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Ann Farr
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Via email to: SEIS@KalamaMfgFacilitySEPA.com

Dear Ms. Farr:

In February this year, we published a discussion brief in which we examined the climate implications of the proposed Kalama methanol facility. The brief, titled "Towards a climate test for industry: Assessing a gas-based methanol plant", has since been cited in the media and by other commenters on the Kalama facility.

Further, the new, Draft Supplemental Environmental Impact Statement (DSEIS) responds (indirectly) to the major critiques we had advanced in our discussion brief – critiques that were directed at the prior, Final Environmental Impact Statement (FEIS). In particular, the DSEIS, unlike the FEIS, now estimates upstream, fugitive methane losses associated with the gas supplied to the facility.

Because of these developments, we now find ourselves compelled to submit our own comments, attached, in order to help evaluate the improvements in the DSEIS.

Herein, we find that the DSEIS treatment of fugitive methane losses, though more comprehensive than in the FEIS, is still not credible. We also make further critiques, including related to the misplaced confidence that the DSEIS places in drawing a direct, causal connection between the planned production of the Kalama facility's methanol and the displacement of coal-based methanol in China.

We are grateful for the opportunity to provide these comments, and would be happy to answer any questions about them.

Sincerely,

Peter Erickson and Michael Lazarus
Senior Scientists
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SEI comments on Kalama DSEIS

Peter Erickson and Michael Lazarus, Stockholm Environment Institute (SEI) U.S. Center
December 27, 2018

In February this year, we published a discussion brief in which we examined the climate implications of the proposed Kalama methanol facility. The brief, entitled "Towards a climate test for industry: Assessing a gas-based methanol plant"[1], presented an approach for assessing whether the construction and operation of the facility would be consistent with internationally-agreed goals of keeping global temperature rise "well below 2 degrees C."[2]

We found that the facility's 2016 "Final" Environmental Impact Statement (FEIS)[3] provided an incomplete and deeply flawed analysis of GHG emissions associated with the facility. In our assessment, correcting these errors would increase the facility's annual emissions by a factor of two to six relative to the estimates in the FEIS. We also found that, even with these corrections, the facility could still reduce global GHG emissions if were to displace coal-based methanol, as proponents, Northwest Innovation Works (NWIW), have claimed.

However, we also found that other more widely used technologies can produce olefins – the precursor to plastics that proponents claim will be the ultimate (and only) destination for the facility's methanol output – would result in lower global emissions. Overall, our analysis suggested that the facility would be inconsistent with a deeply low-carbon future, risking the long-term lock-in of a technology (natural gas-to-methanol-to-olefins) that does not represent a low-emission means of producing plastics. It found the claims that the facility would only displace coal-based methanol less than compelling.

Since our discussion brief, a new Draft Supplemental EIS (DSEIS) was submitted by the Port of Kalama and Cowlitz County,[4] and additional information and studies relevant to the proposed Kalama methanol facility have been released.[5–8] Further, the project developer – Northwest Innovation Works – has disputed our report,[9] and an analysis they commissioned, by the Low Carbon Prosperity Institute, has commented on our findings.[5]

We have reviewed the new DSEIS, and make six observations below. The first three of these relate to "upstream" methane losses, since the DSEIS, though more comprehensive than in the FEIS, is still not credible in this regard. We then remark on the misplaced confidence that the DSEIS places in drawing a direct, causal connection between the planned production of the Kalama facility's methanol and the displacement of coal-based methanol in China. Our final two observations concern the consistency of the Kalama facility with a deeply low-carbon transition in line with the globally agreed goal to limit warming to 'well below 2 degrees C".

1 The DSEIS analysis of upstream natural methane loss rate is not credible.

In 2016, the FEIS made the serious error of assuming that the Kalama facility would lead to *no* upstream methane emissions from the production, gathering, processing, and transportation of natural gas. In doing so, the FEIS defied common practice.

Now, in 2018, the DSEIS has sought to remedy this error by including estimates of upstream methane emissions, but does so, once again, in a flawed manner that significantly underestimates these emissions.

Namely, the DSEIS uses outdated and inaccurate information for its assessment of the GHG emissions associated with the production, gathering, processing, and transportation of natural gas. As the DSEIS notes, the process of producing and transporting natural gas leads to GHG emissions – both methane

(CH_4) and carbon dioxide (CO_2) – from "fugitive losses" as well as ongoing emissions from operating the wells and gathering and processing infrastructure.

