# Exhibits
# I – N-3

https://rbnenergy.com/rocky-mountain-breakdown-western-natural-gas-markets-whack-rockies-producers

# Rocky Mountain Breakdown - Western Natural Gas Markets Whack Rockies Producers

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Efforts to increase natural gas production in the Rockies are running into a brick wall — make that *several* brick walls. To the east, burgeoning gas production in the Marcellus/Utica region is surging into Midwest markets, pushing back on Rockies gas supplies. To the south, Permian gas production is ramping up toward 8 Bcf/d, most of it associated gas from crude-focused wells — volumes that will be produced even if gas prices plummet. To the west, Rockies gas faces an onslaught of renewables in power generation markets, where wind and solar are increasingly replacing gas fired and coal generation, especially during non-peak periods when the sun is shining and the wind is blowing. To the north, Western Canadian producers facing a where-do-we-send-our-gas problem of their own are only days away from having expanded pipeline access to U.S. West Coast markets — access likely to displace some of the Rockies gas which has been flowing west. Today, we discuss highlights from a new report by our friends at Energy GPS that assesses these developments and explores their implications.

There was a time, many years ago, when the Rocky Mountain states (Colorado, Utah, Montana and Wyoming) represented the fastest-growing gas-producing region in the country. From 1998 to 2008, Rockies dry gas production more than doubled, increasing by 6 Bcf/d (from 5 Bcf/d to 11 Bcf/d) while the U.S. as a whole increased by only 3 Bcf/d. Thus, Rockies gas production was growing while the rest of the U.S. was in decline. The region was growing so rapidly that severe pipeline takeaway capacity constraints developed, prompting construction of Rockies Express (REX), the largest pipeline built in a decade at that time, which was completed in November 2009 to bring 1.9 Bcf/d of Rockies gas all the way to Clarington, OH. Then shale happened. But not to the Rockies. Gas producers shifted their attention to the big shale producing basins, leaving the Rockies to muddle along. Rockies production flat-lined.

Then the onslaught of shale gas production from the Marcellus/Utica kicked in, obliterating any reason to move Rockies gas to Ohio. In fact, it soon became apparent that the best thing for REX would be to turn it around and flow gas the other way — out of Ohio. The eastern part of the pipeline was made bi-directional and by late summer 2014, REX reversed into net westbound flows toward Midwest markets. Increasingly, Marcellus/Utica gas has been taking market share that Rockies producers had targeted (see It's Been a Long Time Comin'). Similarly, gas production gains in the Permian and SCOOP/STACK have helped to close off potential markets for Rockies gas in the Midcontinent and Gulf Coast regions. California's aggressive expansion of renewable energy (first wind, then a lot of solar) has reduced Western gas demand (see California Sunset) — another blow to Rockies gas producers — and Western Canadian producers (also struggling to find markets for *their* gas) have been angling to take a larger share of the dwindling U.S. West Coast gas market from (you guessed it) their counterparts in the Rockies (see On the Border).

To really understand what a big deal these developments are for the Rockies — and for that matter all gas in North America — it is necessary to dig deep into the particulars of the Western natural gas market, an area that definitely marches to its own drummer, driven far more by competition with hydro, solar and wind than any other region in North America. It is this competition with renewables, both from the standpoint of short-term developments and long-term trends, that may well be the harbinger of things to come in gas markets across the continent. So today, we summarize these developments, which are the subject of a new report from our friends at Energy GPS titled Rock the Rockies – A Fundamentals Perspective.

**Short-Term**

The 2018 Western gas market provides a window into what is to come, with the most significant developments being driven by (1) California solar, (2) Pacific Northwest hydro and (3) changes to natural gas infrastructure developments. Solar power in California can be segmented into two primary buckets: (a) utility-scale and (b) "behind-the-meter," both of which are growing rapidly and having an impact on the overall dispatch of thermal generation within the state. On the utility side, California law requires that a steadily increasing share of the state's electricity needs come from wind, solar and other renewable sources — with a goal of 50% renewables by 2030. The California Independent System Operator (CAISO) indicates that more than 10,330 MW of utility-scale solar power was online in the fourth quarter of 2017, up from only about 1,000 MW five years earlier. Utility solar continues to gain market share in the California market while wind stayed at just under 5,000 MW over the past few years following rapid growth during 2010-12.

But by far the biggest gains have come from that other California renewables bucket: rooftop or behind-the-meter solar capacity, which is being installed at a 100-MW/month pace. As shown in Figure 1, rooftop solar capacity has increased from less than 1,000 MW in 2011 to almost 6,000 MW in 2017.

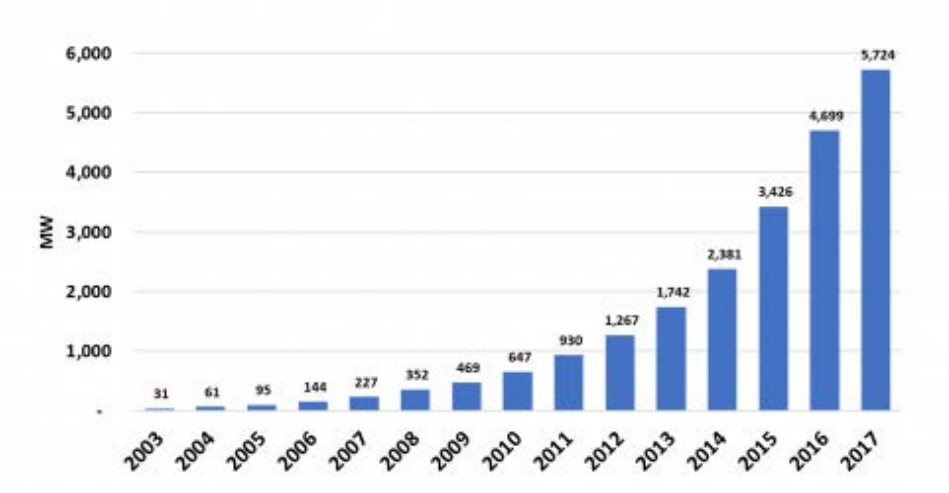



Figure 1. California Behind-the-Meter Solar Capacity (in MW) (Click to Enlarge)

Sources: California Independent System Operator and Energy GPS

The combination of rooftop and utility-scale solar in California has slashed the need for gas-fired power generation in the state. The average number of megawatts of thermal generation (virtually all of it fired by gas) that needs to run each day in California in January and February of 2018 was only half what was required in the same two-month period in 2014 — about 12,000 MW four years ago versus about 6,000 MW in early 2018 — in large part because of increased generation of solar power.

The surge in renewable generation is having a particularly quirky impact on Western power markets, which influences gas demand. The issue is "renewable curtailments" — meaning that utilities are sometimes being forced to shut off power coming from "free" renewables power generators. If there is too much power coming into the grid and all variable-load units are offline, the last-resort option is to turn off wind and solar. The tax credits for these renewable units only accrue when they run, so in some cases, their owners are willing to sell power at negative prices. As you might imagine, all gas generation that can be shut down is shut down when this happens, and it is happening with increasing frequency.

The second important factor impacting the Western gas market is nothing new: hydropower, primarily in the Pacific Northwest, but also in California. Gas has always competed with hydro in this

market, both in the form of melting snowpack and rainfall. In a “good” water year, hydro generation displaces the need for quite a bit of gas. When water behind hydro dams is in short supply, more gas is needed to produce power. So far, 2018 is shaping up to be a relatively good water year, with snowpack in the mountains about 118% of normal. Looking at the breakdown of water that will be available for two of the major power generation river systems — the Columbia (Washington/British Columbia) and the Snake (Idaho/Montana) — there is more snow sitting in the higher elevations of the former than the latter. This should equate to plenty of water hitting the major portion of the hydro system in May and June — especially bad for the gas market, since it is those months when gas demand should be ramping up. In California, the state experienced drought conditions between 2012 and 2016, but last year (2017) experienced the wettest precipitation pattern on record, with precipitation in northern California a whopping 182% of normal. This year is back on the dry side, but hydro storage facilities within California remain in pretty good shape. That again is not good news for gas.

The third factor that Western gas markets are dealing with this year relates to natural gas infrastructure — both pipelines and storage — summarized here:

1. TransCanada’s Sundre Expansion Project, planned for startup within days, will ultimately enable an additional 230 MMcf/d of Western Canadian gas to flow to the Malin gas hub in south-central Oregon. As we discussed in On the Border, it is likely that this will push a similar volume of Rockies gas out of the Pacific Northwest in the process.
2. Capacity reductions at SoCal Gas’s all-important Aliso Canyon gas storage facility have cut the volume of gas that can be stored near Los Angeles, which will lower the supply of gas that can be delivered into the market when needed, further encouraging the use of other generation sources — especially renewables (see California Sunset). Aliso’s maximum allowable storage capacity has been slashed from 82 Bcf to less than 30 Bcf as a result of a gas leak first detected in late 2015.
3. SoCal Gas Transport Capacity Restrictions are also constraining gas supplies into this market. Back in October 2017, planned maintenance work started on the L3000 Topock line tied to the Transwestern and El Paso pipelines. The expected return date is at the beginning of May 2018. In the meantime, gas must move into the region via other routes, or not move at all.
4. Yet another factor affecting Western gas demand in the near term — actually this time in a positive way — is gas storage levels at Pacific Gas & Electric (PG&E) storage facilities in northern California. PG&E removed more-than-typical volumes of gas from its storage facilities this past winter and is likely to be injecting as much gas as it can over the next three months — an achievable plan, given that the large amounts of solar and wind energy to be produced in California will help to minimize the need for gas-fired generation in the state.

Put all of these factors together, and you have a 2018 recipe for lower Western gas demand, more volatile gas prices, and generally wider price basis compared to Henry Hub. None of this bodes well for the Rockies, and in the mid- to longer term, it is only going to get worse.

**Mid- to Longer-Term**

Challenges to gas demand on the horizon include increasing output from wind farms in Texas and the Great Plains states, which would curb the need for gas-fired generation in those regions and force gas producers to look further afield for gas consumers, competing directly with Rockies gas. In the past four years, the combined capacity of operating wind farms in the Electric Reliability Council of Texas (ERCOT) and Southwest Power Pool (SPP) regions has almost doubled — from about 16,700 MW in the first quarter of 2014 to 32,900 MW now. Because these wind farms are located in some of the windiest parts of the U.S., they typically run at full or partial capacity most of the time, significantly reducing the need for gas-fired power when they do.

Rockies gas also must compete with increasing production from the Marcellus/Utica region in Pennsylvania, Ohio and West Virginia, which enjoys lower per-unit production costs compared to the

Rockies. The region has already taken away gas-market share in the Northeast and Midwest from the Rockies and is slated to take more, including the lion's share of the emerging Gulf Coast LNG export market. It gets worse. The Permian is an entirely different animal, where crude oil production is the primary focus, and with the crude comes large volumes of associated gas (a mix of natural gas and natural gas liquids, or NGLs) for which producers need to find a market. Consequently, Permian gas is basically a byproduct, and its production is destined to continue growing, no matter what happens to natural gas prices.

About the only positive sign for Rockies gas on the horizon is about 2,500 MW of planned coal-unit retirements in the Pacific Northwest over the next 24 months that — if replaced by gas-fired power — would equate to about 500 MMcf/d of incremental gas demand on peak days in the region. Perhaps the Rockies could capture some of this market. But Rockies producers should expect competition to be fierce.

The bottom line in both the short, medium and longer-term horizons is this: Rockies gas will be competing with renewables, byproduct associated gas and relatively cheap Marcellus/Utica supplies. If all of these factors result in an oversupplied market, the market can only balance if higher-cost producers curtail drilling plans. And the only factor that will force those decisions will be lower prices. So watch out for falling Rockies.

