VICTORIAN ENERGY UPGRADES SUBMISSION

This is my submission regarding Victorian Energy Upgrades.

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> *"There is no pathway to stabilizing the climate without phasing gas out of our homes and buildings.*
> *This is a must-do for the climate and a liveable planet"*
>
> Rachel Golden
> Sierra Club
> 2019

Executive summary

- The VEU scheme's chosen emission factor for mains gas is incorrect because it is based on invalid assumptions;
- The current emission factor value is 55.2kgCO2e/GJ;
- Emissive impact of methane has been revised upward as the scientific measurements improve;
- Calculation of an emission factor should use the 20-year GWP for methane;
- System methane releases should be re-examined conservatively to help inform calculation of a more plausible emission factor;
- A more reasonable emission factor for gas would appear to exceed the current value by a factor of about 2.4x;
- Selection of a higher gas emission factor for the scheme would give greater incentive to reduce gas use, and to help strategically switch from gas to electricity for some activities;
- The implications of a changed emission factor for gas are much broader than the VEU program.

Current emissions factors and assumptions

The central role of emissions factors. The VEU scheme aims to reduce carbon emissions in Victoria. Where those reduced emissions arise from reduced use of grid energy (electricity and gas), the application of an appropriate emission factor is fundamental to reckoning the avoided emissions. In the latest RIS, the emissions factors associated with grid electricity are adjusted downward to reflect the reduced emission intensity in a rapidly greening electricity grid. **However, VEU nominal gas emissions intensity is left unchanged at 55.2 kg/GJ.** This value purports to include fugitive emissions.

Total emissions. Derived emissions intensity is a function of two factors – direct combustion emissions, and emissive impact of release of unburned gas (usually referred to as *fugitives*).

Combustion emissions. Perfect combustion emissions, by first principles, is 49.5kgCO2/GJ. This is assuming energy content of 55.5MJ/kg[1] and a stoichiometric mass ratio of 2.744 kgCO2/kgCH4.

Methane release. Normal method of calculating the proportional impact of the released methane (so-called fugitive emissions) involves applying a GWP of 25 (kgCO2e/kgCH4). By first-principles calculation, the VEU scheme intensity of 55.2kg/GJ would seem to correspond to a net assumed release rate of about 1.45%[2]. Hence, at face value, the net impact of the released methane is a mere 11.5%[3] increase.

Re-thinking assumptions

GWP

Australian government reckoning. Official reckoning of the GWP of methane follows Australian Greenhouse Accounts Factors[4] (as updated from time to time). Currently this reckons GWP to be 25 (see Figure 1).

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[1] https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html
[2] Author's calculations.
[3] 11.5% is from the ratio of 55.2 to 49.5.
[4] National Greenhouse Accounts Factors, August 2019, https://www.environment.gov.au/system/files/resources/cf13acc9-c660-445e-bd82-3490d74e9d09/files/national-greenhouse-accounts-factors-august-2019.pdf

Appendix 1 Greenhouse Gas Global Warming Potentials

The Global Warming Potential (GWP) is an index used to convert relevant non-carbon dic gases to a carbon dioxide equivalent (CO_2-e) by multiplying the quantity of the gas by its GWP in Table 30 below.

Table 30: Global Warming Potentials

Gas	Chemical formula	Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous oxide	N_2O	298

Figure 1: GWP of methane, according to National Greenhouse Accounts Factors

IPCC reckoning. In Assessment Report 5 (2014), WG1 Chapter 8, the IPCC reckon the GWP to be 28 over 100 years, or 84 over 20 years, assuming no climate-carbon feedbacks. If climate-carbon feedbacks are included the values are 34 and 86 respectively (see Figure 2).

Table 8.7 | GWP and GTP with and without inclusion of climate–carbon feedbacks (cc fb) in response to emissions of the i response to the reference gas CO_2 are always included).

	Lifetime (years)		GWP_{20}	GWP_{100}
CH_4[b]	12.4[a]	No cc fb	84	28
		With cc fb	86	34
HFC-134a	13.4	No cc fb	3710	1300
		With cc fb	3790	1550
CFC-11	45.0	No cc fb	6900	4660
		With cc fb	7020	5350
N_2O	121.0[a]	No cc fb	264	265
		With cc fb	268	298
CF_4	50,000.0	No cc fb	4880	6630
		With cc fb	4950	7350

Figure 2: IPCC reckoning of GWP

More recent research. It seems likely that the IPCC will further revise upwards its value for the methane GWP based on recent research[5] which now calculates the radiative forcing of methane 14% higher than the estimates used in IPCC AR5. IPCC AR6 is in work at the moment.