However, the DSEIS relies on the GHGenius model, which, according to the DSEIS, uses an implausibly low methane loss rate of 0.32% for gas from British Columbia.[i] That rate was self-reported by the Canadian Association of Petroleum producers in the year 2000 and was calculated using an incomplete bottom-up method that does not count all methane losses[10] – especially not those from irregular operations or accidental releases, which have since been found to be a substantial source of emissions from natural gas production.[11]

Further, both of the other sources of methane loss estimates listed in the DSEIS for B.C. gas suffer from similar limitations. The "G7 Study" is also a bottom-up analysis, has not yet undergone peer review, was conducted in Alberta (not BC as claimed in the DSEIS), and looked at a set of unique conditions that cannot be extrapolated to any other operator or region. Similarly, the DSEIS cites the B.C. government inventory – but this too uses a bottom-up method that misses large quantities of fugitive methane.[12]

By contrast to these bottom-up methods, more comprehensive and modern estimates of methane losses from the natural gas supply chain are much higher, about 2%, and are informed by top-down techniques, such as airplanes equipped with sensors that can capture the full range of operating conditions at gas extraction fields.[7,13]

In summary, we see little reason why methane loss rates from the gas provided to the Kalama facility (whether from Canada or the U.S.) would be lower than the current most comprehensive (yet still incomplete) estimate of 2.2%,[ii] published in the journal *Science* in 2018.[6]

2 The DSEIS choice of global warming potential for natural gas does not reflect recent science

Furthermore, the DSEIS uses an outdated figure for how methane contributes to global warming. Specifically, they use a value for methane's "global warming potential" of 25. (The number indicates how much more a molecule of methane contributes to warming over 100 years than does carbon dioxide). That value of 25 is from the Intergovernmental Panel on Climate Change (IPCC)'s 2007 *Fourth Assessment Report*,[14] but the IPCC has since updated the potential to 34 in its 2013 *Fifth Assessment Report*.[15] Government agencies may still use the 2007 value for reporting their GHG emissions to national or international bodies that require consistency over time and across reporting jurisdictions. However, what governments use for reporting to such bodies need not constrain their use of more accurate values in environmental assessments. In sum, we see no legitimate reason not to use the latest science in assessing the Kalama facility's GHG emissions effect.[16]

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[i] Though the DSEIS reports using GHGenius version 4.03 and that GHGenius uses a leakage rate of 0.32% (Table B.3 of Appendix A to the DSEIS), the data the DSEIS reports in Table B.4 of 104 g CH_4 per mmBtu of gas suggest a methane loss rate of between 0.6% and 0.7%. We are not sure how to account for this discrepancy.

[ii] Here we use Alvarez *et al.*'s (2018) estimate of 2.2% methane loss rate (expressed as a function of methane produced) through gas transmission; the rate would be 2.3% if local gas distribution were also included.

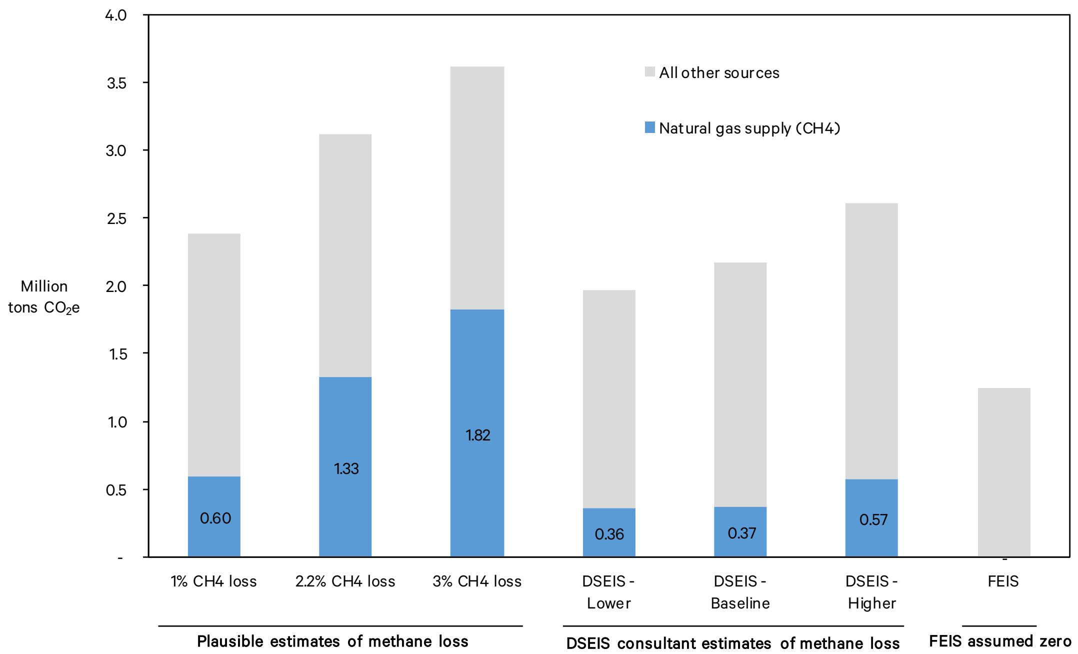
3 Correcting for these errors in the DSEIS methane loss analysis alone increases total facility GHG emissions by 10-70%

