 - 99 | 0 | 0 | 0 | 0 |
| 2000 - 04 | 700 | 700 | 0 | 0 |
| 2005 - 09 | 620 | 620 | 0 | 0 |
| 2010 - 14 | 5004 | 3760 | 1244 | 0 |
| Subtotal less planned | 7122 | 5878 | 1244 | 0 |
| Planned or under construction post 2015 | 48800 | 11264 | 19136 | 1200 |
| Total | 55922 | 17142 | 20380 | 1200 |

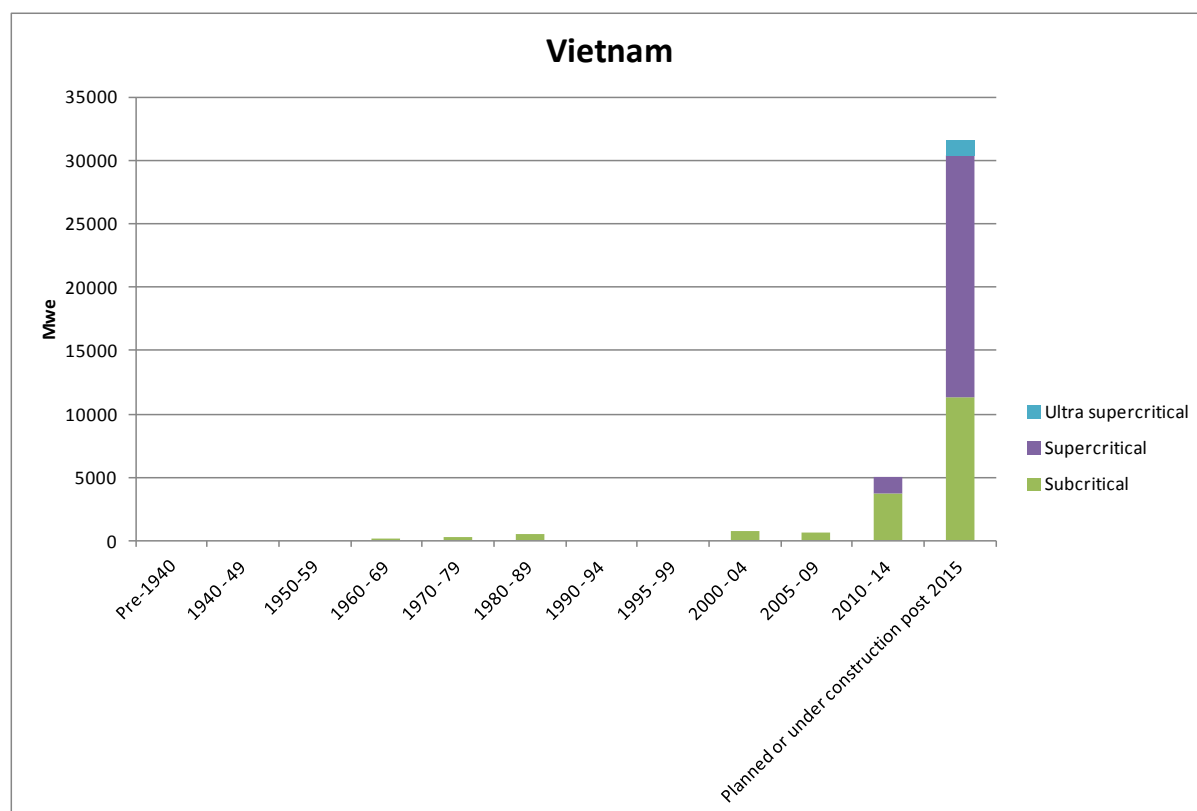


Figure 10 – Vietnamese coal-fired power plant by age and steam cycle conditions

2.2 Potential carbon dioxide emissions for plant planned, or under construction, post 2015 under three scenarios

In order to estimate the emissions of carbon dioxide from the planned plant, assumptions were made on the likely efficiency and load factor of these plants. These assumptions are those set out in Figure 2 of the original IEA CCC HELE report (Barnes, 2014) which is reproduced below.

Assumptions: An 800 MWe power station boiler burning hard coal and operating at a capacity factor of 80%. The unit will generate 6TWh electricity annually and emit the following quantities of carbon dioxide, depending on its steam cycle conditions and corresponding efficiency (LHV, net).