The 100-year time horizon. The choice to use of the GWP corresponding to a 100-year time horizon seems arbitrary and needs to be re-considered in light of the timeframe for effective action. I am not aware of any current credible assessments that suggest that there is a century available for action. The use of a twenty-year time horizon is arguably more in line with the very short time available for effective action to reduce emissions for the sake of a safe climate.

Recommendation: A twenty-year GWP of 84 (at least) needs to be used, instead of a hundred-year GWP of 25 since the impact of methane is very high within the timeframe still available for effective climate mitigation.

Methane release

There are points of direct methane release throughout the entire network of production, processing, distribution, and consumption. As discussed, the emissions factor would appear to correspond to an assumed release rate of 1.45%. Analysis by the University of Melbourne[6] gives cause to doubt the current assumptions, as discussed below.

The Scope 3 emissions associated with release in production, processing, transmission, distribution and consumption need to be added to get the total impact of using gas. In Victoria, the official reckoning is 3.0% gas unaccounted for in distribution alone, of which 55% is assumed to be leakage[7].

Gas release examples. The release of methane arises at many points referred to as *fugitive emissions*. There are also separate *migratory emissions* which can arise as a result of gas production. In addition, there is a common practice of deliberate venting of methane from points including de-watering pipelines. These latter emissions may not always be fully accounted for in emissions reckoning.

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[5] Etminam, M., et al, "Radiative forcing of carbon dioxide, methane, and nitrous oxide: A significant revision of the methane radiative forcing", Geophysical Research Letters, 2016-12-27.

[6] Lafleur, D., et al, "A review of current and future methane emissions from Australian unconventional oil and gas production", October 2016, University of Melbourne",
http://climatecollege.unimelb.edu.au/files/site1/docs/6032/20161023%20Review%20of%20Methane%20Emissions.pdf pp51

[7] National Greenhouse Accounts – Factors, August 2019, Table 19.

Figure 0-3: Methane emissions from gas-well de-watering pipeline (Source: Tim Forcey)

Gas release – impact. The climate impact of methane becomes more significant because of the emissions from releasing methane, not just from the CO_2 arising from burning methane. Australian government estimate of release rates is 0.5% ([6]page 5). Industry's own estimate of leakage from gas fields is 0.1%[8]. The gulf between possible real rates of emission and Australian estimates is shown in Figure 0-4.

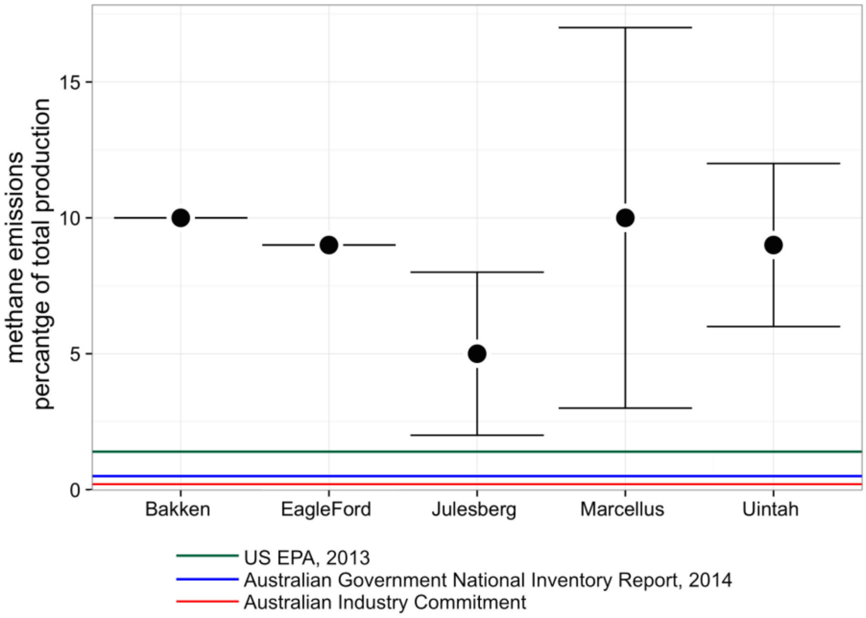

Figure 0-4: US gas-field leakage compared with Australian reporting (Source: Uni of Melbourne[6])

