SUMMARY FOR POLICY MAKERS

Putting Out the Fire:

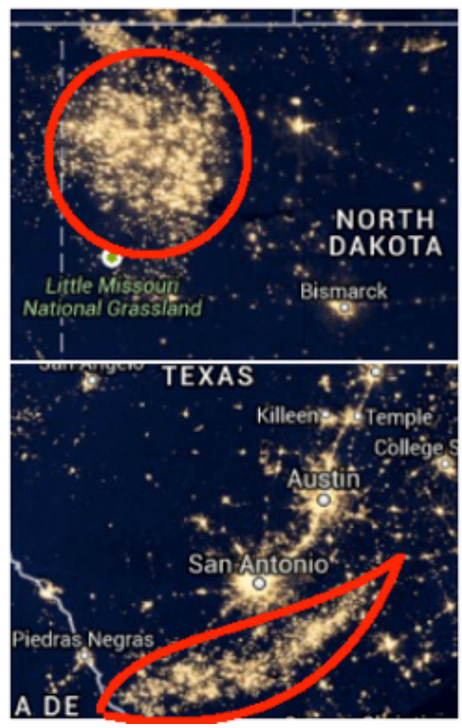
Reducing flaring in tight oil fields by improving utilization of associated gas

The study was designed, carried out, and written by **Carbon Limits AS.** Carbon Limits is a Norwegian consulting company with long standing experience in climate change policies and emission reduction project identification and development. The Carbon Limits team works in close collaboration with industries, government, and public bodies to reduce greenhouse gas emissions, particularly in the oil and gas sector.

The **Clean Air Task Force** works to help safeguard against the worst impacts of climate change by catalyzing the rapid global development and deployment of low carbon energy and other climate-protecting technologies through research and analysis, public advocacy leadership, and partnership with the private sector.

This Report Summary was written by Clean Air Task Force, based on the Carbon Limits report, which is available at:

http://www.catf.us/resources/publications/files/Flaring_Report.pdf



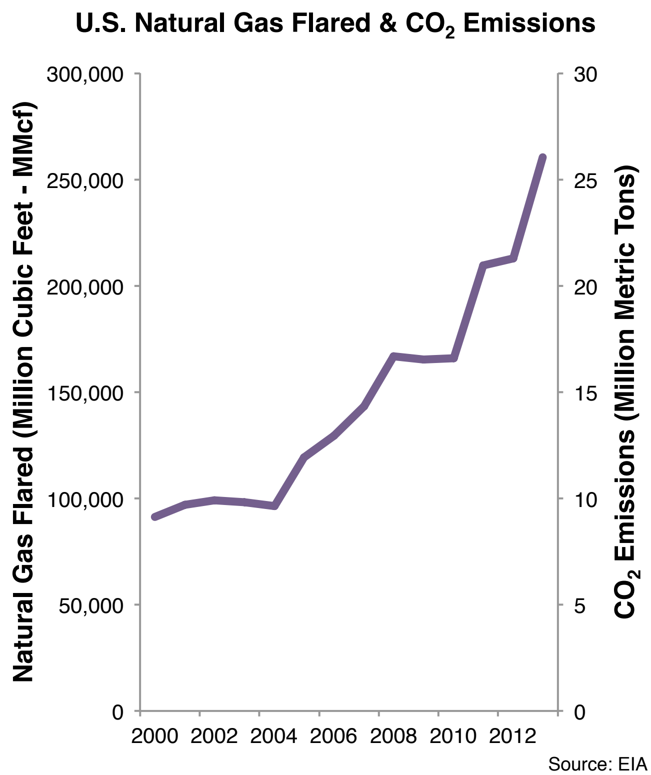
http://blue-marble.de

Tight oil development in North Dakota and part of Texas is now so extensive that the associated light pollution can be seen from space via satellite images. Some of this light is coming from the flaring of natural gas at oil wells that burn 24/7, often for months at a time. This valuable energy resource is literally going up in smoke.

Oil production in the Bakken formation in North Dakota and the Eagle Ford formation in Texas has grown significantly: from 0.2 million barrels a day in 2007 to around 3.1 million barrels a day at the beginning of 2015. In addition to oil, these wells produce large amounts of natural gas, but in the rush to produce oil, too often this "associated gas" is flared off (burned) instead of being captured and brought to market. Flaring of associated gas in the Bakken and the Eagle Ford basins has dramatically increased, reaching approximately 125 billion cubic feet of gas flared per year by 2013, **enough to provide heat for 1.87 million U.S. homes**.

