12 January 2022

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| **To** |  | **From** |  |
| **Client:** | Adam Bandt MP | **Name:** |  |
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**Annual emissions from proposed fossil fuel projects listed in REMP**

Thank you for your question relating to emissions from fossil fuel reserves in Australia, received on Friday 10 December 2021 by email.

As confirmed in our subsequent emails, you have asked for a brief on the quantity of embedded emissions in any coal, oil and gas projects that have not yet commenced extraction operations, restricted to those which are listed in the Department of Industry, Science, Energy and Resources publication *Resources and Energy Major Projects* (*REMP*).

You requested this information by 17 January 2022.

* **Caveat**

Emissions estimates are based on a number of assumptions as detailed below and are contestable. Emissions vary depending on how products are used, which introduces significant uncertainty to estimates of emissions. The approach taken below relies on using emission factors and standardised energy content factors for coal, oil and gas. Several projects listed in *REMP* are described as producing a mix of commodities but *REMP* does not provide information on the proportions for each commodity. To enable inclusion of these projects in our estimates, we have made assumptions about these proportions which increase uncertainty. The estimates we have provided should therefore be used with caution.

We have estimated emissions based on the production capacities listed in *REMP*. Therefore, we are unable to determine if these figures include the energy required for the extraction and transport of these resources or any fugitive emissions released during these processes.

It is possible that using *REMP* may result in some double-counting of emissions. For instance, the listed project ‘Pluto Expansion (Train 2)’ appears to be a proposed LNG train which will, at least in part, be supplied from the proposed project at the Scarborough gas field. Therefore, we have not included the emissions from the Pluto Expansion (Train 2) in our estimations but have included those from the Scarborough gas field. We have marked those projects which may not necessarily represent extraction of new fossil fuels with an ^ symbol in the attached spreadsheet and have excluded them from our estimations.

We note you originally requested a brief on emissions from projects that have not yet commenced extraction operations. *REMP* includes projects at various stages of development (including some listed as ‘Completed’). It also includes expansions and reactivations of existing projects. We have retained this information on the attached spreadsheet and added filtering to enable you to discount these projects if desired.

As discussed in our email correspondence on Monday 13 December, *REMP* does not generally list the total estimated production or expected lifespan for listed projects and instead favours listing annual capacity. However, there are numerous projects listed in *REMP* that either do not have any capacity listed or appear to list only a total production capacity. We are unable to account for the former projects; we have not included the latter projects in our calculations and have marked them with an \* symbol in the attached spreadsheet.

Projects listed in *REMP* provide estimated production only. We are unable to analyse these production assumptions. We note that the ultimate development of projects is subject to various investment decisions, approvals processes and market conditions.

* **Annual emissions from proposed fossil fuel projects listed in REMP**

The Australian National Greenhouse Account Factors explains how the estimation of emissions is performed using emissions factors:

Emission factors for calculating direct emissions are generally expressed in the form of a quantity of a given GHG emitted per unit of energy (kg CO2-e/GJ), fuel (t CH4/t coal) or a similar measure. Emission factors are used to calculate GHG emissions by multiplying the factor (e.g. kg CO2/GJ energy in petrol) with activity data (e.g. kilolitres × energy density of petrol used).

We used this method to estimate the emissions potentially associated with coal, oil and gas projects listed in the [report data](https://www.industry.gov.au/sites/default/files/December%202021/document/resources-and-energy-major-projects-report-2021-data.xlsx) of the Resources and Energy Major Projects publication (*REMP*). As detailed below, we estimated the energy content of the annual production volumes of these commodities, given in REMP, assuming all fuels were combusted. We then used emissions factors (emissions per unit energy) to estimate the emissions from the annual energy production from these projects.

* ***Energy content of REMP projects***

As detailed below, we estimated the energy generated from projects listed in *REMP*, on the assumption that all were combusted. We caution that this is not necessarily the outcome for exports from these projects and that different uses may have different emissions outcomes. For example, some may be used as industrial feedstocks rather than fuels. However, we are unable to determine the breakdown of uses for each project—and this introduced significant uncertainty into this approach. The results of these estimations are shown in the attached spreadsheet.

Additionally, some projects listed in *REMP* may not necessarily represent extraction of new fossil fuels (marked with an ^ symbol in the attached spreadsheet). For example, *REMP* lists several projects which are described as LNG import terminals, which we have excluded from our estimates.

* **Coal**

Coal quality varies between different mines and regions in Australia. Therefore, we have used an average energy content of black thermal coal types of 25.7 GJ/t (bituminous coal, sub–bituminous coal and anthracite, Table 1 of the [National Greenhouse Accounts Factors HYPERLINK "https://www.industry.gov.au/sites/default/files/August%202021/document/national-greenhouse-accounts-factors-2021.pdf"August 2021](https://www.industry.gov.au/sites/default/files/August%202021/document/national-greenhouse-accounts-factors-2021.pdf) p. 10).