Correcting for the under-estimate of methane losses (point 1 above) and the incorrect use of an outdated global warming potential (point 2 above) in the DSEIS would substantially increase the estimate of the Kalama facility's annual GHG emissions.

Figure 1 shows the total GHG emissions associated with producing methanol at the Kalama refinery, under a range of plausible long-term methane loss rates of 1 to 3% (but with the DSEIS estimates of all other emissions), and including the current "best" estimate of 2.2%[iii]

We estimate that, in total, production and delivery of methanol from the Kalama refinery to Chinese ports would lead to 2.4 million to 3.6 million tons CO_2e annually, assuming a 100-year Global Warming Potential (GWP). These estimates are 10% to 70% higher than the DSEIS baseline estimate of 2.2 million tons CO_2e. (Figure 1 compares our three scenarios to those in both the DSEIS and the prior FEIS). The only difference between our estimates and those in the DSEIS is the amount of methane losses from natural gas supply and how much that contributes to the proposed facility's total GHG emissions.

Figure 1. Greenhouse gas emissions associated with the proposed Kalama facility under alternative assumptions about methane (CH_4) loss, as compared to EIS estimates



Source: SEI Analysis based on the Kalama DSEIS and FEIS, supplemented with a new, best estimate of current methane loss of 2.2%, plus a wider, plausible range of future methane loss of 1% to 3% based on a literature review, and with global warming potentials (GWP) for methane of 34 times higher than CO_2 over a 100-year timeframe, based on IPCC.[15] For the three bars on the left, we assumed the same emissions from other sources as in the DSEIS baseline case.

It is also important, in our view, to be simple and transparent about assumptions, such as methane loss rate, that have such a large influence on the emissions estimates. By contrast, the DSEIS cites a model,

[iii] The 1 to 3% range was also used in another recent study comparing the lifecycle emissions of power plants. We adopt the Kalama DSEIS baseline estimates for all other sources for simplicity, not necessarily because we agree with them. In particular, the DSEIS presents a confusing and misleading representation of marginal power resources that ignores the Northwest Power and Conservation Council's analysis of marginal CO_2 emissions rates.

GHGenius version 4.03, which – when it comes to methane loss rate – appears not really to be a model at all, but primarily a single assumption drawn from an industry study 18 years ago, as described above.

The math for estimating methane emissions attributable to the Kalama facility is not complicated, and need not be spread out over multiple tables as in the DSEIS. Our estimate of the methane emissions attributable to the project, 1.33 million tonnes CO_2e, is calculated as follows in Table 1.

Table 1. Calculation of methane loss associated with the Kalama facility

Parameter	Value	Source	Notes
Gas delivered	107 Tera BTU	DSEIS	Calculated as 29.6 mmBtu/tonne from DSEIS Appendix A Table 3.9 multiplied by 3.6 million tonnes methanol as on DSEIS page 3-32
Divided by	/		
Gas energy content	23,180 BTU per pound	DSEIS	This value from the DSEIS is about 10% higher than imputed from a heat content of 1049 BTU/ft as in the DSEIS Appendix A Table C.1 and an imputed gas density of 22.3 g/ft^3 from PSE. We aren't sure how to explain the difference.
Divided by	/		
English to metric conversion	2,205 pounds per metric tonne	Unit Conversion	
Multiplied by	X		
Methane content, by weight	83.1%	Puget Sound Energy	Methane content of delivered gas by volume is 91.3%, as reported in Table 2.5 of the DSEIS for the Tacoma LNG project where it is attributed to PSE. Considering the molecular weight of methane relative to other gas components (e.g., ethane and propane), this is about 83.1% by weight.
Multiplied by	X		
Methane loss as a fraction of methane delivered	2.25%	Alvarez et al 2018	Alvarez reports methane loss of 2.2% as a function of methane *produced*, not *delivered*; we convert between those here as 0.022/(1-0.022)
Multiplied by	X		
Global Warming Potential (100 year)	34	IPCC 2013 (Myhre et al 2013)	This is the value including climate feedbacks.
Equals	=		
Annual GHG emissions	1.33 million tonnes CO_2e	Arithmetic	