For more information about Energy GPS's new report on Rockies gas and Western gas markets, click here.

https://www.lngworldnews.com/mexico-pacific-secures-funds-for-sonora-lng-project/?lipi=urn%3Ali%3Apage%3Ad_flagship3_profile_view_base_recent_activity_details_all%3BdTLN0LB1TIiXi22OQG1NeA%3D%3D#.We7I7JJymww.linkedin

# Mexico Pacific secures funds for Sonora LNG project

zoomIllustration purposes only (Image courtesy of DKRW Energy)

Mexico Pacific Limited said that Aecom Capital's Infrastructure fund pledged to invest in the development of its LNG liquefaction complex on the Gulf of California in Mexico.

Based at Puerto Libertad in the state of Sonora, MPL has a deep-water port and is interconnected with the US shale gas grid by multiple natural gas pipelines, which are already in service bringing natural gas to the site.

MPL president Robert Kelly said, *"AECOM Capital's Infrastructure fund's financial commitment and development investment expertise materially strengthens MPL's position and will allow us to conclude pre-construction work and ensure the LNG facility achieves target operations by 2022."*

MLP is a joint venture of DKRW Energy Sonora Holding and Aecom Capital.

Kelly noted the investment is an important milestone for the project that would supply the Mexican, South American, Central American and Pacific basin markets.

Aecom Capital's Infrastructure fund's senior managing director, Mark McComiskey said the fund studied a multiple LNG infrastructure projects globally finding MLP as offering *"significant advantages to serving leading growth LNG markets in Mexico, the Americas and Asia."*

Oregon Attitudes about Jordan Cove Energy Facility Siting
On-line Survey source: ResearchNow Jan/Feb 2018 & MTurk Jan/Feb 2018
Full survey sample combined sources N=1115; Source break-out avail. on request
Conducted by PolicyInteractive Research: info@policyinteractive.org
(Sample is weighted, see methodology at end of survey - Columns may not total 100% due to rounding)
Blue columns represent selected benchmark comparisons, buff columns present combined source totals

| 1. Are you a resident of Oregon and age 18 or older? [disqualify if "No"*] | Weighted C.District N=1115 |
|---|---|
| Yes | 100% |

| **2. Do you think things in Oregon are going in the right direction or are things on the wrong track?** | N=1115 % |
|---|---|
| Right direction | 29 |
| Wrong direction | 33 |
| In-between or unsure | 39 |

| 3. Which of these two statements do you agree with more, even if neither represents your view exactly? | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| FEEL STRONGLY A: Economic growth should be given priority, even if the environment suffers to some extent. | 36 | 11 |
| Lean towards A | | 25 |
| Lean toward B | 57 | 34 |
| FEEL STRONGLY B: Protection of the environment should be given priority even at the risk of slowing economic growth. | | 23 |

*no opinion omitted ~6%

| **4. An energy company is proposing new facilities to export fossil fuel from Coos Bay, a project called Jordan Cove. The proposal involves installing a 36-inch pipe across 229 miles of private and public land, storage facilities and a gas liquification plant, becoming the largest greenhouse gas emitter in Oregon. Proponents say it will create about 2000 temporary jobs and about 200 permanent jobs; they like the jobs and economic growth promises. Opponents say it will spoil public and private lands, require governmental condemnation of private property, and contribute to global warming from mining and burning fossil fuel. From what you know about this project would you say that you...** | N=1115 Combined Strong+ Lean % | N=1115 % |
|---|---|---|
| Strongly oppose the project | 57 | 30 |
| Lean toward opposing the project | | 27 |
| Undecided or neutral | 20 | 20 |
| Lean towards supporting the project | 22 | 16 |
| Strongly support the project | | 6 |

| 5.1 Jobs and economic growth justify the project. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| Strongly disagree | 49 | 24 |
| Lean disagree | | 25 |
| Undecided or don't know | 21 | 21 |
| Lean agree | 31 | 23 |
| Strongly agree | | 8 |

| 5.2 Construction crossing steep forest lands will have negative impacts on watersheds, landowners and local communities. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| Strongly disagree | 19 | 5 |
| Lean disagree | | 14 |
| Undecided or don't know | 20 | 19 |
| Lean agree | 63 | 28 |
| Strongly agree | | 35 |

| 5.3 Fossil fuel projects should be prevented because it contributes to global warming, ocean acidification, sea level rise and habitat loss. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| Strongly disagree | 28 | 11 |
| Lean disagree | | 17 |
| Undecided or don't know | 21 | 20 |
| Lean agree | 52 | 26 |
| Strongly agree | | 26 |

| 5.4 The project should be built because of the free market principles of our democracy. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| Strongly disagree | 49 | 27 |
| Lean disagree | | 22 |
| Undecided or don't know | 26 | 26 |
| Lean agree | 25 | 18 |
| Strongly agree | | 7 |

| 5.5 Fossil fuels should be reserved for U.S. jobs and energy security within this country instead of exported to foreign countries. | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| Strongly disagree | 18 | 7 |
| Lean disagree | | 11 |
| Undecided or don't know | 32 | 31 |
| Lean agree | 52 | 32 |
| Strongly agree | | 20 |

| 6. Hundreds of Oregon landowners own land the pipeline would need to cross. Condemnation (eminent domain) by government would be used against unwilling landowners. Does the use of government condemnation of private property for a private Canadian corporation affect your opinion? | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| **Strongly increases support** | **8** | **3** |
| **Somewhat increases support** | | **5** |
| **No change in support or opposition** | **27** | **26** |
| **Somewhat increases opposition** | **66** | **29** |
| **Strongly increases opposition** | | **37** |
| Total % | **100** | **100** |

| 7. The Jordan Cove proposal allows up to 100% of the natural gas to come from Canada and be exported to Asian markets through Oregon. If you knew it was Canadian natural gas, not U.S. sourced gas serving the project would this increase or decrease your support? | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| **Strongly increases support** | **10** | **2** |
| **Somewhat increases support** | | **8** |
| **No change in support or opposition** | **47** | **47** |
| **Somewhat increases opposition** | **42** | **19** |
| **Strongly increases opposition** | | **23** |
| **Total %** | **100** | **100** |

| **8.** A recent report* found that the total greenhouse gas emissions of Jordan Cove would be above 36 million metric tons per year which is more than half of Oregon's present total of 62 million tons of greenhouse gas emissions. This report says that the liquified natural gas (LNG) impacts from Jordan Cove are equal to those of burning coal. At this time, Oregon's energy policy aims at reducing greenhouse emissions dramatically each year to reach Oregon's, as well as the Paris Climate Agreement, goals. Proponents claim that natural gas is cleaner than coal and can serve as a bridge fuel toward non-fossil fuel options. From all things you know now, which statement comes closest to your view even if neither represents your view exactly? *(citation: http://priceofoil.org/2018/01/11/jordan-cove-lng-and-pacific-connector-pipeline-greenhouse-gas-emissions/) | N=1115 % |
|---|---|
| **A. The revenue generated in Oregon and subsequent economic benefit from the project will more than offset any adverse effects to Oregon from climate change.** | **31** |
| **B. Climate change impacts are already threatening Oregon's economic and environmental future and Jordan Cove will have more cost than benefit to our state.** | **69** |
| Total % | 100 |

| Q9. Which of these two statements comes closer to your view about the project: A. It is desirable because of the jobs and economic growth. OR B. It is undesirable because of private property rights and environmental impacts. | N=1115 % |
|---|---|
| **A. It is desirable because of the jobs and economic growth.** | **31** |
| **B. It is undesirable because of private property rights and environmental impacts.** | **69** |
| Total (may not total due rounding error) | 100 |

**Which of the following statements comes closest to your view even if neither represents your view exactly:**

| Q10. A or B: A: Too much power is concentrated in the hands of large corporations. OR B: Large corporations and companies have the necessary muscle to get good things done. | PEW 2014 national telephone N=10013* q.25n | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|---|
| **FEEL STRONGLY A: Too much power is concentrated in the hands of large corporations.** | 78 | **76** | **41** |
| Lean towards A. | | | **35** |
| Lean towards B. | 18 | **24** | **18** |
| **FEEL STRONGLY B: Large corporations and companies have the necessary muscle to get good things done.** | | | **6** |

*Pew 2014: 4% volunteer neither/both/don't know

| Q11. A or B: A: It's best for the future of our country to be active in world affairs. OR B: We should pay less attention to problems elsewhere and concentrate on problems here at home. | PEW National 2014 N10013*% | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|---|
| **FEEL STRONGLY A: It's best for the future of our country to be active in world affairs.** | 35 | **51** | **23** |
| Lean towards A. | | | **28** |
| Lean towards B. | 59 | **48** | **25** |
| **FEEL STRONGLY B: We should pay less attention to problems elsewhere and concentrate on problems here at home.** | | | **23** |

*Pew 2014: 6% volunteer neither/both/don't know

| Q12. A or B: A: Abundant fossil fuels are necessary to power our economic prosperity. OR B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the ground. | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| **Feel Strongly A. Abundant fossil fuels are necessary to power our economic prosperity..** | **28** | **9** |
| LEAN TOWARD A. | | **19** |
| LEAN TOWARD B. | **72** | **24** |
| **Feel Strongly B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the ground.** | | **48** |

| Q13. A or B: A: Our country would be better off if we all consumed less. OR B: We need to buy goods for the good of the economy. | PI Oregon Internet Dec '17 N=518 | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|---|
| **Feel Strongly A. Our country would be better off if we all consumed less.** | **32** | **75** | **40** |
| LEAN TOWARD A. | **36** | | **35** |
| LEAN TOWARD B. | **30** | **26** | **17** |
| **Feel Strongly B. We need to buy goods for the good of the economy.** | **7** | | **9** |

| Q14. From what you've read and heard, is there solid evidence that the average temperature on earth has been getting warmer over the past few decades, or not? | PI IA Telephone Sept.2017 N400 - % | N=1115 % |
|---|---|---|
| **Hoax. It's just not happening.** | **4** | **7** |
| **No solid evidence; we just don't know enough yet.** | **13** | **14** |
| **Yes, solid evidence. Mostly because of natural patterns in Earth's environment.** | **22** | **22** |
| **Yes, solid evidence. Mostly because of human activity such as burning fossil fuels.** | **54** | **48** |
| **Don't know** | **8** | **8** |
| Total % (may not total due rounding error) | 100 | 100 |

Oregon random dial cell/landline N=400 Sept 2017 full survey on request: info@policyinteractive

## DEMOGRAPHICS

| Mark your age category: | Oregon SOS Voter 2017* | Oregon (US Census 2016* | N=1115 |
|---|---|---|---|
| **Below 18 years of age** | **0** | **0** | **0** |
| **18-24** | **22** | **29** | **6** |
| **25-34** | | | **17** |
| **23** | | | |
| **35-44** | **15** | **17** | **21** |
| **45-54** | **15** | **17** | **18** |
| **55-64** | **18** | **17** | **20** |
| **65 and above** | **31** | **20** | **18** |
| Total | 100 | 100 | 100 |

*note that the two data sources target registered voters who frequently vote, thus the census of general population age distribution will show higher percentage of lower age cohorts because younger ages do participate in elections as much as older cohorts.