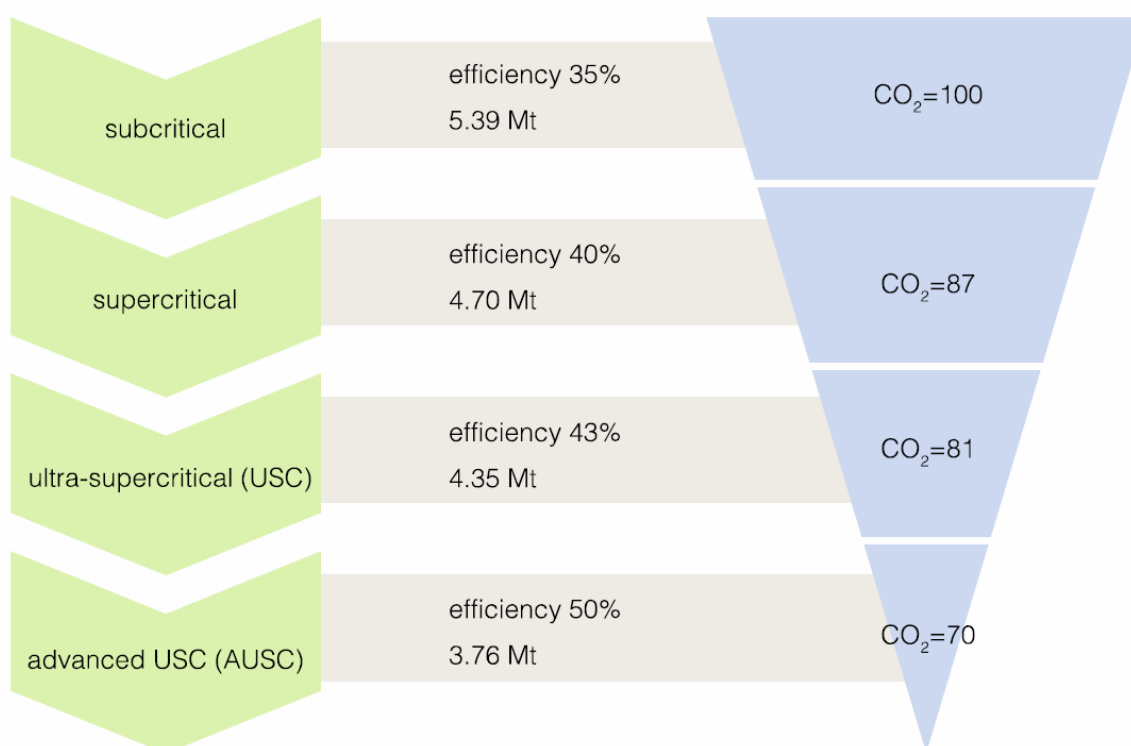


Figure 11 – The impact of HELE technologies on emissions of carbon dioxide

The plant planned, or under construction post 2015, and that reported for the periods 2004 – 2009 and 2009 – 2014 for the ten countries is summarised in Table 11 below. A significant proportion of the plant reported in Platts, post 2015, is uncategorised and so this has been assigned to one of the steam cycle groupings by choosing the cycle that features most prominently in the individual country plans (e.g. ultra-supercritical for China, supercritical for Indian etc.). The revised country data are set out in Table 12. Emissions of carbon dioxide were then calculated using the emission factors from Figure 11 and are summarised in Table 13 to and Figure 12 and Figure 13.

Table 11 Plant planned, or under construction post 2015 plant by country and steam cycle conditions (MWe)

| Country | Subcritical | Supercritical | Ultra-supercritical | Unassigned |
|-------------|-------------|---------------|---------------------|------------|
| China | 64065 | 143950 | 225338 | 50620 |
| Bangladesh | 425 | 0 | 5440 | 6001 |
| India | 79178 | 221065 | 16900 | 74555 |
| Japan | 826 | 400 | 7290 | 2600 |
| Malaysia | 1800 | 1000 | 4080 | 0 |
| Philippines | 12789 | 500 | 0 | 300 |
| South Korea | 1288 | 1290 | 15040 | 0 |
| Taiwan | 0 | 0 | 8800 | 8140 |
| Thailand | 560 | 600 | 600 | 6000 |
| Vietnam | 11264 | 19136 | 1200 | 17200 |