4 The DSEIS is far too confident that Kalama methanol will displace coal. Still, the possibility does exist.

As the DSEIS points out, the GHG emissions of producing methanol from coal in China are far higher than producing methanol from gas. Therefore, *if* methanol and olefin markets were restricted to China and the country were otherwise likely to commit to intensive coal use (despite its Paris Agreement commitment) for another 3 decades, then indeed gas-based methanol from Kalama could directly displace the production of methanol from coal, and GHG savings could be quite significant. However, methanol and olefin markets are complex and global, and it is difficult to be certain what Kalama methanol would displace.

In particular, we see several problems with DSEIS market analysis of the displacement of coal-based methanol.

First, the DSEIS market analysis, i.e. Figures 4.16 and 4.17 in DSEIS Appendix A, constrains the analysis to just the methanol producers that can access China's methanol-to-olefin market. Because methanol and olefin markets are global, as the DSEIS acknowledges, we see no good reason to limit the scope in this way. The practical implication of the DSEIS constraining the market this way is to exclude, inappropriately, a large number of international, gas-based methanol producers from consideration for what may be displaced by Kalama methanol.

Second, the DSEIS market analysis assumes that demand for methanol is fixed. But as the DSEIS notes elsewhere, demand for methanol from the olefin market is highly dependent on oil price. If oil prices are low, olefin producers would favor naphtha-based routes, and have less demand for methanol-based-routes, especially for new, coal-based methanol. The DSEIS does not report what oil prices they assume, and so we cannot know what underlies their anticipated demand. There is some reason to believe that oil prices could be low in the future, and not exceed, e.g. $60 per barrel, for extended periods. This could occur, for example, if the global market for electric vehicles and commitments to address climate change cut into future oil demand.[17,18] Oil prices at that level could make other olefin routes more cost competitive, reducing the demand for methanol; in that case, methanol-to-olefin facilities (fed by coal-based methanol) may not actually be the marginal producer that the DSEIS assumes they are.

Third, and relatedly, the DSEIS projects far too much confidence in the future of coal-to-methanol in China. The DSEIS relies on a proprietary forecast from China's chemical industry, but it is common in China for announced facilities to never be built. For example, analysis has shown that a significant fraction of announced coal-based power plants in China are cancelled or shelved rather than proceed to construction and operation.[iv] Cancellation of potential coal-based facilities could well occur for methanol, too, especially if China expands its carbon pricing and other climate policy efforts to the industrial sector. Already, China has taken important steps to curb coal, both in response to air pollution concerns and its own commitments to address climate change, including a national emission trading system. Indeed, some analysts believe that coal consumption in China, which in recent years was increasing rapidly, has entered a plateau phase and will soon begin a long decline.[19,20]

Lastly, the DSEIS makes the argument that the Kalama facility will displace other methanol producers based on cash costs of production of $150/tonne, but these costs are not spelled out or justified, nor sensitivities examined. Were methanol demand to be lower (as described above) and the many other global gas-to-methanol-facilities not excluded (as also described above), it is conceivable that, were the

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[iv] According to the CoalSwarm Coal Plant Tracker, 359 GW of announced coal plants in China have been cancelled since 2010, as compared with 431 GW that went into operation and 126 GW currently under construction. (See www.coalswarm.org) In addition, in 2016 and 2017, the Chinese government suspended another 444 GW of coal plants at various stages of development. (Shearer, C. *et al.* Boom and Bust 2018: Tracking the Global Coal Plant Pipeline, CoalSwarm, Greenpeace USA, and Sierra Club (2018)).

capital costs of the Kalama facility to also be included, that the facility may not be in the strong economic position it claims to be. For example, a $2 billion capital cost, financed over the 40-year facility lifetime at 7% cost of capital, would amount to about $42 per tonne, assuming 3.6 million tonnes methanol produced per year. Adding this $42 per tonne to the facility's stated cash costs of $150/tonne would potentially place it in range – especially if gas prices are not as low as envisioned – of being economically vulnerable to reduced methanol demand.