Estimating methane release. By some accounts, emission factors assume net methane release of 0.8%[9] in Victoria and 1.77% in metro Queensland. My own take on the literature is that plausible real-world, end-to-end release rates for methane emissions

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[8] http://www.abc.net.au/cm/lb/4421188/data/greenhouse-gas-emissions-study-of-australian-csg-to-lng-data.pdf, pp 52

[9] https://www.environment.gov.au/system/files/resources/5a169bfb-f417-4b00-9b70-6ba328ea8671/files/national-greenhouse-accounts-factors-july-2017.pdf, Table 38 (3.9 kgCO2e/GJ corresponds to 0.80%)

in Australia are in the range 5% to 7.5% [10,11,12] once the effect of unconventional gas extraction is included.

Emissions from gas 'conditioning'. The Victorian resource of fossil gas has declined in quality as new lower-quality fields[13] are brought online, leading to increased CO_2 content in the extracted gas. This led Esso and BHP to build a new facility at Longford to extract the CO_2 [14]. The facility was commissioned in 2017. The waste CO_2 that is extracted is deliberately and continuously vented to the atmosphere[15]. This facility is reported to be venting about 800,000 tonnes of CO_2 per annum[16]. Total facility operating emissions are reported to be about 1,000,000 tonnes per annum[17]. As the gas fields continue to deplete, the quality will further decline and the amount of CO_2 per unit of gas energy will continue to rise.

Downstream release. Release of gas includes from pipeline networks and even within premises. There is a lack of data in the Australian context. However, recent Californian data[18] suggest that in-premises leakage is "*an order of magnitude larger than current inventory estimates*" and "*equivalent to ~15% of (total gas) emissions*". In other recent US research[19,20] urban methane leakage was found to be at rates twice that reported in the EPA inventory. Equivalent Australian investigations are lacking.

> ***"Emissions from natural gas are found to be two to three times larger*** *than predicted by existing inventory methodologies and industry reports. Our findings suggest that natural-gas–consuming regions may be larger sources of methane to the atmosphere than is currently estimated and represent areas of significant resource loss."*
>
> Kathryn McKain, et al
> Proceedings of the National Academy of Science, 2015[20]

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10 'A review of current and future methane emissions from Australian unconventional oil and gas production: October 2016', http://climatecollege.unimelb.edu.au/files/site1/images/20161026%20Review%20of%20Methane%20Emissions.pdf,
11 https://renew.org.au/renew-magazine/climate-change/greenhouse-gas-footprint-of-gas/
12 https://phys.org/news/2019-06-industrial-methane-emissions-higher.html
13 New Bass Strait gas fields using the gas conditioning plant are known as Kipper, Tuna and Turrum.
14 https://www.abc.net.au/news/2017-05-07/longford-plant-will-boost-gas-production-esso-says/8504560
15 https://www.theage.com.au/business/esso-bhp-could-put-carbon-under-sea-20070320-ge4grv.html, and http://theoildrum.com/pdf/theoildrum_3180.pdf
16 https://www.melbournefoe.org.au/longford_gas_plant
17 https://www.theage.com.au/business/esso-bhp-could-put-carbon-under-sea-20070320-ge4grv.html, and http://theoildrum.com/pdf/theoildrum_3180.pdf
18 https://pubs.acs.org/doi/10.1021/acs.est.8b03217
19 Plant et al, "Large Fugitive Methane Emissions From Urban Centers Along the U.S. East Coast", https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2019GL082635, reported on here https://grist.org/article/natural-gas-leaks-are-a-much-bigger-problem-than-we-though
20 https://www.pnas.org/content/112/7/1941

Victorian vs Queensland gas

Historically all gas to Victoria has been locally sourced. Now a non-trivial and increasing proportion of gas consumed in Victoria is sourced from Queensland, especially in winter.

Since Queensland gas is used to make up shortfalls, it can be argued that the marginal unit of gas avoided by efficiency measures in Winter is more likely to be Queensland, not Victorian. As a result, the increased emission intensity associated with unconventional gas production also needs to be factored into the calculation of emissions factor for gas consumed in Victoria.