| What is your political party affiliation? - Selected Choice | | |
|---|---|---|
| | Oregon SOS Voter Registration 2017 % | N=1115 % |
| Republican | 31 | 27 |
| Democrat | 42 | 35 |
| Non-affiliated or independent | 27 | 36 |
| Another party (please specify - 20 CHARACTER LIMIT) | | 1 |
| Total | | 100 |

| Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | |
|---|---|---|
| | Oregon SOS Voter Registration 2017 | N=1115 % |
| Republican | 31% | 35 |
| Democrat | 42% | 47 |
| I try to avoid voting for candidates of either of the two major parties. | 27% (other party or registration) | 19 |
| Total | | 100 |

| The terms conservative, moderate, and liberal are sometimes used to describe how people feel about social and political issues. What best describes your own position, using these terms? | | |
|---|---|---|
| | American National Election Studies 2017 | N=1115 % |
| Very Conservative | 11 | 10 |
| Lean Conservative | 13 | 19 |
| Moderate | 32 | 27 |
| Lean Liberal | 20 | 23 |
| Very Liberal | 16 | 14 |
| Don't know NA | 8 | 7 |
| Total | 100 | 100 |

| Mark your gender | | | |
|---|---|---|---|
| | | Oregon Census 20132016 % | N=1115 % |
| | **Male** | **48.4** | **48** |
| | **Female** | **51.6** | **52** |
| | **Decline to answer** | **--** | **1** |
| | **Total** | | **100** |

| Indicate your household income last year, your best estimate will do. | | | |
|---|---|---|---|
| | | Oregon Census 2016 % | N=1115 % |
| | **Less than $25,000** | **21** | **18** |
| | **$25,000-49,999** | **22** | **22** |
| | **$50,000-74,999** | **17** | **22** |
| | **$75,000-99,999** | **12** | **14** |
| | **$100,000–150,000** | **14** | **13** |
| | **Above $150,000** | **7** | **6** |
| | **Decline to answer** | **--** | **5** |
| | Total | | 100 |

**Optional: Do you have any comments you'd like to make about this survey or the current political scene? We appreciate any feelings or thoughts you may have, and we read comments carefully.**

| Open answers on request, to be attached to final as appendix | | Response Percent | Response Total |
|---|---|---|---|
| 1 | Open-Ended Question | 100.00% | 237 |

Full Methodology available on request: info@policyinteractive.org

Brief methodology:

General: Survey designed and conducted by PolicyInteractive Research, Eugene, Oregon. This is a non-statistical sample as defined by American Association of Public Research because it employs opt-in internet sampling. Two sources of respondent participation were employed: Mechanical Turk panel of 147 Oregon resident respondents and Research Now Panel of 985 Oregon citizen respondents. Both panels provide a token monetary reward of approximately one dollar for taking the survey similar to inserting a dollar bill in an envelope in a traditional mail-out survey. The use of these panels is based on five years of respondent modeling opinion research and pilot projects of Oregon opinion. Our methods are partly driven by the dramatic drop in response rates in random dial telephone surveying and subsequent concerns about validity. PI has run a series of survey comparisons using both random dial opt-out telephone and opt-in internet sampling across six years of surveying finding that the two sampling styles yield similarity generally within five percent variation. Greater variation in response characteristics are commonly observed in demographic variations in political party, gender, age, and regional identities, and weighting selected demographic skews are occasionally employed to address representativeness. The tables above present in buff background the percentages of total respondents by both response option and, where applicable, “strongly” and “lean” responses combined. The blue columns employ control benchmarks drawn from other sources we deem

reputable and pertinent, including Census, Oregon Secretary of State, Pew Research Center, and others. A more detailed explanation is available on request.

Weighting: As mentioned above, it is optimal to obtain naturally run match to key demographics of the population being studied. Nonetheless, sometimes sampling will skew outside of acceptable bounds of normal distribution. In practice, examination of sample distribution is undertaken after the sample is run naturally and collected. In this survey, key demographic distributions were acceptably distributed except for geographic location across Oregon. For this study, we selected Congressional districts as our geographic distribution to maintain numerical population counts of the districts approximate to n=200. Congressional districts #3 and #2 where 7% and 4% below target, respectively. These unacceptable deviations were corrected by mathematical proportional weighting of each congressional district using statistical software whereby each district was assigned greater or lesser influence. This brings the skews into alignment with these geographic district targets while retaining all of the respondent participants. The consequences of the weighting turned out to have minor influence on response percentages, with changes commonly one percent or less.

Internet Surveys - How valid are they? As described above in "general", this survey employed two internet survey audiences source providers to obtain Oregon public participants. A question often arises, why use internet surveying instead of telephone sampling? The explanation of pros and cons of telephone vs. internet polling can fill a book or take many pages of detailed discussion. For the ambitious reader willing to read something between a brief discussion and a series of books, we suggest reading Pew Research Centers excellent discussion: Link to Mode Difference Study[i] Pew Research Center has released a series of studies and comparative results on the topic of telephone vs. internet sampling. The recent study titled "Does telephone interviewing understate support for President Trump" summarizes its results with: "*Little evidence that telephone versus online interviewing affects polling data on public support for key policy proposals.*" As with Pew's comparative overview of public policy questions, PI's six years of of phone and internet sampling side-by-side comparisons find differences are commonly less than 5%. Our objective is to obtain accurate representativeness of the population, in this instance Oregon. We follow recommended practices of knowing our sample providers, use of multiple providers to improve broader representation, control for geo-demographic skews, evaluation of comparison with valid benchmark indicators for consistency and application of post survey weighting to bring influential demographic skews into alignment with population.

With the question of how valid are internet surveys should be asked how valid are telephone surveys. Response rates to telephone surveys have plummeted over the past several decades to less than 10%, raising some questions as to how characteristic of the population are these people willing to undergo an interruption in their life to field a set of unexpected questions. We find that research shows they both are valid if properly administered. Importantly, those who use the information must understand that either mode is susceptible to various types of survey error. Research by others finds that several key advantages of internet sampling over telephone sampling include less sensitivity to social desirability response error, less sensitivity to clarity of verbal exchange over the telephone, less sensitivity to recency-latency question scale error, and improved disposition of respondent taking a survey at their choice of time compared to being interrupted by a random telephone call.

We invite critique of or feedback on our methodology at: info@policyinteractive.org.

[i] http://www.pewresearch.org/2017/03/31/appendix-a-summary-of-mode-differences-by-question/

# Cross Tabs of 2018 Poll on JCEP/PCGP

## Oregon Attitudes about Jordan Cove Energy Facility Siting

On-line Survey source: ResearchNow Jan/Feb 2018 & MTurk Jan/Feb 2018
Full survey sample combined sources N=1115; Source break-out avail. on request
Conducted by PolicyInteractive Research: info@policyinteractive.org

(Sample is weighted, see methodology at end of survey - Columns may not total 100% due to rounding)
Blue columns represent selected benchmark comparisons, buff columns present combined source totals

In January/February 2018 PolicyInteractive conducted an Oregon statewide online public opinion poll on Jordan Cove Energy Project and Pacific Connector Gas Pipeline. The following are some of the crosstab results by Congressional District and by voting tendencies reflecting Oregon attitudes.

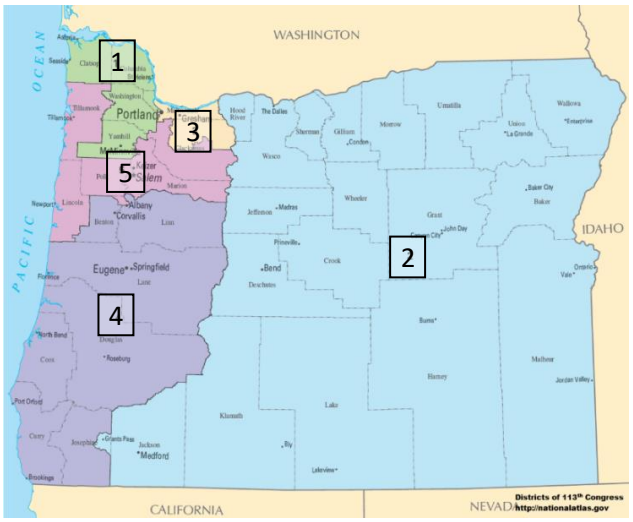
Link to complete Survey with methodology is available online at:
http://www.policyinteractive.org/public/JordanCoveFacilityProposalOpinionSurvey2.14.18.pdf

| KEY: | Main Question | Cross Tab Questions | >50% | Total |
|---|---|---|---|---|

Proposed Jordan Cove Energy Project is located in Oregon Congressional District 4

Proposed Pacific Connector Gas Pipeline crosses property in Congressional Districts 2 and 4.

Survey is weighed for 214-215 respondents from each Congressional District



| 4. An energy company is proposing new facilities to export fossil fuel from Coos Bay, a project called Jordan Cove. The proposal involves installing a 36-inch pipe across 229 miles of private and public land, storage facilities and a gas liquification plant, becoming the largest greenhouse gas emitter in Oregon. Proponents say it will create about 2000 temporary jobs and about 200 permanent jobs; they like the jobs and economic growth promises. Opponents say it will spoil public and private lands, require governmental condemnation of private property, and contribute to global warming from mining and burning fossil fuel. From what you know about this project would you say that you... | N=1115 Combined Strong+ Lean % | N=1115 % |
|---|---|---|
| Strongly oppose the project | 57 | 30 |
| Lean toward opposing the project | | 27 |
| Undecided or neutral | 20 | 20 |
| Lean towards supporting the project | 22 | 16 |
| Strongly support the project | | 6 |