For metallurgical (coking) coal, we used the energy factor 30 GJ/t as listed in Table 1 of the National Greenhouse Accounts Factors (p. 10).

Several projects in *REMP* are listed as ‘Thermal and metallurgical coal’. We have therefore averaged the above energy contents on the assumption these projects will produce a mix of these commodities, however we caution we are unable to verify this assumption or what proportion would be most appropriate. The averaged energy content used was 27.85 GJ/t.

We note that the gross energy content listed for these coal types, as listed in Table 5.4 of the [Guide to Australian Energy Statist HYPERLINK "https://www.energy.gov.au/sites/default/files/Guide%20to%20the%20Australian%20Energy%20Statistics%202021\_0.docx"i HYPERLINK "https://www.energy.gov.au/sites/default/files/Guide%20to%20the%20Australian%20Energy%20Statistics%202021\_0.docx"cs 2021](https://www.energy.gov.au/sites/default/files/Guide%20to%20the%20Australian%20Energy%20Statistics%202021_0.docx) (p. 22) are different (e.g. thermal coal for export is 27 GJ/t and metallurgical coal for export is 29 GJ/t).

* **Gas**

Gas quality varies between different fields in Australia. *REMP* lists natural gas projects using energy units, which we have converted to GJ per year as shown in the attached spreadsheet.

Additionally, as shown in the attached spreadsheet (marked with an \* symbol), several projects listed in REMP do not list an annual rate of production—only a raw number. We are unable to confirm whether this number should be an annual or total figure. Therefore, we have omitted these cases from our estimates.

* **Liquefied Natural Gas (LNG)**

*REMP* lists liquefied natural gas (LNG) projects using two different units (weight and volume).

As detailed in the attached spreadsheet, we have converted the weight figure (mtpa or million tonnes per annum) using the energy content factor 54.4 GJ/t, drawn from Table 5.6 of the Guide to Australian Energy Statistics 2021 (p. 23). We note that this slightly differs from the value given by the [Santos Conversion Calculator](https://www.santos.com/conversion-calculator/) (55.5 GJ/t).

As detailed in the attached spreadsheet, we have converted the volume figure (mmcfd or million cubic feet per day) using the Santos Conversion Calculator. We are unable to independently verify the accuracy of the Santos Conversion Calculator. The Santos Conversion Calculator gives the conversion 1 mmcfd = 1.195 TJ/day.

* **Oil**

Oil quality varies between different fields and therefore we have used an average energy content. *REMP* lists oil projects using two different units (bbl/d and kbpd; barrels per day and thousand barrels per day). We have assumed the listed production capacity for the oil projects in *REMP* represents crude oil production only but are unable to verify this assumption.

As detailed in the attached spreadsheet, we have converted this volumetric figure using the conversion 1 bbl = 159 L drawn from the Santos Conversion Calculator and the energy content factor 37 MJ/L drawn from Table 5.6 of the Guide to Australian Energy Statistics 2021 (p. 23).

* **Gas/Oil**

*REMP* lists one project under the category of ‘Gas/Oil’, producing 18 PJ pa. As this is already a unit of energy, we have converted this to GJ per year, as shown in the attached spreadsheet.

* **Gas/LNG**

*REMP* lists several projects under the category of ‘Gas/LNG’. Two of these projects are listed using energy units (TJ/d), which we have converted to GJ per year in the attached spreadsheet. Of these projects, both appear to involve new extraction.

Two additional projects (Scarborough and Transborders Energy's Generic FLNG Solution) are listed using units of weight (mtpa). As detailed in the attached spreadsheet, we have converted the weight figure (mtpa) using the energy content factor 54.4 GJ/t, drawn from Table 5.6 of the [Guide to Australian Energy Statistics 2021](https://www.energy.gov.au/sites/default/files/Guide%20to%20the%20Australian%20Energy%20Statistics%202021_0.docx) (p. 23).

The Scarborough project appears to involve new production of natural gas, which will be converted into LNG via the Pluto facility. We note that *REMP 2021* lists the annual capacity of Scarborough at 44,477 mtpa, however this is significantly and unrealistically higher than the estimate listed in *REMP 2020* of 7-9 mtpa. Woodside’s webpage on the [Scarborough project](https://www.woodside.com.au/what-we-do/australian-growth-projects/scarborough) indicates ‘approximately five million tonnes per annum (Mtpa) of Scarborough gas will be processed through Pluto Train 2, with up to 3 Mtpa processed through the existing Pluto Train 1’. Therefore, we have used the 8 mtpa figure.

The Transborders Energy Generic FLNG Solution refers to a floating conversion plant, which appears to involve the extraction of natural gas from fields otherwise ‘stranded’ (and thus unable to be extracted due to either economic or physical constraints). On the basis of this assumption, this project would represent new extraction. Based on reporting from Transborders Energy, we have assumed the final product will be LNG (rather than a mix of LNG and condensate). We are unable to estimate the quantity of natural gas consumed for the production of this LNG and can only estimate the energy and emissions released from the combustion of the project’s final LNG product.