Combined impact

Applying reasonable assumptions about GWP and leakage makes a huge impact on the net emissions factor for gas. If we assume a GWP of 84 and net leakage of, say, 5% then the emissions factor would increase by a factor of 2.4x relative to the current value of 51.5kg/GJ. In other words, a more plausible emissions factor for gas is 128kg/GJ.

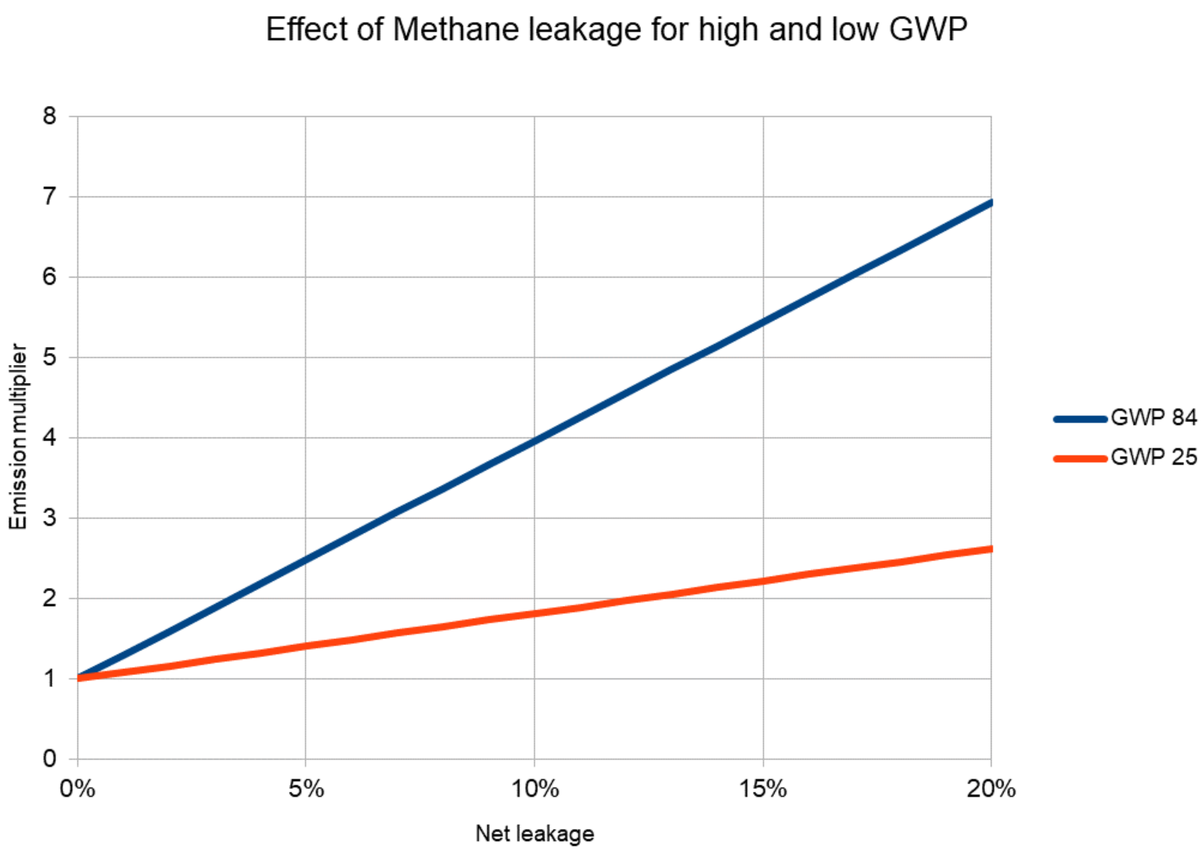

Figure 5: Effect of methane release on net emissive impact for different GWPs (source: author)

I am not drawing any conclusion about a specific actual rate of methane release or a specific alternative emission factor. However, there are sufficient grounds to safely conclude that actual net methane release is probably understated by a large margin. Further, the application of the precautionary principle would suggest that a low-ball estimate of emissions is not safe.

Recommendation. Possible sources of methane release across the entire gas system should be re-examined and conservative estimates applied. This can inform a new emission factor for gas.