Table 12 Revised capacities after allocating unassigned plant post 2015 (MWe)

| Country | Subcritical | Supercritical | Ultra-supercritical | Total |
|-------------|-------------|---------------|---------------------|--------|
| China | 64065 | 143950 | 275958 | 483973 |
| Bangladesh | 425 | 0 | 11441 | 11866 |
| India | 79178 | 295620 | 16900 | 391698 |
| Japan | 826 | 400 | 9890 | 11116 |
| Malaysia | 1800 | 1000 | 4080 | 6880 |
| Philippines | 13089 | 500 | 0 | 13589 |
| South Korea | 1288 | 1290 | 15040 | 17618 |
| Taiwan | 0 | 0 | 16940 | 16940 |
| Thailand | 560 | 600 | 6600 | 7760 |
| Vietnam | 11264 | 36336 | 1200 | 48800 |

| Table 13 Projected annual carbon dioxide emissions by country and steam cycle post 2015 (M tonnes) | | | | |
|--|-----------------|-------------|-------------------------|------------------------------|
| If planned capacity is: | All subcritical | As reported | All ultra-supercritical | Total planned capacity (MWe) |
| China | 3261 | 2574 | 2275 | 483973 |
| Bangladesh | 80 | 57 | 56 | 11866 |
| India | 2639 | 2350 | 1841 | 391698 |
| Japan | 75 | 54 | 52 | 11116 |
| Malaysia | 46 | 37 | 32 | 6880 |
| Philippines | 92 | 91 | 64 | 13589 |
| South Korea | 119 | 87 | 83 | 17618 |
| Taiwan | 114 | 80 | 80 | 16940 |
| Thailand | 52 | 38 | 36 | 7760 |
| Vietnam | 329 | 295 | 229 | 48800 |

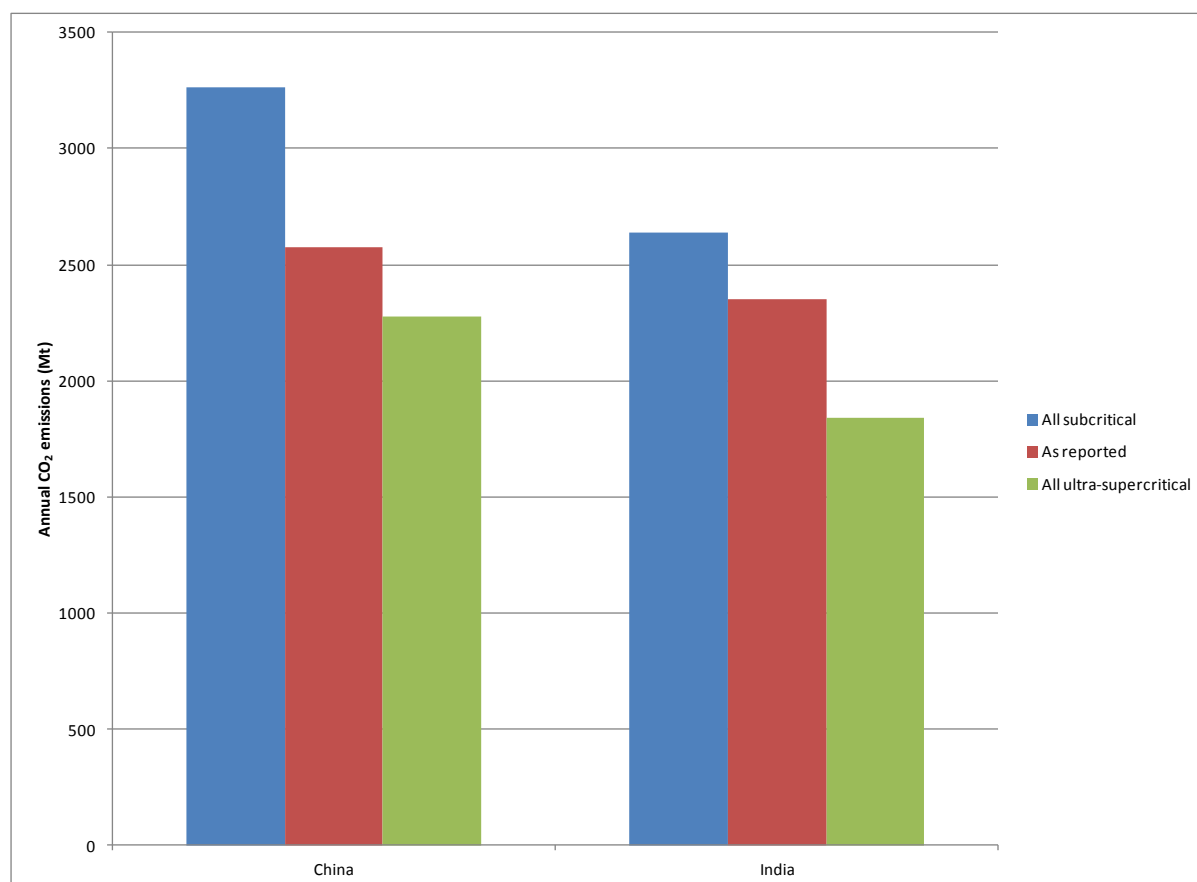


Figure 12 – Projected annual carbon dioxide emissions, China and India, by steam cycle (M tonnes)