This flaring not only wastes energy, it produces air contaminants including toxic **volatile organic compounds**, smog-forming **nitrogen oxides**, and deadly **particulate matter** – most of which is black carbon soot, a very potent climate warmer. Flaring emits large amounts of **carbon dioxide**, and it is also a large source of **methane**, a potent climate pollutant, especially because oil companies often use crude flares that do not ensure that gas is fully burned.

Some in the oil and gas industry have defended this practice on the grounds that building adequate pipeline capacity to carry the gas before wells go into production is often not feasible or economic and that alternatives are not available. That is, they claim it is literally not worth the time and money to capture and use this natural gas, so they burn it off.



A new study, commissioned by Clean Air Task Force, and performed by Carbon Limits, shows that these arguments are not valid reasons to allow oil companies to continue to routinely flare associated gas. The study shows that there are several technologies, beyond building pipelines, that provide alternative means to utilize associated gas or bring it to markets. These technologies are proven and in-use today in tight oil formations, and include:

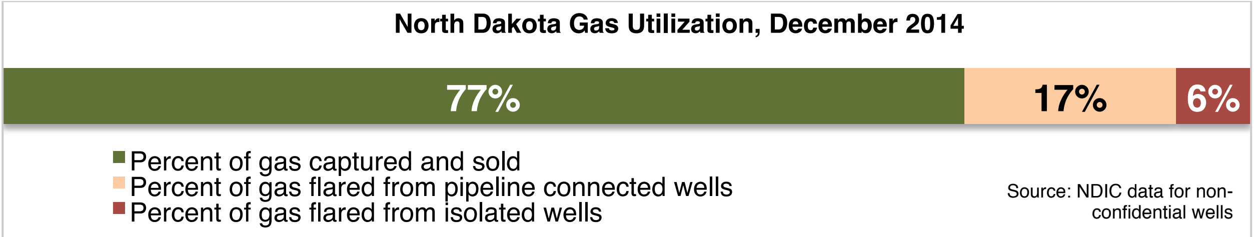
- Natural Gas Liquids Recovery
- Compressed Natural Gas Trucking
- Gas-to-Power Generation

Ultimately, flaring is not a failure of technology, but of regulation. In areas with adequate regulations, flaring is virtually non-existent. Indeed, even in the Bakken and the Eagle Ford, some companies flare almost no gas, because they have ensured that pipelines are in place as wells are completed. However, where regulations are lax, like in North Dakota (see box on page 5), companies often have lower incentive to capture and sell natural gas as they rush to begin receiving revenue from oil sales.

The availability of these proven alternative technologies demonstrates that there is no excuse for routine flaring. Companies can get pipelines to their wells; if that proves challenging or expensive, they can use these profitable, demonstrated technologies to utilize and get the gas to market. Nationally applicable rules should prevent oil companies from continuing the wasteful and harmful practice of routinely flaring associated gas from oil wells.

Flaring: Background

Flaring at tight oil wells is a consequence of many diverse factors and actors, but it is a problem that can be solved. Traditionally, the main way to utilize gas instead of flaring it has been to connect wells to gathering pipelines systems, which convey the gas into the natural gas system to be used as an energy source or feedstock. In this study, Carbon Limits identifies two main causes of flaring in tight oil formations (short-term flaring due to safety concerns or unexpected problems is not a subject of the report):



Lack of gas utilization capacity – isolated well flaring: If an oil company begins producing oil from a well with no connection to a gas gathering system or other gas utilization technology in place, they will flare off the gas from the well.

Lack of gas utilization capacity – pipeline connected well flaring: If an oil company produces more gas from a well connected to a gas gathering system than the system can handle (due to limited pipeline or compression capacity), they will flare some or all of the associated gas from the well.

The technologies identified by Carbon Limits can utilize gas and in many cases reduce both types of flaring.

Feasible and Proven Alternatives to Flaring

Carbon Limits evaluated nine candidate technologies (beyond gathering pipelines) for capturing and using associated gas. Of these technologies, Carbon Limits found that three are proven and in-use in tight oil formations. The other technologies did not meet one or more of our criteria, but they may become mature in the future; flaring regulations may hasten their commercialization.

- **Natural Gas Liquid (NGL) Recovery:** separating out heavier hydrocarbons (propane, butane, pentane, etc.), which can easily be transported as liquids, from associated gas. NGL recovery is complementary to other technologies that utilize the remaining gas after NGLs are removed, since this relatively "dry" gas is more suitable for use in compressors and engines and causes fewer problems in gas gathering pipelines.
- **Compressed Natural Gas (CNG) Trucking:** compressing associated gas and trucking it to a gas processing plant or other point where it can be transported to market via pipelines.
- **Gas to Power Generation:**
  - *Local*: generating electrical power with portable units to serve local electric demand at oil and gas production sites.
  - *Grid*: generating electrical power for sale to the grid.