Nevertheless, despite these problems, the possibility remains that Kalama could displace a substantial amount of coal-based methanol. An analysis by the Low Carbon Prosperity Institute (LCPI)[5] introduces a useful concept – a ratio of how much the Kalama facility would displace coal-based methanol (with substantial GHG *reductions*) relative to naphtha-based olefins (with smaller GHG *increases*) to render the net effect on emissions neutral.

However, though innovative, even that LCPI analysis may give too much weight to coal-based methanol. As Figure 4.15 in DSEIS Appendix A shows, globally, there is even more gas-based-methanol available than coal-based methanol, so other gas-to-olefin facilities should also be considered as possible sources displaced (with little effect on GHG emissions either way).

Similarly, on the downstream end (meaning, what the methanol is used for), it is not just other olefin routes that may be displaced (they are a relatively small share of the methanol market), but also vehicle fuel, formaldehyde, and other chemical products, as Figure 4.5 in Appendix A to the DSEIS shows, all of which themselves also have GHG implications. For example, blending gasoline with gas-derived methanol would increase GHG emissions: an 85% blend of gas-derived methanol would yield life-cycle GHG emissions 15% to 19% higher than conventional gasoline.[21] In addition, the market effects of inducing additional liquid fuel consumption could also increase emissions by up to 20-60% on top of that.[22]

Taking the LCPI innovation of assessing relative likelihood further – to look, probabilistically, at how new gas-to-methanol may displace *multiple* ways of both producing and consuming methanol – would be a useful contribution. Unfortunately, it is beyond the scope of what we can do in this limited comment window. Regardless, it is clear that the approach taken in the DSEIS's central results (e.g., Table 6.1 of Appendix A of the DSEIS) – of assuming it is *only* coal that is displaced -- is tenuous, at best.

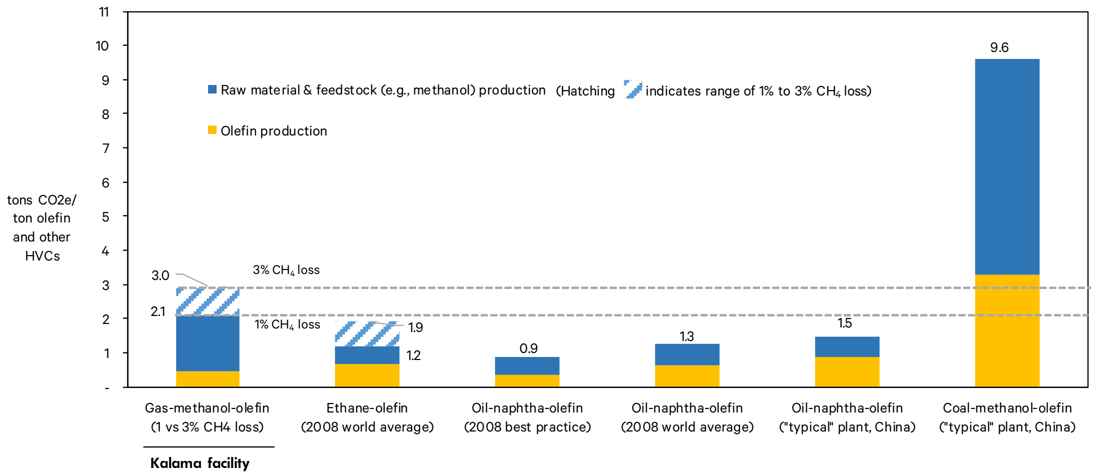
5 New, long-lived industrial infrastructure should manufacture products (here, olefins) with very low life-cycle emissions. The Kalama methanol facility does not.

Our discussion above recognized the possibility that the Kalama facility may displace coal-based methanol. Still, even if the facility *were* to reduce emissions relative to coal-based methanol, its construction and operation might not be consistent with long-term climate goals. A low-carbon transition – in line with the globally-agreed guardrail of keeping warming "well below 2" degrees Celsius – might call for investment in even lower-emitting production processes. In other words, comparing against a "business-as-usual" technology – regardless of whether that technology is coal-based methanol or instead a more common naphtha-based route – may simply be inadequate for assessing whether a facility "makes sense" in light of the need to steeply reduce global emissions.