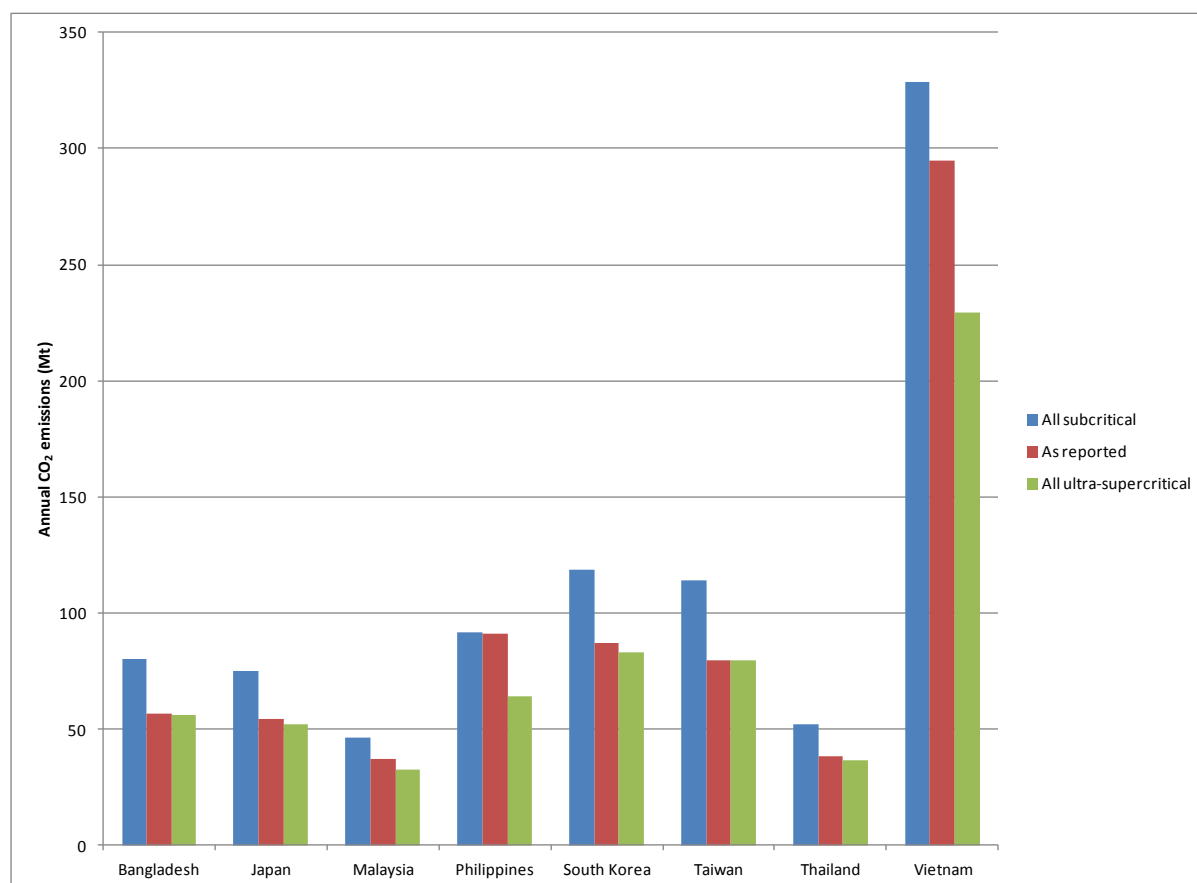


Figure 13 – Projected annual carbon dioxide emissions by country (less China and India) and steam cycle (Mt tonnes)

The exercise was then repeated for each country focussing on plant reported for the two five year periods 2005 – 2009 and 2010 – 2014. The fleet profiles are summarised in Table 14 and the estimated carbon dioxide emissions in Table 15 and Table 16 and Figure 14 to Figure 17. A small amount of unassigned plant has been included in the appropriate steam cycle total using the assumptions outlined earlier.