Flickr/Tim Evanson

These technologies are mature (they have all been deployed commercially in a tight oil development), right-sized, scalable (they can scale up and down depending on the level of gas production at a site), and portable. These technologies are able to handle the conditions found in tight oil formations. In many installations today, they are making money for companies that use them. Even where there is a net cost involved, that cost is small considering the large amount of pollution that is prevented when these technologies are used.

Low Cost Pollution Reductions

The report analyzes the economic and environmental impact of the technologies using a simple cost model. The model uses a typical associated gas production profile as an input and allows the implications of key factors, such as gas composition, number of wells per pad, and design size of the gas utilization technology, to be assessed. In this section, we present some of the model results. The model shows that all three technologies can be deployed profitably, or at low net cost, even though it does not account for some of the important factors that may improve the overall economics of the systems—such as renting equipment instead of purchasing a single size installation or using technologies in tandem. Since these technologies reduce pollution by large amounts, the abatement cost of deploying them (net cost per ton of avoided pollution) is negative or quite low.

CO_2 Abatement Costs

Compressed Natural Gas (CNG) Trucking is appropriate regardless of associated gas composition (both rich and lean). It can be scaled up to utilize nearly all of the natural gas produced, and the CO_2 abatement cost is negative in all scenarios we modeled. This technology will generally be feasible at wells that are relatively close to a processing plant or other point where gas can be put into the pipeline system (20-25 miles or less). The model results shown below range between a smaller design size that maximizes profitability of the deployment, and a somewhat larger size that maximizes flare reduction (while remaining profitable).

	Gas Composition	Pad Size	Flare Reduction	CO_2e Reduction (including compressor emissions)	Abatement Cost ($/ton CO_2e)
CNG Trucking *	Lean	Single Well	91% to 97%	65% to 85%	-$26 to $0
		Multi Well	95% to 97%	70% to 85%	-$53 to -$40
	Rich	Single Well	93% to 98%	65% to 85%	-$126 to -$107
		Multi Well	96% to 98%	70% to 85%	-$159 to -$151

Natural Gas Liquid (NGL) Recovery works best when associated gas has a high percentage of heavy hydrocarbons (rich), and it is suitable for both single and multi-well pads. Systems that can capture pentane (C5) and heavier hydrocarbons are simple and inexpensive, but only achieve limited flare reductions. Technologies that also capture propane (C3) and butane (C4) capture a larger portion of the input gas and therefore result in less flaring. They require a larger initial investment, but smaller systems are profitable, while larger systems, which will reduce emissions more, have limited costs. The results shown below for C3+ systems range between the equipment size that maximizes the profitability of the deployment and a somewhat larger size that maximizes flare reduction.

	Gas Composition	Pad Size	Flare Reduction	CO_2e Reduction (flare only)	Abatement Cost ($/ton CO_2e)
NGL Recovery (C5+) *	Rich	Single Well	4%	5%	$250
		Multi Well	4% to 5%	5% to 6%	-$21 to $0
NGL Recovery (C3+) *		Single Well	14% to 18%	15% to 19%	-$23 to $0
		Multi Well	18% to 21%	19% to 22%	-$89 to $0

As noted above, while NGL recovery itself can only be a partial solution, it is complementary to the other technologies discussed here (and to gas gathering pipelines), because removal of the NGLs makes gas more suitable for engines and compressors and easier to handle in pipelines.

* Without blending heavy natural gas liquids into crude.

Well owners will profit more, and reduce flaring more, by coupling NGL recovery with other technologies discussed here. However, this type of coupling was not modeled in this report.

Gas-to-Power (local loads) works best when using lean associated gas (which has a low percentage of heavy hydrocarbons), including the residual gas after NGL recovery. The results shown below are for equipment sized to match the power demand on the well-site.

	Gas Composition	Pad Size	Flare Reduction	CO_2e Reduction (including flare and diesel substitution)	Abatement Cost (\$/ton CO_2e)
Reciprocating Engine	Lean	Single Well	18%	33%	-\$165
		Multi Well	19%	36%	-\$194
Gas Turbine		Single Well	21%	31%	-\$33
		Multi Well	22%	33%	-\$54

While the size of gas-to-power deployments is limited by the power demand on well pads, the technology can be coupled with others to increase flaring reductions.