Cross tabulated with Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q4. An energy company is proposing new facilities to export fossil fuel from Coos Bay, a project called Jordan Cove. The proposal involves installing a 36-inch pipe across 229 miles of private and public land, storage facilities and a gas liquification pl | Strongly oppose the project | 56% | 52% | 67% | 53% | 57% | 57% |
| | Lean towards opposing the project | | | | | | |
| | Undecided or neutral | 17% | 27% | 17% | 21% | 20% | 20% |
| | Lean towards supporting the project | 27% | 22% | 17% | 26% | 23% | 23% |
| | Strongly support the project | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q4. An energy company is proposing new facilities to export fossil fuel from Coos Bay, a project called Jordan Cove. The proposal involves installing a 36-inch pipe across 229 miles of private and public land, storage facilities and a gas liquification pl | Strongly oppose the project | 33% | 76% | 54% | 57% |
| | Lean towards opposing the project | | | | |
| | Undecided or neutral | 22% | 14% | 31% | 20% |
| | Lean towards supporting the project | 45% | 10% | 15% | 23% |
| | Strongly support the project | | | | |
| Total | | 386 | 523 | 207 | 1116 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| 5.1 Jobs and economic growth justify the project. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| **Strongly disagree** | **49** | **24** |
| **Lean disagree** | | **25** |
| **Undecided or don't know** | **21** | **21** |
| **Lean agree** | **31** | **23** |
| **Strongly agree** | | **8** |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| **Q5_1. Jobs and economic growth justify the project.** | Strongly disagree | 50% | 40% | 62% | 42% | 47% | 48% |
| | Lean disagree | | | | | | |
| | Undecided or don't know | 16% | 28% | 18% | 19% | 22% | 21% |
| | Lean agree | 33% | 32% | 19% | 39% | 31% | 31% |
| | Strongly agree | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| **Q5_1. Jobs and economic growth justify the project.** | Strongly disagree | 24% | 68% | 43% | 48% |
| | Lean disagree | | | | |
| | Undecided or don't know | 20% | 17% | 32% | 21% |
| | Lean agree | 57% | 14% | 25% | 31% |
| | Strongly agree | | | | |
| Total | | 386 | 523 | 207 | 1116 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| 5.2 Construction crossing steep forest lands will have negative impacts on watersheds, landowners and local communities. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| Strongly disagree | 19 | 5 |
| Lean disagree | | 14 |
| Undecided or don't know | 20 | 19 |
| Lean agree | 63 | 28 |
| Strongly agree | | 35 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q5_2. Construction crossing steep forest lands will have negative impacts on watersheds, landowners and local communities. | Strongly disagree | 18% | 17% | 16% | 23% | 18% | 18% |
| | Lean disagree | | | | | | |
| | Undecided or don't know | 19% | 22% | 11% | 23% | 20% | 19% |
| | Lean agree | 63% | 61% | 74% | 54% | 62% | 63% |
| | Strongly agree | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of | Total |
| Q5_2. Construction crossing steep forest lands will have negative impacts on watersheds, landowners and local communities. | Strongly disagree | 33% | 9% | 14% | 18% |
| | Lean disagree | | | | |
| | Undecided or don't know | 26% | 11% | 25% | 19% |
| | Lean agree | 41% | 80% | 60% | 63% |
| | Strongly agree | | | | |
| Total | | 386 | 522 | 207 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| 5.3 Fossil fuel projects should be prevented because it contributes to global warming, ocean acidification, sea level rise and habitat loss. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| Strongly disagree | 28 | 11 |
| Lean disagree | | 17 |
| Undecided or don't know | 21 | 20 |
| Lean agree | 52 | 26 |
| Strongly agree | | 26 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q5_3. Fossil fuel projects should be prevented because it contributes to global warming, ocean acidification, sea level rise and habitat loss. | Strongly disagree | 29% | 31% | 23% | 33% | 26% | 28% |
| | Lean disagree | | | | | | |
| | Undecided or don't know | 18% | 25% | 13% | 23% | 22% | 20% |
| | Lean agree | 53% | 44% | 64% | 44% | 51% | 51% |
| | Strongly agree | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q5_3. Fossil fuel projects should be prevented because it contributes to global warming, ocean acidification, sea level rise and habitat loss. | Strongly disagree | 55% | 13% | 17% | 28% |
| | Lean disagree | | | | |
| | Undecided or don't know | 24% | 12% | 35% | 20% |
| | Lean agree | 21% | 75% | 48% | 51% |
| | Strongly agree | | | | |
| Total | | 384 | 522 | 207 | 1113 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| 5.4 The project should be built because of the free market principles of our democracy. | N=1115 Combined Strong+Lean % | N=1115 % |
|---|---|---|
| Strongly disagree | 49 | 27 |
| Lean disagree | | 22 |
| Undecided or don't know | 26 | 26 |
| Lean agree | 25 | 18 |
| Strongly agree | | 7 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q5_4. The project should be built because of the free market principles of our democracy. | Strongly disagree | 52% | 42% | 62% | 45% | 45% | 49% |
| | Lean disagree | | | | | | |
| | Undecided or don't know | 21% | 34% | 19% | 22% | 32% | 26% |
| | Lean agree | 27% | 23% | 19% | 33% | 23% | 25% |
| | Strongly agree | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q5_4. The project should be built because of the free market principles of our democracy. | Strongly disagree | 26% | 69% | 44% | 49% |
| | Lean disagree | | | | |
| | Undecided or don't know | 25% | 21% | 38% | 26% |
| | Lean agree | 49% | 11% | 18% | 25% |
| | Strongly agree | | | | |
| Total | | 385 | 522 | 208 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| 5.5 Fossil fuels should be reserved for U.S. jobs and energy security within this country instead of exported to foreign countries. | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| Strongly disagree | 18 | 7 |
| Lean disagree | | 11 |
| Undecided or don't know | 32 | 31 |
| Lean agree | 52 | 32 |
| Strongly agree | | 20 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q5_5. Fossil fuels should be reserved for U.S. jobs and energy security within this country instead of exported to foreign countries. | Strongly disagree | 20% | 9% | 22% | 17% | 19% | 17% |
| | Lean disagree | | | | | | |
| | Undecided or don't know | 34% | 30% | 29% | 29% | 33% | 31% |
| | Lean agree | 46% | 61% | 49% | 54% | 48% | 51% |
| | Strongly agree | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q5_5. Fossil fuels should be reserved for U.S. jobs and energy security within this country instead of exported to foreign countries. | Strongly disagree | 16% | 19% | 14% | 17% |
| | Lean disagree | | | | |
| | Undecided or don't know | 19% | 37% | 40% | 31% |
| | Lean agree | 65% | 44% | 46% | 52% |
| | Strongly agree | | | | |
| Total | | 384 | 523 | 207 | 1114 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| 6. Hundreds of Oregon landowners own land the pipeline would need to cross. Condemnation (eminent domain) by government would be used against unwilling landowners. Does the use of government condemnation of private property for a private Canadian corporation affect your opinion? | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| Strongly increases support | 8 | 3 |
| Somewhat increases support | | 5 |
| No change in support or opposition | 27 | 26 |
| Somewhat increases opposition | 66 | 29 |
| Strongly increases opposition | | 37 |
| Total % | 100 | 100 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q6. Hundreds of Oregon landowners own land the pipeline would need to cross. Condemnation (eminent domain) by government would be used against unwilling landowners. Does the use of government condemnation of private property for a private Canadian corpora | Strongly increases support | 10% | 7% | 9% | 4% | 9% | 8% |
| | Somewhat increases support | | | | | | |
| | No change in support or opposition | 26% | 23% | 22% | 31% | 28% | 26% |
| | Somewhat increases opposition | 64% | 70% | 69% | 65% | 63% | 66% |
| | Strongly increases opposition | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q6. Hundreds of Oregon landowners own land the pipeline would need to cross. Condemnation (eminent domain) by government would be used against unwilling landowners. Does the use of government condemnation of private property for a private Canadian corpora | Strongly increases support | 11% | 5% | 8% | 8% |
| | Somewhat increases support | | | | |
| | No change in support or opposition | 29% | 19% | 39% | 26% |
| | Somewhat increases opposition | 59% | 76% | 53% | 66% |
| | Strongly increases opposition | | | | |
| Total | | 386 | 522 | 207 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| 7. The Jordan Cove proposal allows up to 100% of the natural gas to come from Canada and be exported to Asian markets through Oregon. If you knew it was Canadian natural gas, not U.S. sourced gas serving the project would this increase or decrease your support? | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| Strongly increases support | 10 | 2 |
| Somewhat increases support | | 8 |
| No change in support or opposition | 47 | 47 |
| Somewhat increases opposition | 42 | 19 |
| Strongly increases opposition | | 23 |
| Total % | 100 | 100 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q7. The Jordan Cove proposal allows up to 100% of the natural gas to come from Canada and be exported to Asian markets through Oregon. If you knew it was Canadian natural gas, not U.S. sourced gas serving the project would this increase or decrease your s | Strongly increases support | 13% | 7% | 11% | 11% | 12% | 11% |
| | Somewhat increases support | | | | | | |
| | No change in support or opposition | 45% | 46% | 51% | 48% | 46% | 47% |
| | Somewhat increases opposition | 42% | 47% | 38% | 41% | 43% | 42% |
| | Strongly increases opposition | | | | | | |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q7. The Jordan Cove proposal allows up to 100% of the natural gas to come from Canada and be exported to Asian markets through Oregon. If you knew it was Canadian natural gas, not U.S. sourced gas serving the project would this increase or decrease your s | Strongly increases support | 12% | 10% | 10% | 11% |
| | Somewhat increases support | | | | |
| | No change in support or opposition | 43% | 47% | 55% | 47% |
| | Somewhat increases opposition | 45% | 43% | 35% | 42% |
| | Strongly increases opposition | | | | |
| Total | | 386 | 522 | 206 | 1114 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| **8.** A recent report* found that the total greenhouse gas emissions of Jordan Cove would be above 36 million metric tons per year which is more than half of Oregon's present total of 62 million tons of greenhouse gas emissions. This report says that the liquified natural gas (LNG) impacts from Jordan Cove are equal to those of burning coal. At this time, Oregon's energy policy aims at reducing greenhouse emissions dramatically each year to reach Oregon's, as well as the Paris Climate Agreement, goals. Proponents claim that natural gas is cleaner than coal and can serve as a bridge fuel toward non-fossil fuel options. From all things you know now, which statement comes closest to your view even if neither represents your view exactly? *(citation: http://priceofoil.org/2018/01/11/jordan-cove-lng-and-pacific-connector-pipeline-greenhouse-gas-emissions/) | N=1115<br>% |
|---|---|
| **A. The revenue generated in Oregon and subsequent economic benefit from the project will more than offset any adverse effects to Oregon from climate change.** | **31** |
| **B. Climate change impacts are already threatening Oregon's economic and environmental future and Jordon Cove will have more cost than benefit to our state.** | **69** |
| Total % | 100 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| **Q8. A recent report (found here) found that the total greenhouse gas emissions of Jordan Cove would be above 36 million metric tons per year which is more than half of Oregon's present total of 62 million tons of greenhouse gas emissions. This report says** | A. The revenue generated in Oregon and subsequent economic benefit from the project will more than offset any adverse effects to Oregon from climate change. | 30% | 36% | 25% | 36% | 29% | 29% |
| | B. Climate change impacts are already threatening Oregon's economic and environmental future and Jordan Cove will have more cost than benefit to our state. | 70% | 64% | 75% | 64% | 71% | 71% |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| **Q8. A recent report (found here) found that the total greenhouse gas emissions of Jordan Cove would be above 36 million metric tons per year which is more than half of Oregon's present total of 62 million tons of greenhouse gas emissions. This report says** | A. The revenue generated in Oregon and subsequent economic benefit from the project will more than offset any adverse effects to Oregon from climate change. | 57% | 12% | 31% | 31% |
| | B. Climate change impacts are already threatening Oregon's economic and environmental future and Jordan Cove will have more cost than benefit to our state. | 43% | 88% | 69% | 69% |
| Total | | 385 | 522 | 207 | 1114 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| Q9. Which of these two statements comes closer to your view about the project: A. It is desirable because of the jobs and economic growth. OR B. It is undesirable because of private property rights and environmental impacts. | N=1115 % |
|---|---|
| A. It is desirable because of the jobs and economic growth. | 31 |
| B. It is undesirable because of private property rights and environmental impacts. | 69 |
| Total (may not total due rounding error) | 100 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q9. A. It is desirable because of the jobs and economic growth. OR B. It is undesirable because of private property rights and environmental impacts. | A. It is desirable because of the jobs and economic growth. | 32% | 31% | 25% | 37% | 30% | 29% |
| | B. It is undesirable because of private property rights and environmental impacts. | 68% | 69% | 75% | 63% | 70% | 71% |
| Total | | 100% | 100% | 100% | 100% | 100% | 100% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q9. A. It is desirable because of the jobs and economic growth. OR B. It is undesirable because of private property rights and environmental impacts. | A. It is desirable because of the jobs and economic growth. | 57% | 14% | 24% | 31% |
| | B. It is undesirable because of private property rights and environmental impacts. | 43% | 86% | 76% | 69% |
| Total | | 385 | 523 | 207 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| Q10. A or B: A: Too much power is concentrated in the hands of large corporations. OR B: Large corporations and companies have the necessary muscle to get good things done. | PEW 2014 national telephone N=10013* q.25n | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|---|
| **FEEL STRONGLY A: Too much power is concentrated in the hands of large corporations.** | 78 | **76** | **41** |
| Lean towards A. | | | **35** |
| Lean towards B. | 18 | **24** | **18** |
| **FEEL STRONGLY B: Large corporations and companies have the necessary muscle to get good things done.** | | | **6** |