| Table 14 Coal fleet profiles 2004 – 2009, and 2010 - 2014 by country and steam cycle conditions (MWe) | | | | |
|---|-------------|---------------|---------------------|--------|
| Country (Period) | Subcritical | Supercritical | Ultra-supercritical | Total |
| China (2005-2009) | 192525 | 102490 | 33590 | 328605 |
| China (2010-2014) | 73859 | 86970 | 99116 | 259945 |
| Bangladesh (2006-2009) | 250 | 0 | 0 | 250 |
| Bangladesh (2010-2014) | 0 | 0 | 0 | 0 |
| India (2005-2009) | 23255 | 0 | 0 | 23255 |
| India (2010-2014) | 57260 | 24535 | 0 | 81795 |
| Japan (2005-2009) | 1022 | 507 | 600 | 2129 |
| Japan (2010-2014) | 16 | 0 | 2500 | 2516 |
| Malaysia (2005-2009) | 4019 | 0 | 0 | 4019 |

| | | | | |
|-------------------------|------|------|------|------|
| Malaysia (2010-2014) | 0 | 0 | 0 | 0 |
| Philippines (2005-2009) | 308 | 0 | 0 | 308 |
| Philippines (2010-2014) | 1298 | 0 | 0 | 1298 |
| South Korea (2005-2009) | 100 | 0 | 6815 | 6915 |
| South Korea (2010-2014) | 727 | 1740 | 0 | 2467 |
| Taiwan (2005-2009) | 1100 | 0 | 0 | 1100 |
| Taiwan (2010-2014) | 50 | 0 | 0 | 50 |
| Thailand (2005-2009) | 1517 | 0 | 0 | 1517 |
| Thailand (2010-2014) | 127 | 700 | 0 | 827 |
| Vietnam (2005-2009) | 620 | 0 | 0 | 620 |
| Vietnam (2010-2014) | 3760 | 1244 | 0 | 5004 |

Table 15 Estimated annual carbon dioxide emissions by country and steam cycle 2005 – 2009 (M tonnes)

| If planned capacity is: | All subcritical | As reported | All ultra-supercritical | Total fleet capacity (MWe) |
|-------------------------|-----------------|-------------|-------------------------|----------------------------|
| China | 2214 | 2057 | 1544 | 328605 |
| India | 157 | 157 | 109 | 23255 |
| Bangladesh | 2 | 2 | 1 | 250 |
| Japan | 14 | 13 | 10 | 2129 |
| Malaysia | 27 | 27 | 19 | 4019 |
| Philippines | 2 | 2 | 1 | 308 |
| South Korea | 47 | 33 | 33 | 6915 |
| Taiwan | 7 | 7 | 5 | 1100 |
| Thailand | 10 | 10 | 7 | 1517 |
| Vietnam | 4 | 4 | 3 | 620 |