* **Gas/LNG/condensate/LPG**

*REMP* lists a single project as ‘Gas/LNG/condensate/LPG’ (marked with an # symbol in the attached spreadsheet) and assigns a weight value (mtpa). *REMP* does not provide a breakdown of the proportion of projected production for each product, and we were unable to find one on the project website. While the project [website](https://www.woodside.com.au/what-we-do/australian-growth-projects/browse) lists contingent resources for dry gas and condensate, it is unclear whether the project aims to fully extract these resources and what relation these figures have to the *REMP* figure. Therefore, we have not attempted to estimate the energy content and consequently the emissions generated by this project.

* ***Emissions per unit energy***

Having estimated the annual energy content associated with these projects as detailed above, we then used standard emissions factors (as detailed below) to estimate the emissions from the combustion of these products, as detailed in the attached spreadsheet. We continued the assumption that all products from these projects were combusted. Emissions vary depending on the type of fuel being combusted, therefore we estimated emissions factors for each export category. The results of these estimations for each project are detailed in the attached spreadsheet and high-level summaries are shown in Table 1, below.

* **Coal**

For black thermal coal, we used the greenhouse gas emissions factor of 90.24 kilograms of carbon dioxide equivalent per gigajoule of coal consumed (kg CO2-e/GJ), drawn from Table 1 of the [National Greenhouse Accounts Factors HYPERLINK "https://www.industry.gov.au/sites/default/files/August%202021/document/national-greenhouse-accounts-factors-2021.pdf"August 2021](https://www.industry.gov.au/sites/default/files/August%202021/document/national-greenhouse-accounts-factors-2021.pdf) (p. 10), noting that all types of black thermal coal share the same emissions factor.

For metallurgical coal, we used the greenhouse gas emissions factor of 92.03 kg CO2-e/GJ, drawn from Table 1 of the National Greenhouse Accounts Factors August 2021 (p. 10).

For projects listed as ‘thermal and metallurgical coal’, we averaged the two emissions factors on the unverified assumption these projects will produce equal proportions of these commodities. The averaged emissions factor used is 91.14 kg CO2-e/GJ.

* **Gas**

For natural gas, we used the greenhouse gas emissions factor of 51.53 kg CO2-e/GJ, drawn from Table 2 of the National Greenhouse Accounts Factors August 2021 (p. 13), as detailed in the attached spreadsheet.

* **LNG**

For LNG, we used the greenhouse gas emissions factor of 51.53 kg CO2-e/GJ, drawn from Table 2 of the National Greenhouse Accounts Factors August 2021 (p. 13). The attached spreadsheet details our estimates for the emissions resulting from the combustion of projects listed in *REMP* as ‘LNG’.

* **Oil**

For oil, we used the greenhouse gas emissions factor of 69.88 kg CO2-e/GJ, drawn from Table 3 of the National Greenhouse Accounts Factors August 2021 (p. 15). The attached spreadsheet details our estimates for the emissions resulting from the combustion of crude oil from projects listed in *REMP* as ‘oil’.

* **Gas/Oil**

For the single project listed as ‘Gas/Oil’, without a breakdown of how much of the energy produced is from natural gas and how much is from crude oil, we have assumed the total energy from this project will be evenly proportioned between these two fossil fuels and have consequently estimated a greenhouse gas emission factor based on the average of that for gas and oil listed above. This gives an emissions factor of 60.71 kg CO2-e/GJ; the application of which is detailed in the attached spreadsheet. We caution we are unable to verify this assumption.

* **Gas/LNG**

The emissions factors for gas and LNG drawn from Table 2 of the National Greenhouse Accounts Factors August 2021 (p. 13) are identical (51.53 kg CO2-e/GJ). The attached spreadsheet details their application to *REMP* projects listed as ‘Gas/LNG’.

* ***Total emissions from REMP projects***

The attached spreadsheet details our estimations of the annual energy content and emissions generated by full combustion of the coal, oil, and gas products from projects listed in the latest *REMP*. Table 1, below, shows a high-level summary of our estimations. We note that these results are subject to the assumptions and caveats outlined above.

* **Table 1: Energy and emissions from REMP projects**

|  |  |  |
| --- | --- | --- |
| **Resource** | **Energy per year (GJ)** | **Emissions per year (Mt CO2-e)** |
| Metallurgical coal | 2,632,200,000 | 242.24 |
| Thermal and metallurgical coal | 5,132,755,000 | 467.77 |
| Thermal coal | 5,122,010,000 | 513.23 |
| Gas | 493,845,000 | 25.45 |
| LNG | 555,465,000 | 28.62 |
| Oil | 292,461,579 | 20.44 |
| Gas/oil | 18,000,000 | 1.09 |
| Gas/LNG | 629,950,000 | 32.46 |

* **Feedback**

Please contact the author if you would like further information or explanation.

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