*Pew 2014: 4% volunteer neither/both/don't know

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| **Q10. A: Too much power is concentrated in the hands of large corporations. OR B: Large corporations and companies have the necessary muscle to get good things done.** | FEEL STRONGLY A: Too much power is concentrated in the hands of large corporations. | 73% | 73% | 85% | 73% | 78% | 76% |
| | Lean towards A. | | | | | | |
| | Lean towards B. | 27% | 27% | 15% | 27% | 22% | 24% |
| | FEEL STRONGLY B: Large corporations and companies have the necessary muscle to get good things done. | | | | | | |
| Total | | 223 | 222 | 222 | 223 | 223 | 1113 |
| | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| **Q10. A: Too much power is concentrated in the hands of large corporations. OR B: Large corporations and companies have the necessary muscle to get good things done.** | FEEL STRONGLY A: Too much power is concentrated in the hands of large corporations. | 57% | 90% | 77% | 76% |
| | Lean towards A. | | | | |
| | Lean towards B. | 43% | 10% | 23% | 24% |
| | FEEL STRONGLY B: Large corporations and companies have the necessary muscle to get good things done. | | | | |
| Total | | 385 | 522 | 207 | 1114 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| Q11. A or B: A: It's best for the future of our country to be active in world affairs. OR B: We should pay less attention to problems elsewhere and concentrate on problems here at home. | PEW National 2014 N10013*% | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|---|
| **FEEL STRONGLY A: It's best for the future of our country to be active in world affairs.** | 35 | **51** | **23** |
| Lean towards A. | | | **28** |
| Lean towards B. | 59 | **48** | **25** |
| **FEEL STRONGLY B: We should pay less attention to problems elsewhere and concentrate on problems here at home.** | | | **23** |

*Pew 2014: 6% volunteer neither/both/don't know

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| **Q11. A: It's best for the future of our country to be active in world affairs. OR B: We should pay less attention to problems elsewhere and concentrate on problems here at home.** | FEEL STRONGLY A: It's best for the future of our country to be active in world affairs. | 58% | 42% | 58% | 48% | 49% | 51% |
| | Lean towards A. | | | | | | |
| | Lean towards B. | 42% | 58% | 42% | 52% | 51% | 49% |
| | FEEL STRONGLY B: We should pay less attention to problems elsewhere and concentrate on problems here at home. | | | | | | |
| Total | | 224 | 222 | 223 | 224 | 223 | 1116 |
| | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| **Q11. A: It's best for the future of our country to be active in world affairs. OR B: We should pay less attention to problems elsewhere and concentrate on problems here at home.** | FEEL STRONGLY A: It's best for the future of our country to be active in world affairs. | 37% | 68% | 35% | 51% |
| | Lean towards A. | | | | |
| | Lean towards B. | 63% | 32% | 65% | 49% |
| | FEEL STRONGLY B: We should pay less attention to problems elsewhere and concentrate on problems here at home. | | | | |
| Total | | 385 | 523 | 207 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| Q12. A or B: A: Abundant fossil fuels are necessary to power our economic prosperity. OR B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the ground. | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|
| **Feel Strongly A. Abundant fossil fuels are necessary to power our economic prosperity..** | **28** | **9** |
| LEAN TOWARD A. | | **19** |
| LEAN TOWARD B. | **72** | **24** |
| **Feel Strongly B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the** | | **48** |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| **Q12. A. Abundant fossil fuels are necessary to power our economic prosperity. OR B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the ground.** | Feel Strongly A. Abundant fossil fuels are necessary to power our economic prosperity. | 30% | 30% | 25% | 31% | 27% | 28% |
| | Lean toward A. | | | | | | |
| | Lean toward B. | 70% | 70% | 75% | 69% | 73% | 72% |
| | Feel Strongly B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the ground. | | | | | | |
| Total | | 223 | 223 | 223 | 223 | 224 | 1116 |
| | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| **Q12. A. Abundant fossil fuels are necessary to power our economic prosperity. OR B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the ground.** | Feel Strongly A. Abundant fossil fuels are necessary to power our economic prosperity. | 55% | 12% | 21% | 29% |
| | Lean toward A. | | | | |
| | Lean toward B. | 45% | 88% | 79% | 71% |
| | Feel Strongly B. Renewable energy like wind and solar power is the most promising economic path with fossil fuels best left in the ground. | | | | |
| Total | | 386 | 522 | 207 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| Q13. A or B: A: Our country would be better off if we all consumed less. OR B: We need to buy goods for the good of the economy. | PI Oregon Internet Dec '17 N=518 | N=1115 Strong+Lean Combined % | N=1115 % |
|---|---|---|---|
| Feel Strongly A. Our country would be better off if we all consumed less. | 32 | 75 | 40 |
| LEAN TOWARD A. | 36 | | 35 |
| LEAN TOWARD B. | 30 | 26 | 17 |
| Feel Strongly B. We need to buy goods for the good of the economy. | 7 | | 9 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q13. A: Our country would be better off if we all consumed less. OR B: We need to buy goods for the good of the economy. | FEEL STRONGLY A: Our country would be better off if we all consumed less. | 78% | 67% | 82% | 71% | 75% | 74% |
| | Lean towards A. | | | | | | |
| | Lean towards B. | 22% | 33% | 18% | 29% | 25% | 26% |
| | FEEL STRONGLY B: We need to buy goods for the good of the economy. | | | | | | |
| Total | | 223 | 224 | 223 | 223 | 222 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q13. A: Our country would be better off if we all consumed less. OR B: We need to buy goods for the good of the economy. | FEEL STRONGLY A: Our country would be better off if we all consumed less. | 63% | 85% | 69% | 75% |
| | Lean towards A. | | | | |
| | Lean towards B. | 37% | 15% | 31% | 25% |
| | FEEL STRONGLY B: We need to buy goods for the good of the economy. | | | | |
| Total | | 385 | 523 | 206 | 1114 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

| Q14. From what you've read and heard, is there solid evidence that the average temperature on earth has been getting warmer over the past few decades, or not? | PI IA Telephone Sept.2017 N400 - % | N=1115 % |
|---|---|---|
| Hoax. It's just not happening. | 4 | 7 |
| No solid evidence; we just don't know enough yet. | 13 | 14 |
| Yes, solid evidence. Mostly because of natural patterns in Earth's environment. | 22 | 22 |
| Yes, solid evidence. Mostly because of human activity such as burning fossil fuels. | 54 | 48 |
| Don't know | 8 | 8 |
| Total % (may not total due rounding error) | 100 | 100 |

Cross tabulated by Oregon Congressional Districts

| | | Zip codes assigned to respective districts | | | | | |
|---|---|---|---|---|---|---|---|
| | | District 1 | District 2 | District 3 | District 4 | District 5 | Total |
| Q14. From what you've read and heard, is there solid evidence that the average temperature on earth has been getting warmer over the past few decades, or not? | Hoax, It's just not happening. | 20% | 28% | 17% | 24% | 19% | 22% |
| | No solid evidence; we just don't know enough yet. | | | | | | |
| | Yes, solid evidence. Mostly because of natural patterns in Earth's environment. | 74% | 63% | 74% | 67% | 72% | 70% |
| | Yes, solid evidence. Mostly because of human activity such as burning fossil fuels. | | | | | | |
| | Don't know | 5.4% | 9.0% | 9.0% | 9.4% | 8.9% | 8.3% |
| Total | | 222 | 222 | 223 | 223 | 225 | 1115 |
| | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

Cross tabulated with how respondents tend to vote

| | | Q20. Irrespective of your political party registration, is your general tendency to vote more for a Republican or Democrat in an election? | | | |
|---|---|---|---|---|---|
| | | Republican | Democrat | I try to avoid voting for candidates of either of the two major parties. | Total |
| Q14. From what you've read and heard, is there solid evidence that the average temperature on earth has been getting warmer over the past few decades, or not? | Hoax, It's just not happening. | 44% | 6% | 18% | 21% |
| | No solid evidence; we just don't know enough yet. | | | | |
| | Yes, solid evidence. Mostly because of natural patterns in Earth's environment. | 46% | 90% | 64% | 70% |
| | Yes, solid evidence. Mostly because of human activity such as burning fossil fuels. | | | | |
| | Don't know | 10% | 4% | 18% | 8% |
| Total | | 385 | 522 | 207 | 1114 |
| | | 100.0% | 100.0% | 100.0% | 100.0% |

OILCHANGE INTERNATIONAL

JANUARY 2018

# JORDAN COVE LNG AND PACIFIC CONNECTOR PIPELINE GREENHOUSE GAS EMISSIONS BRIEFING

## FACTS AT A GLANCE

| | |
|---|---|
| **Total Annual GHG Emissions:** | **36.8 million metric tons** |
| **Emissions Equivalent:** | **15.4 times the 2016 emissions of Oregon's last remaining coal-fired power plant (the Boardman plant) – or 7.9 million passenger vehicles** |
| **Pipeline Project Name:** | Pacific Connector Gas Pipeline |
| **LNG Export Terminal Project Name:** | Jordan Cove Energy Project |
| **Ownership:** | Pembina Pipeline Corporation |
| **Operator:** | TBD |
| **Pipeline Length:** | 229 miles |
| **Pipeline Diameter:** | 36 inches |
| **Pipeline Capacity:** | 1.2 billion cubic feet per day (cf/d) |
| **LNG Export Capacity:** | 7.8 million metric tons of gas per year (MMT/Y) |
| **Project Cost:** | $10 billion |
| **Land Affected:** | 5,146 acres |
| **States Directly Affected:** | Oregon |
| **Counties Affected:** | Coos, Douglas, Jackson, and Klamath |
| **Gas Source:** | The Rocky Mountain states of Utah, Wyoming, and Colorado and the Montney Basin in British Columbia |
| **Claimed Destination Markets:** | Primarily Asia – Japan and China |
| **Intended Permit and Project Schedule (Est.):** | Final Environmental Impact Statement (August 2018); FERC order granting authorization and state permits (November 2018); Construction (first half of 2019); In-service date (first half of 2024) |

## SUMMARY


The proposed Pacific Connector Gas Pipeline and Jordan Cove Energy Project would transport and process into liquefied natural gas (LNG) around 430 billion cubic feet of fossil gas annually.[a] The greenhouse gas (GHG) emissions triggered by the project will be significant, but to date the scope of these emissions has not been well understood.

This paper provides an estimate of the full lifecycle emissions of the project, calculating a reference and high case estimate using the best available information. It finds that the project would add significantly to greenhouse gas emissions both globally and within the state of Oregon.

The emissions estimate includes an estimated range of methane leakage along the supply chain and finds that even a conservative estimate of methane leakage undermines claims that the gas supplied to global markets via the project would lead to a net reduction in GHG emissions. The paper also finds that there is no evidence to support an assumption that gas supplied by the project would replace coal in global markets.

In order to address the global climate crisis, emissions from all sources of fossil fuel must be reduced to zero by mid-century. Building and operating this project will undermine that goal. This paper provides the clear climate rationale against the project going ahead.


a We use the term fossil gas to mean natural gas produced from fossil fuel sources.

Above: LNG Tanker ©Smit Ebro , Grace Dahlia & Fairplay 21

# PACIFIC CONNECTOR GAS PIPELINE MAP

# PROJECT OVERVIEW

The Pacific Connector Gas Pipeline (PCGP) is a proposed 36-inch fracked gas pipeline that would run 229 miles across southern Oregon to a proposed liquefied natural gas export terminal at Jordan Cove, near Coos Bay, OR. The pipeline would start in southern Klamath County in the farming community of Malin, OR.

The proposed route of the pipeline crosses the Cascade mountains, threatening public and private lands, traditional tribal territories, and more than 2,000 acres of forest. Close to 400 rivers and streams would be crossed, including the Rogue, Klamath, Umpqua, Coos, and Coquille Rivers.