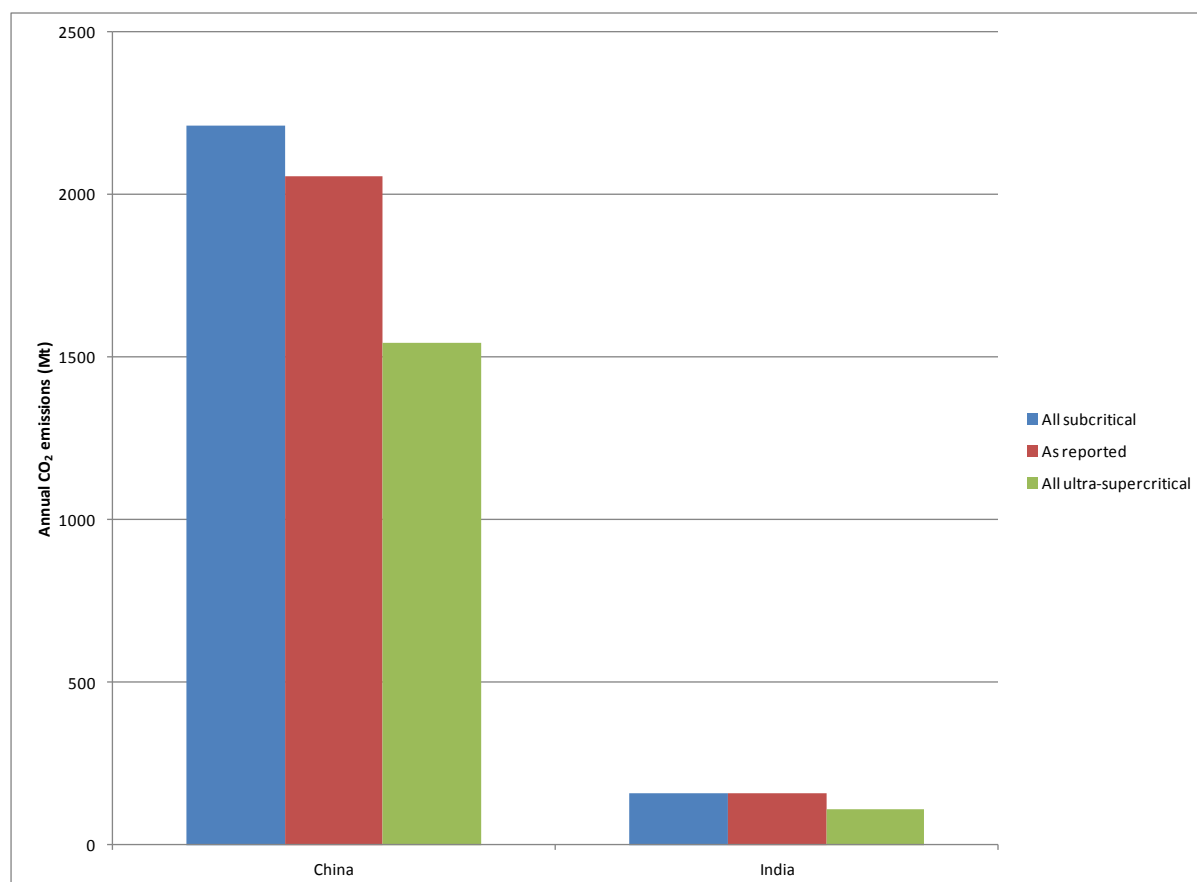


Figure 14 – Estimated annual carbon dioxide emissions, China and India, by steam cycle 2005 – 2009 (M tonnes)

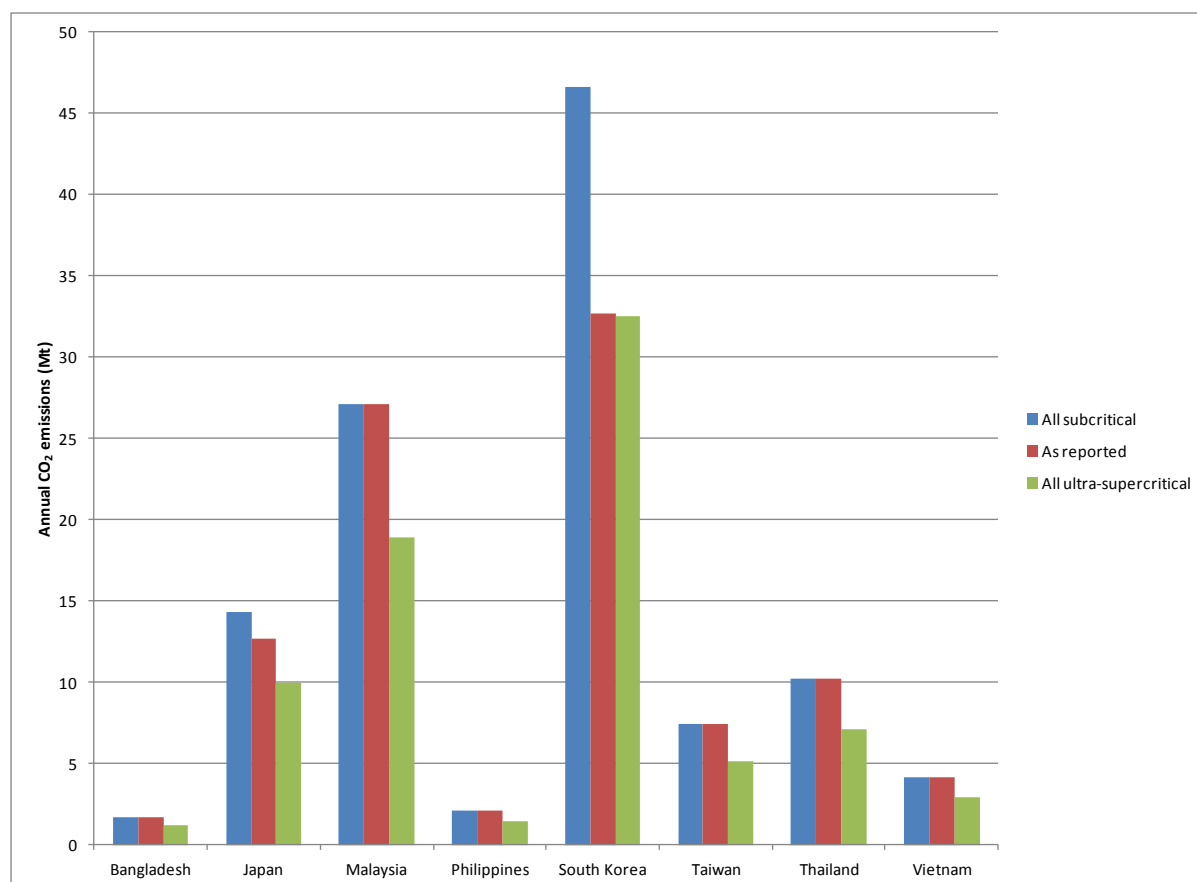


Figure 15 – Estimated annual carbon dioxide emissions by country (less China and India) and steam cycle 2005 – 2009 (M tonnes)