Gas-to-Power (grid) (not modeled) works best at sites with lean associated gas and is suitable for large multi-well pad developments in areas with small well spacing. This option should be considered if a number of wells are distant from gas gathering systems.

Other Pollutants

In addition to reducing CO_2 emissions, utilizing these technologies instead of flaring would also reduce emissions of harmful pollutants that degrade air quality such nitrogen oxides (NO_x), volatile organic compounds (VOC), and particulate matter (PM). VOCs and NO_x form ground level ozone (smog) when they react in the air with sunlight. Ozone smog impairs lung function, triggers asthma attacks, and aggravates conditions of people with bronchitis and emphysema. Children, the elderly, and people with respiratory conditions are most at risk from ozone smog. The report explores the effectiveness, and cost, of these technologies in reducing emissions of NO_x and VOC. While flares also emit harmful PM, the report did not quantify PM reductions from these technologies due to a lack of appropriate emissions factors in the scientific literature.

As discussed above, deploying these technologies will often be profitable, and an investment in gas utilization technologies with positive net present value presents a good opportunity to minimize VOC and NO_x emissions associated with tight oil production. Furthermore, even projects that are not profitable per se may still reduce VOC and NO_x emissions at reasonable costs—below \$5,000 per ton of avoided emissions.

North Dakota's New Flaring Regulations are Inadequate

By 2020, North Dakota's recent (2014) regulations aim to require 90% of produced associated gas to be captured – nominally a significant improvement over recent performance there. In the years leading up to the passage of these rules, oil companies only captured about two-thirds of the gas they produced and flared the rest. However, even if the rules work and the state meets the goal, North Dakota oil producers will still flare a larger percentage of the gas they produce than companies in any other state with significant gas production. The 2014 rules are a step in the right direction, and in January 2015, oil producers captured over 80% of the gas they produced, meeting the target set by the regulation. However, the unambitious final target (90% capture) means that North Dakota producers will still be able to wastefully, and unnecessarily, routinely flare thousands of wells, even after the rule is fully in effect.

As the Carbon Limits report shows, there are numerous technologies are available today that companies can use to beneficially use this gas instead of flaring it. Tighter national standards are needed to prevent the harmful pollution resulting from this unnecessary routine flaring.

Nationwide Emission Standards are Needed

Due to the recent spike in tight oil production, the problem of natural gas flaring has sharply increased; in 2013, flaring wasted nearly a billion dollars worth of natural gas nationwide. In North Dakota, even as the percentage of gas flared dropped from 2013 to 2014, the volume of gas flared increased as the growth in production "outran" the progress in capturing gas. The technologies highlighted in this report demonstrate that it is feasible to use natural gas from tight oil wells, even when pipeline infrastructure is not in place (or cannot be put in place) at a given well. However, unnecessary and harmful routine flaring will continue if robust nationwide standards limiting this wasteful practice are not quickly put into place.

Two agencies have critical opportunities to address this in the near future - the Bureau of Land Management (BLM) and the U.S. Environmental Protection Agency (EPA). BLM is currently in the process of updating its regulations that cover oil and gas development on public land. As the manager of public lands and to comply with its statutory duty to require operators to "use all reasonable precautions to prevent waste of oil or gas," BLM must prohibit the wasteful practice of routinely flaring gas for no beneficial use and require operators to send associated gas to a pipeline or to utilize one of these technical solutions.

EPA had the opportunity to require these technologies when it issued emission standards for the oil and natural gas sector in 2012, but opted not to, in part, because it wanted more data on control technologies. This study shows that these technologies are available for immediate application nationwide. EPA has been directed to address methane and other air pollutants from oil and natural gas this year. EPA data shows that flaring is a large source of methane in tight oil fields like the Bakken, and EPA must expand the 2012 standards for oil and natural gas to include oil wells and, among other things, require that associated gas from these wells either be routed to a pipeline or captured using these technologies.

Robust rules from these two agencies could provide a strong legal framework to reduce flaring, and provide incentives for companies to develop gas utilization plans and/or coordinate pipeline infrastructure build-out in advance of drilling.

The Carbon Limits study identifies adequately demonstrated solutions to improve associated gas utilization at tight oil wells, such as those in the Bakken and the Eagle Ford, at reasonable costs to the industry. These technologies give well owners options for using gas beyond traditional gas gathering, and they will give companies a flexible means to comply with needed regulations that limit flaring. In short, these technologies demonstrate that it is feasible to eliminate routine flaring of associated gas. While there are a variety of technical, geographical, and commercial factors that must be considered, the study shows that it is technically and economically feasible for companies to virtually eliminate flaring.

Kelly Finan/Environment America

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