The project is facing significant opposition from indigenous communities along the pipeline route, including the Klamath Tribes, as well as the Yurok and Karuk Tribes along the Klamath River. The construction of the pipeline and the terminal would disturb sacred sites, burial grounds, and cultural resources and could also impact critical runs of salmon and steelhead. The Jordan Cove LNG export terminal would be built on traditional Coos tribal territory. There are also over 500 landowners along the pipeline route that would be impacted by the pipeline, and many will face eminent domain proceedings for the private project if it moves forward. More than 400 landowners, organizations, tribal members, and concerned citizens have filed motions to intervene with the Federal Energy Regulatory Commission (FERC) in opposition to the project, with only five interventions filed in support.[1]

The project backer is the Canadian company Pembina Pipeline Corporation, a fossil fuel giant that recently merged with Veresen, the original proponent of the pipeline proposal. The pipeline would be fed by either of two existing pipelines – the Ruby Pipeline that runs from the Rocky Mountains in Wyoming to Malin, or the Gas Transmission Northwest pipeline that runs from British Columbia. Each pipeline is capable of carrying 100 percent of Pacific Connector's capacity of 1.2 billion cubic feet per day. This creates a unique situation in which Canadian and U.S. fracked gas could compete for export, and opens the possibility that Jordan Cove could provide export service for 100 percent Canadian-sourced fracked gas.

The Pacific Connector Pipeline and the Jordan Cove Energy Project were first proposed in 2005 as a gas import project. The original project was vacated in 2012 and replaced with a LNG export proposal in 2013. In a rare federal decision, FERC denied the project application in 2016, stating that, "because the record does not support a finding that the public benefits of the Pacific Connector Pipeline outweigh the adverse effects on landowners, we deny Pacific Connector's request for certificate authority to construct and operate its project."[2] In early 2017, project backers reapplied under the Trump administration, which has stacked FERC with new appointees.

Pembina plans to complete the federal and state permit process by November 2018. It plans to begin construction in the first half of 2019 and bring the export terminal online by the first half of 2024.

Proposed path of pipeline through Umpqua National Forest, south of Tiller, MP 109.

# FOSSIL GAS AND CLIMATE CHANGE

Climate science clearly indicates the need to reduce consumption of all fossil fuels and make a just transition to a clean energy economy.[3] Building major fossil gas infrastructure today undermines action to protect our climate. Increasing access to fossil gas spurs its use, locking us into releasing more emissions when we must progressively produce and use less of all fossil fuels, including gas.

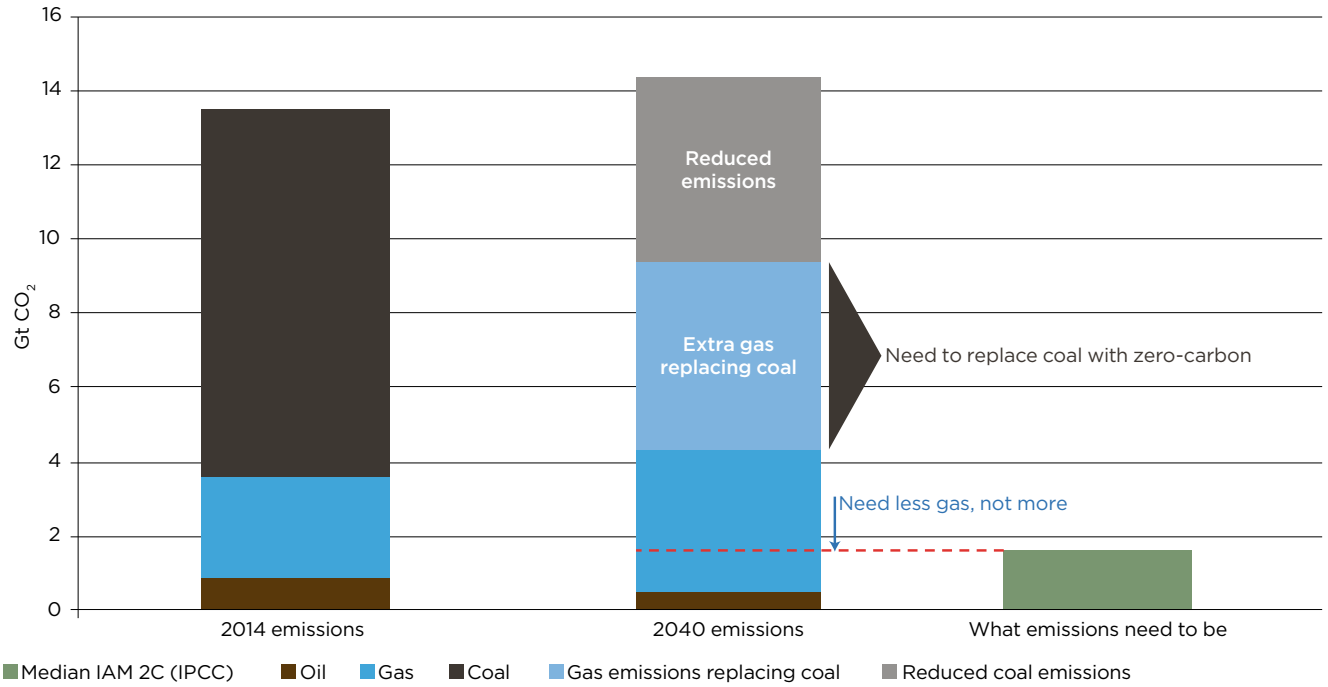
Much of the debate on fossil gas and climate has focused on measuring and reducing the leakage of methane, a potent greenhouse gas, to the atmosphere. But focusing on methane leakage alone distracts from the core issue at hand. To meet climate goals, fossil gas production and consumption must, like that of other fossil fuels, be phased out. Reducing methane leakage, even to zero, does not alter that fact.

Fossil gas proponents also argue that more gas capacity is needed to complement renewable energy sources. Several factors undermine this case, summarized as follows:[4]

1. **No Room for New Fossil Gas:** Climate goals require the power sector to be decarbonized by mid-century. This means gas use must be phased out, not increased (see Figure 1).
2. **New Gas is Holding Back Renewable Energy:** Wind and solar are now cheaper than coal and gas in many regions. This means new gas capacity often displaces new wind and solar rather than old coal.
3. **The Wrong Gas at the Wrong Time:** Claims that gas supports renewable energy development are false. The cheapest gas generation technology, Combined Cycle Gas Turbines (CCGT), is designed for base load operation, not intermittent peaking. In any case, most grids are a long way from renewable energy penetration levels that would require back up. Storage and demand response will be ready to step in by the time they are really required.
4. **New Gas Locks in Emissions for 40+ Years:** Companies building multibillion-dollar gas infrastructure today expect to operate their assets for around 40 years. Emissions goals mean this expectation cannot be met.
5. **Too Much Gas Already:** The coal, oil, and gas in the world's currently producing and under construction projects, if fully extracted and burned, would take the world far beyond safe climate limits. Opening new gas fields is inconsistent with the Paris climate goals.

The fact that methane leakage cannot be reduced to zero, and therefore emissions from fossil gas are in fact higher than is often accounted for, only makes the phasing out of fossil gas more urgent. By enabling an increase in production and consumption of fossil gas, the Jordan Cove LNG terminal and Pacific Connector Gas pipeline will contribute significant amounts of greenhouse gas emissions that will exacerbate climate change.

**Figure 1: We Need Less Gas, Not More: Global Emissions from Power Generation (2014 and projected 2040 in IEA New Policies Scenario) Compared to Median IPCC 2040 Power Emissions Consistent With a Likely 2°C Scenario**




Source: Oil Change International analysis, see Endnote 4.

# PROJECT EMISSIONS ESTIMATED AT 36.8 MILLION METRIC TONS ANNUALLY

The lifecycle greenhouse gas emissions of the project depend on the amount of gas exported through it, and the methane and carbon emissions associated with extracting, piping, processing, transporting, and burning that volume of gas.

The Jordan Cove LNG terminal is expected to export 7.8 million tons of LNG per year.[5] This would require around 85 percent of the 1.2 billion cf/d capacity of the Pacific Connector pipeline.[6] However, the Jordan Cove Energy Project has signed agreements to use 95.8 percent of the pipeline's capacity. This allows for an additional 10 percent of pipeline capacity for seasonal fluctuations and to carry gas to run equipment at the LNG terminal. The greenhouse gas emissions estimate is therefore based on delivering 1.15 billion cf/d to Jordan Cove.

In our reference case, which utilizes a mean methane leakage rate of 1.77 percent across the gas supply chain, we estimate the total lifecycle emissions caused by the project to be over 36.8 million metric tons (MMT) of carbon dioxide equivalent ($CO_2e$) per year. This is equivalent to over 15.4 times the 2016 emissions from Oregon's only remaining coal plant, the Boardman coal plant, or equivalent to the annual emissions from 7.9 million passenger vehicles. The Boardman plant is scheduled to close in 2020 because of climate and air pollution concerns.[7]

Based on a peer-reviewed study of methane leakage for gas production in three Rocky Mountain states,[8] a high-end estimate brings the overall leakage rate to just over 4 percent. This would raise the annual lifecycle emissions from the project to nearly 52 million metric tons. This would be nearly 22 times the emissions from the Boardman coal plant, or equivalent to the annual emissions from 11.1 million passenger vehicles.

For Oregon's emissions inventory, emissions savings from shutting down Boardman will be cancelled out by this project.

Annual emissions within Oregon would be over 2.2 MMT, which is slightly less than the 2016 emissions from the Boardman plant. For Oregon's emissions inventory, emissions savings from shutting down Boardman will be cancelled out by this project. In fact, in-state emissions could be higher if the project leads to additional gas being transported on the GTN pipeline from Canada. This would increase emissions at GTN compressor stations located in Oregon.

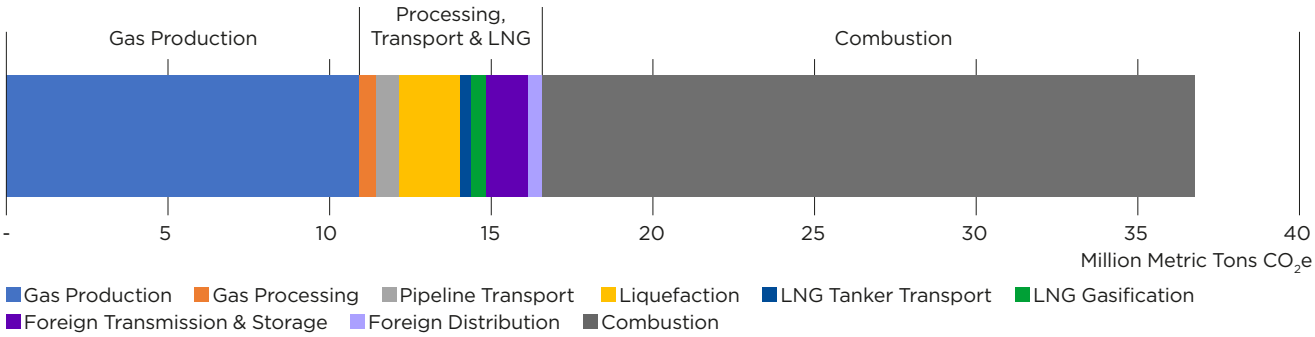
Outside of Oregon, emissions come from fracked gas production and processing, pipeline transport to the state line, tanker transport from Jordan Cove to destinations in Asia, transmission, distribution, and storage between the regasification facility

**Table 1: Lifecycle GHG Emissions from Jordan Cove LNG and Pacific Connector Pipeline**

| Lifecycle Stage | Reference Case (MMT/Y) | High Case (MMT/Y) |
|---|---|---|
| **Gas Production** | 10.9 | 26.0 |
| **Gas Processing** | 0.51 | 0.52 |
| **Pipeline Transport to Jordan Cove** | 0.78 | 0.78 |
| **Gas Liquefaction** | 1.8 | 1.8 |
| **Tanker Transport** | 0.44 | 0.44 |
| **LNG Gasification** | 0.40 | 0.40 |
| **Foreign Transmission & Storage** | 1.3 | 1.3 |
| **Foreign Distribution** | 0.43 | 0.43 |
| **Combustion** | 20.2 | 20.2 |
| **Total** | 36.8* | 52.0* |

*Figures may not add due to rounding.
Source: Oil Change International – See Appendix for details.