| If planned capacity is: | All subcritical | As reported | All ultra-supercritical | Total fleet capacity (MWe) |
|-------------------------|-----------------|-------------|-------------------------|----------------------------|
| China | 1751 | 1474 | 1222 | 259945 |
| India | 551 | 530 | 384 | 81795 |
| Bangladesh | 0 | 0 | 0 | 0 |
| Japan | 17 | 12 | 12 | 2516 |
| Malaysia | 0 | 0 | 0 | 0 |
| Philippines | 9 | 9 | 6 | 1298 |
| South Korea | 17 | 15 | 12 | 2467 |
| Taiwan | 0 | 0 | 0 | 50 |
| Thailand | 6 | 5 | 4 | 827 |
| Vietnam | 34 | 33 | 24 | 5004 |

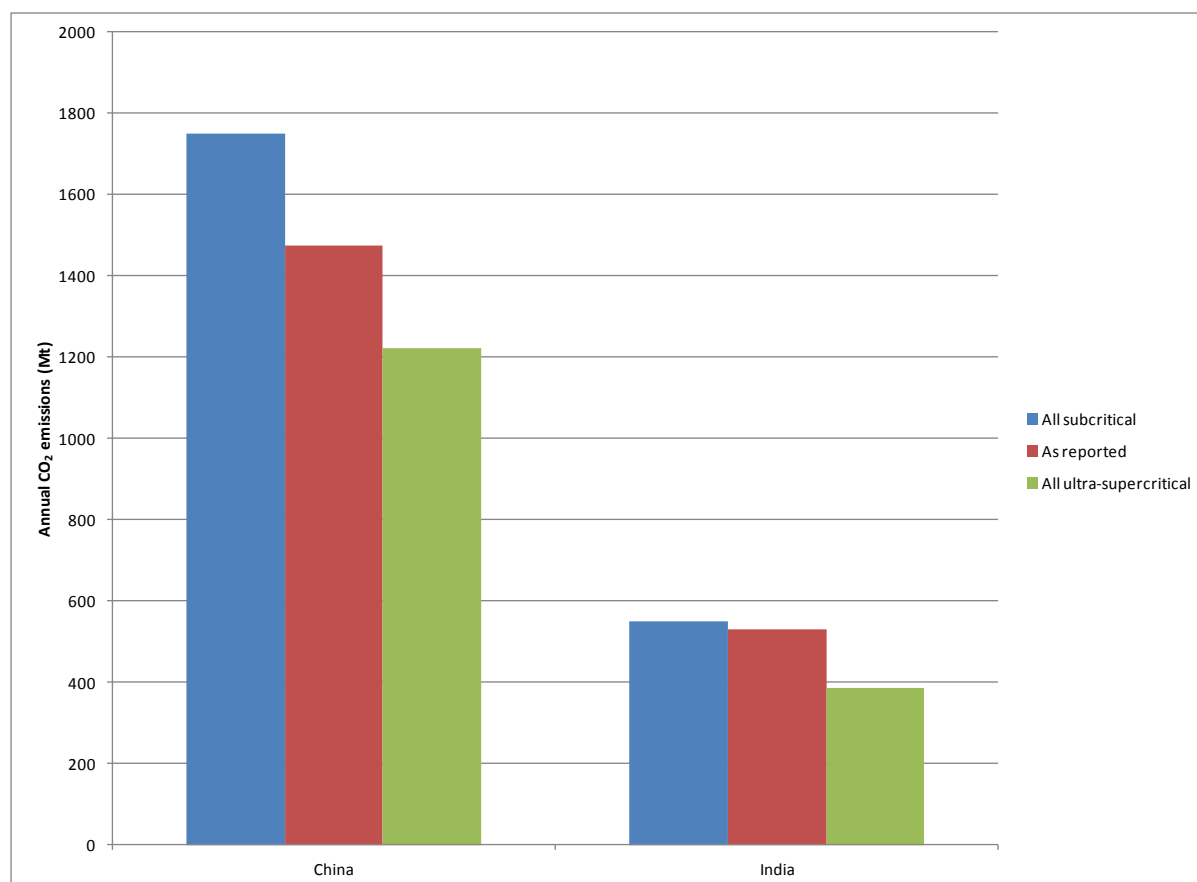


Figure 16 – Estimated annual carbon dioxide emissions, China and India, by steam cycle 2010 – 2014 (Mt tonnes)