Several technologies produce olefins and related chemicals. The predominant technology globally has been steam cracking of naphtha (a product of crude oil refining) and, to a lesser extent, ethane (a co-product of natural gas production).[23] For example, in 2016, 82% of ethylene capacity was naphtha and ethane based, and only 2% was methanol based.[24]

Figure 2 shows the GHG emissions implications of these and other alternative pathways to making olefins and the related high-value chemicals that are often minor co-products of olefin refining. As shown, producing a ton of these chemicals from naphtha would result in 0.9 to 1.3 tons CO_2e, depending on whether best or average practice is followed. That is about half the GHG emissions as a facility using natural-gas-based methanol from Kalama (2.1 to 3.0 tons CO_2e, depending on methane loss rates). (Appendix E to Appendix A of the DSEIS reports a higher estimate for the GHG-intensity of naphtha-based chemicals – equivalent to 1.9 t CO_2e per tonne of HVCs, which it acknowledges is higher than in the peer-reviewed literature.[v] Even this value is lower than the corrected Kalama estimate, however.)

Figure 2. Greenhouse gas intensity of alternative olefin production pathways



Source: SEI Analysis based on the following sources. GHG emissions intensity of methanol production at the proposed Kalama facility is drawn from the DSEIS, adjusted to account for a range of methane loss rates of 1% to 3%. GHG emissions intensity of olefin and other HVC production from the Kalama facility's methanol is assumed to be 2008 best practice from Ren et al 2008.[25] GHG emissions intensity of the ethane-olefin and oil-naphtha-olefin routes are 2008 values for CO_2 intensity drawn from Ren et al 2008,[25] supplemented with a range of methane loss for ethane production of 1 to 3% (same as for gas-methanol-olefin) and a methane intensity for naphtha from Xiang et al 2015.[26] GHG emissions intensity of the oil-naphtha-olefin and coal-methanol-olefin pathways in China are based on current plants of "typical" capacity as drawn from Xiang et al 2014.[25,27] This chart is updated from our prior discussion brief in two additional ways: (1) to take a more conservative approach to estimating methane emissions from the world average and best practice ethane and naphtha-based routes (increasing those estimates); (2) correcting the "functional unit", or denominator, for all pathways to be "high value chemicals" (olefins and other high value byproducts, such as aromatics) using the approach in Ren et al 2008, which discounts the non-olefin byproducts for naphtha and ethane by 50% relative to olefins. The denominator of our previous chart was a mix of HVCs and true olefins.

Figure 2 suggests that the gas-to-methanol-to-olefin route represented by the Kalama methanol facility is not a low-GHG emission way to make olefins and related high-value chemicals, compared to ethane and naphtha-based routes. This would seem to indicate that the Kalama facility would not meet the industrial sector climate "test" we advanced in our prior discussion brief, and cannot confidently be claimed to be part of a deeply low-carbon future.

A recent report from the International Energy Agency does, however, include an increase in gas-to-methanol-to-olefin in its "Clean Technology Scenario". We address this in the next point.

[v] Here we adjust the DSEIS estimate of 2.3 tonnes CO2e per tonne olefin (Table 5.12) by the ratio of olefins to HVCs in Table E.1 of 1.21 to reach an estimate of the GHG-intensity of naphtha-based HVCs of 1.9 t CO2e/ t HVC.

6 A recent study by the International Energy Agency includes gas-based methanol in its low-carbon scenario, but that scenario was based on market trends and costs of production, not an analysis of greenhouse gas intensity

A recent study by the International Energy Agency (IEA) suggests that Chinese coal-based methanol (as olefin feedstock) would expand under reference conditions, and its low-emissions ("Clean Technology") scenario foresees some replacement of coal-based methanol by gas-based methanol.[8] As argued by the Low Carbon Prosperity Institute in a recent review, this would appear to indicate that natural gas methanol has a role a low-carbon future.[5] However, the IEA study did not "choose" specific technologies for making olefins and other high-value chemicals in its scenarios based on relative GHG emissions intensity, but instead based on production costs and macroeconomic conditions.[vi] Carbon constraints in its Clean Technology Scenario are instead considered implicitly (aligned with the IEA's Sustainable Development Scenario), but critically the IEA did not consider methane (CH_4) emissions. When methane emissions are considered, as Figure 2 and the analysis above show, there appears to be little if any GHG advantage for gas-to-methanol-to-olefin routes compared to naphtha- and ethane-based routes.

[vi] This is described on page 31 of the IEA study, and confirmed by communication with the authors.

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