**Figure 2: Full Lifecycle Emissions from Jordan Cove LNG and Pacific Connector Pipeline - Reference Case**




Source: Oil Change International – See Appendix for details.

and points of final use, and finally the combustion of gas.

For methane leakage rates in the production zone, we reference a study published in *Environmental Science & Technology* in June 2017 by researchers from University of Wyoming and Colorado State University. That study quantified atmospheric methane emissions from active natural gas production sites in normal operation in four major U.S. basins/plays: Upper Green River (Wyoming), Denver-Julesburg (Colorado), Uintah (Utah), and Fayetteville (Arkansas).[9] The difference between our reference and high case estimates is primarily based on the difference between the middle and high measurements in the range of figures presented in this paper. However, we did make some downward adjustments to leakage rates in Colorado in both cases, in acknowledgment of new methane regulations in that state (see the Appendix for more details on leakage rates).[10]

For the pipeline and liquefaction emissions of the Jordan Cove and Pacific Connector project, we used emissions data from the latest project application.[11] Elsewhere in the supply chain, we used methane leakage rates based on EPA national averages where we did not have project-specific data. These figures likely underestimate leakage, leading to a conservative estimate of total emissions in our analysis.

We used a 20-year global warming potential factor of 86 to convert methane to carbon dioxide equivalent. For more details on methane assumptions and full details of sources and methods, please see the Appendix.

## LNG EXPORTS WOULD HAVE NO EMISSIONS ADVANTAGE OVER COAL

As climate science indicates we must move as quickly as possible toward zero emissions, replacing coal with gas is clearly not a climate solution.[12] Nonetheless, the gas industry and its supporters continue to use this as a talking point, claiming that doing so would lead to a net reduction in emissions. However, even in the hypothetical scenario that every molecule of gas exported from Jordan Cove replaces coal in the destination market, the emissions associated with this project suggest that no net saving in greenhouse gas emissions would occur. In fact, the project could lead to higher net greenhouse gas emissions.

In 2014, the U.S. Department of Energy (DOE) released a "Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States."[13] The report, conducted by the National Energy Technology Laboratory (NETL), found that "compared to domestically produced and combusted gas, there is a significant increase in the lifecycle GHG emissions that are attributed to the LNG supply chain, specifically from liquefaction, tanker transport, and regasification processes."

Domestically, the current climate "break-even" point for lifecycle methane leakage is about 2.7 percent when switching from coal to gas for electricity over a 20-year lifecycle. That means that new gas combined cycle power plants reduce climate impacts compared to coal plants only when leakage remains under 2.7 percent.[14] Other estimates have put the domestic break-even point at 2.8 percent.[15]

When exporting LNG to Asia, the methane leakage rate must be significantly lower to have a "break-even" climate impact. The DOE/NETL report found that when comparing the climate impacts of LNG to coal-fired electricity in China, the lifecycle methane leakage rate would have to stay below 1.4 percent – when exporting LNG from New Orleans to Shanghai – to produce benefits over a 20-year timeframe.

NETL did not model lifecycle greenhouse gas emissions resulting from exporting LNG from the West Coast of the United States to Asian markets. Presumably, the climate break-even point would be slightly higher when exporting LNG from Oregon's Jordan Cove to Asia, given the closer geographic proximity. For comparison, the report found that the break-even point for LNG exports from New Orleans to Europe is 1.9 percent. Therefore, based on the DOE/NETL estimates, the climate break-even point for LNG exported from Jordan Cove to Asia is likely somewhere between 1.4 and 1.9 percent.

Our reference case estimate of methane leakage along the project's entire chain of supply is 1.77 percent. This is likely a conservative estimate as a number of factors could mean the real leakage rate is significantly higher (see Appendix). Even at this relatively low methane leakage rate, claims that greenhouse gas emissions are reduced by replacing coal in Asia with LNG exports from Jordan Cove are unsubstantiated, in part because the methane leakage associated with the project will likely be above the break event point.

# FERC'S INADEQUATE CLIMATE ANALYSIS

The Federal Energy Regulatory Commission (FERC) is the primary federal agency that assesses the need for and impacts of interstate gas pipelines and LNG facilities, and it issues permits for construction and operation.[16]

FERC has yet to conduct an updated analysis of the Jordan Cove project, but we know FERC has repeatedly failed to fully assess and analyze the greenhouse gas emissions of the projects it permits. In August 2017, the Sierra Club together with landowners successfully overturned FERC's approval of the Southeast Market Pipelines Project, an interstate fossil gas pipeline project proposed through Alabama, Georgia, and Florida, based on inadequate information on greenhouse gas emissions in the project's environmental impact statement (EIS).[17] Although the project is already completed, the U.S. Court of Appeals vacated and remanded FERC's permits and ordered the agency to issue a supplemental EIS (SEIS) quantifying the project's downstream emissions.

FERC issued a draft of the SEIS in September 2017[18] and the Sierra Club filed detailed and scathing comments on the draft in November.[19] The Sierra Club comments not only call out the continuing inadequacy of FERC's climate emissions analysis, but also add clarity to the case for fully accounting for the entire emissions profile of fossil gas projects.

As in many of FERC's EIS documents, FERC preempts its discussion of greenhouse gas emissions and climate change in the draft SEIS with an assertion that the gas delivered by the project will replace dirtier fossil fuels, namely coal-fired power generation. The Sierra Club raises a number of points regarding this assumption that have salience for Jordan Cove LNG and similar proposed fossil gas infrastructure.

The Sierra Club argues that, to demonstrate that a project is instrumental to the retirement of other fossil fuel capacity, FERC must compare future scenarios with and without the project, rather than simply "juxtapos(ing) past conditions with a future in which the pipeline is built."[20]

A paper published in the international journal *Energy* in November 2017 discussed this issue in detail, specifically examining scenarios in which U.S. LNG is exported to Asia.[21] The paper found that the displacement of coal by LNG exports is far from a given, and that, as a result of U.S. exports of LNG, "emissions are not likely to decrease and may increase significantly due to greater global energy consumption, higher emissions in the US, and methane leakage."[22]

The Sierra Club comments also point out that accelerating projections of renewable energy adoption indicate that retiring coal capacity is not necessarily replaced with gas. Further, much of the coal generation capacity slated for retirement is old and inefficient. It is therefore typically operating far below capacity and likely to be retired whether a new gas pipeline is built or not. In this way, comparisons between retiring installed coal capacity and building new gas-fired capacity are misleading. For power plant emissions to be reduced by retiring coal and adding gas, new gas capacity would have to be run at similarly low utilization rates, which would likely not be economical. With no concrete analysis to back up its assumptions, FERC's attempt to discount gas pipeline emissions based on the offset of dirtier energy sources has no basis in fact.

The Jordan Cove Energy Project makes similar assertions regarding gas replacing coal, claiming that, "(n)atural gas is the cleanest-burning hydrocarbon available, and its transportation to other markets will allow consumers to move away from higher-emission fuels such as coal."[23] The company provides no evidence to support this.

Finally, as the "Climate and Fossil Gas" section explains, the premise that replacing coal with gas leads to positive climate outcomes is flawed. Emissions from fossil fuels need to be close to zero by mid-century to ensure a safe climate. Therefore, any new gas infrastructure built today will need to be replaced with zero emissions energy sources before it reaches the end of its economic life. With Jordan Cove currently scheduled to come online in 2024, investors would expect it to still be operating long after the transition to clean energy should be complete.

There is no evidence that the project would reduce emissions in line with the climate goals established by science - in fact, existing analyses point to the opposite. The 36.8 million tons of annual GHG emissions associated with the project must therefore be viewed as additional pollution that cannot be squared with any greenhouse gas reduction strategy.

There is no evidence that the project would reduce emissions in line with the climate goals established by science - in fact, existing analyses point to the opposite.

# OREGON'S CLIMATE GOALS

In 2007, the Oregon legislature adopted goals to reduce climate pollution to 10 percent below 1990 levels in 2020 and at least 75 percent below 1990 levels by 2050.[24] According to these goals, Oregon's greenhouse gas emissions should be below 14.1 MMT in 2050. The state legislature is currently considering the "Clean Energy Jobs Bill," which creates a mechanism to reduce climate pollution in line with state goals.

These goals may fall below the targets set in the UNFCCC's Paris Agreement, which Governor Kate Brown committed to after President Donald Trump withdrew in 2017. The Paris Agreement commits to keeping global temperature rise "well below" 2 degrees Celsius (C) compared to pre-industrial levels and aims for a maximum temperature rise of 1.5°C. The latter goal requires global greenhouse gas emissions to fall to zero by around 2050, while the former (2°C) goal requires emissions to reach zero by about 2065.[25] According to the Oregon Global Warming Commission 2017 Report, Oregon is currently not on track to reach statutorily mandated emission reduction goals in 2020 or 2050.[26]

The total in-state annual emissions of the Jordan Cove Project, which only includes emissions from the LNG terminal, compressor stations, and leakage along the pipeline route, would be over 2.2 MMT, while the total lifecycle emissions of this project are over 36.8 MMT. The LNG terminal alone would emit over 1.8 MMT of greenhouse gas pollution a year, becoming the largest single source of climate pollution in the state of Oregon after 2020. If Oregon reaches its 2050 climate reduction goals, the in-state emissions of Jordan Cove will be equal to 16 percent of Oregon's total emissions, while the lifecycle greenhouse gas emissions will be over 261 percent.

The project's in-state emissions will constitute an increasingly large proportion of remaining allowable emissions, while providing no actual energy supply for the state.

In 2016, the Oregon legislature passed SB-1547, which requires investor-owned utilities to eliminate coal-fired power from Oregon by 2035 because of pollution and climate concerns. Only considering in-state emissions, the Jordan Cove LNG Export Terminal and the Pacific Connector Pipeline would be roughly equivalent to the Boardman coal plant, which is set to close in 2020 in order to meet emissions goals. Considering the total life cycle emissions, this project would be equivalent to over 15.4 Boardman coal plants.

If the state of Oregon's climate policies progress toward alignment with the goals of the Paris Agreement, as Governor Brown has stated she intends,[27] then the project's in-state emissions will constitute an increasingly large proportion of remaining allowable emissions, while providing no actual energy supply for the state. By mid-century, the project will have to be shut down – decades before investors expect the project's economic life to end. Finally, Oregon's commitment to climate leadership would be undermined by hosting a facility that supports unsustainable global emissions and undermines climate action in other regions.

**Table 2: GHG Emissions of the Jordan Cove Energy Project as a Percentage of Oregon's GHG Emissions**

| | | Jordan Cove Energy Project | | |
|---|---|---|---|---|
| | | LNG Terminal Emissions | Total Project In-State Emissions | Total Project Lifecycle Emissions |
| | MMT $CO_2e$ per year | 1.8 | 2.2 | 36.8 |
| Oregon 2015 Emissions | 63.4 | 2.9% | 3.5% | 58% |
| Oregon 2050 Goals (75% below 1990) | 14.1 | 13% | 16% | 261% |
| Under 2 MOU[b] (2 MT per capita by 2050[c]) | 11.2 | 16% | 20% | 329% |

Source: Oil Change International

b The Under 2 MOU, signed by Oregon Gov. Kate Brown in 2015, is a commitment by sub-national governments to reduce GHG emissions towards net-zero by 2050. Central to this is the public commitment by all signatories to reduce GHG emissions by 80-95% below 1990 levels, or to 2 metric tons of carbon dioxide-equivalent per capita, by 2050.
c Based on 5,588,500 Oregon estimated population in 2050. http://www.oregon.gov/das/OEA/Pages/forecastdemographic.aspx

# CONCLUSIONS

This briefing provides a calculation and discussion of the greenhouse gas emissions of the Pacific Connector Gas Pipeline and Jordan Cove LNG Export Terminal proposed in the state of Oregon. It clearly shows that the project would add significantly to greenhouse gas emissions both in the state of Oregon and globally.