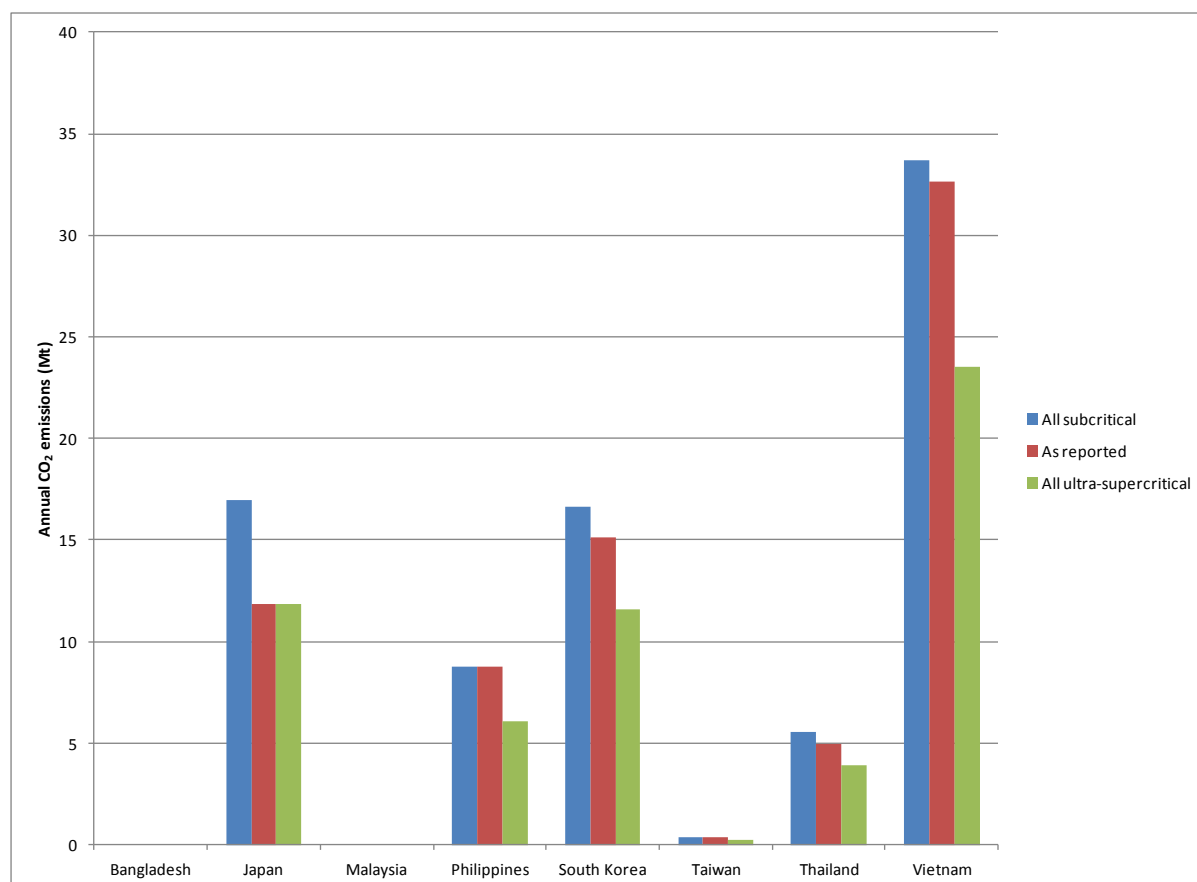


Figure 17 – Estimated annual carbon dioxide emissions by country (less China and India) and steam cycle 2010 – 20014 (M tonnes)

3 Comments

An inspection of the projected emissions of carbon dioxide shows that significant savings may be achieved in all cases by incorporating HELE plant over subcritical capacity. Even when comparing the “as reported” planned future coal fleet mix (post 2015), relative and absolute savings may be possible in many cases, even for China which is leading the way in the use of advanced steam cycles. The most significant savings are projected for the Indian power sector where the adoption of a fully ultra-supercritical coal fleet over the planned “as reported” build profile could achieve savings of 509 Mtonnes carbon dioxide annually (over 20%). Even the Philippines’ relatively modest coal fleet could achieve absolute savings of almost 30% by adopting the most efficient plant.

The assumptions used in this short study are considered adequate for the comparison of relative emissions from the ten countries studied, but for more detailed analysis it is recommended that a more complete study is undertaken of the scope and depth of “Upgrading the efficiency of the world's coal fleet to reduce CO₂ emissions” (Barnes, 2014).

4 References

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