The analysis shows that methane leakage along the project's supply chain undermines any claim that the project would supply destination markets with cleaner fuel. In addition, the remaining global carbon budget has no room to replace coal with gas, even if methane leakage were zero. In fact, the expansion of fossil gas undermines renewable energy development.

The project would increase the flow of fossil gas to the global market and in doing so would run counter to the goals of the Paris Agreement on climate change. The project would undermine Oregon's potential to play a leadership role in addressing global climate change.

# APPENDIX: METHODS AND SOURCES FOR ESTIMATING JORDAN COVE LNG GREENHOUSE GAS EMISSIONS

## GENERAL OVERVIEW OF LIFECYCLE EMISSIONS

Lifecycle greenhouse gas emissions include a combination of combustion emissions from burning fossil gas, emissions from producing, processing, and transporting the gas, and methane leakage – the intentional or unintentional leakage of fossil gas into the atmosphere along the full supply chain. In the case of liquefied natural gas export, additional combustion and leakage emissions from liquefaction, tanker transport, regasification, and transport from the import terminal to the ultimate point of consumption must also be included.

Developing any estimate of potential lifecycle greenhouse gas emissions from a proposed project requires using a variety of sources and assumptions. An emissions factor of 117.1 pounds of $CO_2$ per thousand cubic feet for the combustion of fossil gas is well established and this comprises the largest proportion of total emissions.[28]

Estimates of emissions occurring upstream of the proposed project include the production and processing of fossil gas and are based on available peer-reviewed and government data. For the Pacific Connector pipeline and Jordan Cove terminal, emissions estimates for equipment to be installed, such as compressors and engines, or electricity to be consumed, are supplied in the project applications and environmental impact statement. Emissions occurring downstream or after the defined project's parameters must be determined using other available sources.

The production, processing, and transport of fossil gas requires energy. For example, diesel, gasoline, fossil gas, or electricity are consumed to run drilling rigs, trucks for materials transport, compressors for pipeline pressure, and many other processes that require engines, turbines, and other equipment. Much of the emissions estimates for these stages are derived from expectations of the fuel such equipment is expected to consume based on projected utilization rates and operating times.

In addition to these fuel-based emissions, the production and handling of fossil gas leads to significant quantities of the gas being emitted to the atmosphere uncombusted. Some of this is emitted as part of standard processes such as the blow down of pipelines during maintenance. These intentional emissions of fossil gas are considered 'venting.' Some gas escapes from valves and seals as a result of equipment wear and tear or malfunction and these emissions are considered 'fugitive.'

Fossil gas is primarily made up of methane ($CH_4$), a hydrocarbon that, pound for pound, is a more powerful heat-trapping gas than carbon dioxide ($CO_2$), the primary GHG that is causing global temperatures to rise and the climate to change. Because the measurement and analysis of GHGs is based on much more abundant $CO_2$, the impact of methane on the atmosphere is expressed as a carbon dioxide equivalent ($CO_2e$) according to its global warming potential (GWP).

## CALIBRATING $CH_4$ WITH $CO_2$

The study of methane's impact on warming has evolved in the past decade and estimates of the GWP of methane have increased as more has been learned. Methane lasts about 12 years in the atmosphere while $CO_2$ lasts for centuries. To calibrate methane's impact with that of $CO_2$, two time horizons have been used: 20 years and 100 years.

We use the 20-year GWP timeframe and 86 GWP for methane from the Intergovernmental Panel on Climate Change's (IPCC) most current *Assessment Report 5* (AR5), because whereas $CO_2$ accumulates in the atmosphere over the long term, the impact of methane is felt in the short term. Its most important contribution to total warming occurs at the time of peak atmospheric $CO_2$ concentrations (i.e. net zero $CO_2$ emissions) – that is, when $CO_2$ has its greatest warming effect, and methane potentially adds to that maximum amount of warming. According to analyses of IPCC scenarios, net $CO_2$ emissions need to reach zero around 2050 to have a 50 percent chance of limiting warming to 1.5 degrees Celsius, and around 2065 to have a likely chance of staying below 2 degrees Celsius of warming.[29]

With those scenarios in mind, if the Jordan Cove plant operates from 2024 to 2064, the average molecule of methane will be emitted in 2044 – respectively six years or twenty-six years before peak $CO_2$ concentrations. As those molecules will have their greatest impact in the period immediately prior to or beyond the point at which $CO_2$ concentrations should peak, the shorter range GWP is the more relevant measure for the project's methane emissions.[30]

The 100-year GWP is most commonly used by government and industry. It calibrates the GWP of methane at 34 times that of $CO_2$. However, according to the IPCC: "There is no scientific argument for selecting 100 years compared with other choices. The choice of time horizon is a value judgement because it depends on the relative weight assigned to effects at different times."[31]

The U.S. Environmental Protection Agency (EPA) generally uses the 100-year metric.[32] We strongly urge the EPA and all federal government agencies assessing the impact of fossil gas systems to use the 20-year GWP to properly measure the impact of methane leaked to the atmosphere. This is particularly important at a time when the production of gas is growing so fast, driving increased gas consumption.

## STAGES AND SOURCES FOR THE JORDAN COVE GHG ESTIMATE

The estimate of lifecycle emissions begins with fossil gas production and runs the entire journey of the gas through to combustion. In the case of the Jordan Cove LNG terminal, gas would be primarily produced from shale plays in either the Canadian or U.S. Rockies and be transported by pipeline to Malin on the southern Oregon border where the Pacific Connector pipeline would begin.

Project application documents were used for the emissions estimates for the Pacific Connector pipeline and the Jordan Cove LNG plant. The only change we made to these estimates was to convert $CH_4$ to $CO_2e$ using the 20-year GWP discussed in the previous section.

Methane leakage estimates at the production stage were based on the latest available peer-reviewed science for gas produced in the Rocky Mountain states of Colorado, Utah, and Wyoming.[33] While gas for the project may also be sourced from Canada, data for Canadian production were not available.

The stages, rounded figures, emissions assessed, and data sources for the full lifecycle GHG emissions of the Jordan Cove Energy Project are summarized in Table A1. Calculations are based on producing 7.8 million tons of LNG per year (374.4 Bcf/y), the maximum the project can produce. Fossil gas reaching the project was set to 431.4 Bcf/y, or 95.8% of the maximum 1.2 Bcf/d capacity of the Pacific Connector pipeline, which is how much capacity the company has reserved. The initial volume of gas needed from the wellhead to supply that volume of gas to the project is 437.7 Bcf/y (after factoring in methane leakage). All GHG emissions are shown in million metric tons per year (MMT/Y).

The leakage rates from Table A3 and Table A4 were applied to the Production, Gas Processing, Foreign Transmission and Storage, and Foreign Distribution stages, and resulting emissions are shown as 'Reference Case' and 'High Case' emissions per lifecycle stage in Table A1. Data for combustion and leakage emissions for the Pacific Connector Pipeline and Jordan Cove liquefaction facility were taken from the respective FERC applications. Emissions from the Ruby Pipeline, which would feed gas to the Pacific Connector, were based on 77 percent (1.15 Bcf/d) of the total estimated emissions (0.523 MMT/Y) described in the project's FERC order.[34]

## METHANE LEAKAGE RATE ESTIMATE

The gas arriving for liquefaction at Jordan Cove would be delivered by the proposed Pacific Connector Pipeline, which would connect to the Ruby and Gas Transmission Northwest Pipelines. While it is not known at this point exactly where that gas would come from, for purposes of estimating methane leakage, this analysis assumes that 100 percent of the gas will be sourced from the Rocky Mountains region – specifically from Colorado, Wyoming, and Utah, the three most productive Rocky Mountain states for natural gas.[35] This choice was made because, while gas could also come from the Montney Basin in British Columbia, there is a lack of peer-reviewed data sources about fugitive methane emissions from natural gas production in British Columbia.

**Table A1: Lifecycle Stages, Emissions, and Sources for the Pacific Connector Pipeline and Jordan Cove Energy Project**

| Lifecycle Stage | Reference Case (MMT/Y) | High Case (MMT/Y) | Emissions Assessed | Sources |
|---|---|---|---|---|
| Gas Production | 10.9 | 26.0 | Methane emissions resulting from normal operations, routine maintenance, and system upset – mainly from gathering stations, pneumatic controllers, liquids unloading, and offshore platforms; and $CO_2$ emissions from fuel combustion. | Methane Leakage: Robertson, et al. in *Environmental Science & Technology*, June 2017. http://pubs.acs.org/doi/abs/10.1021/acs.est.7b00571 $CO_2$: International Institute for Sustainability Analysis and Strategy. http://iinas.org/tl_files/iinas/downloads/GEMIS/2014_Fracking_analysis_comparison.pdf |
| Gas Processing (dry-wet gas separation) | 0.51 | 0.52 | Methane emissions resulting from normal operations, routine maintenance, and system upsets – mainly fugitive emissions from compressors and seals. | Based on national EPA data in "Inventory of U.S. Greenhouse Gas Emissions and Sinks": https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf |
| Transmission to Jordan Cove | 0.78 | 0.78 | $CO_2$, $CH_4$, and $N_2O$ emissions from compressor station, pipeline, and meter stations associated with Pacific Connector and Ruby pipelines. Includes fugitive emissions, venting, and combustion-related emissions. | Emissions for PCGP based on project application. http://pacificconnectorgp.com/wp-content/uploads/2017/09/1.1-PCGP-Application-and-Exhibit.pdf For Ruby pipeline, estimate based on FERC certificate order. https://www.ferc.gov/CalendarFiles/20100405150436-CP09-54-000.pdf |
| LNG Liquefaction | 1.8 | 1.8 | $CO_2$, $CH_4$, and $N_2O$ emissions from liquefaction operations, fugitive emissions, and on-site vessel fuel combustion. | Figures from Jordan Cove application. http://pacificconnectorgp.com/wp-content/uploads/2017/09/1.1-PCGP-Application-and-Exhibit.pdf |
| Tanker Transport | 0.44 | 0.44 | $CO_2$ emissions from fuel combustion. | Based on distance to Tokyo and Shanghai, and Jaramillo et al. http://www.ce.cmu.edu/~gdrg/readings/2005/10/12/Jaramillo_LifeCycleCarbonEmissionsFromLNG.pdf |
| LNG Gasification | 0.40 | 0.40 | $CO_2$ emissions from fuel combustion. | Based on: Jaramillo et al http://www.ce.cmu.edu/~gdrg/readings/2005/10/12/Jaramillo_LifeCycleCarbonEmissionsFromLNG.pdf |
| Foreign Transmission & Storage | 1.3 | 1.3 | Methane emissions resulting from normal operations, routine maintenance, and system upsets – fugitive emissions from compressor stations and venting from pneumatic controllers account for most of the emissions from this stage. | Based on EPA estimates in U.S. "Inventory of U.S. Greenhouse Gas Emissions and Sinks": https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf |
| Foreign Distribution | 0.43 | 0.43 | Methane emissions resulting from normal operations, routine maintenance, and system upsets – mainly from fugitive emissions from pipelines and stations. | Based on EPA estimates in U.S. "Inventory of U.S. Greenhouse Gas Emissions and Sinks": https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf |
| Combustion | 20.2 | 20.2 | $CO_2$ emissions from fuel combustion. | EPA Fuel Emissions Factors Assumptions https://www.epa.gov/sites/production/files/2015-08/documents/chapter_11_other_fuels_and_fuel_emission_factors.pdf |
| Total | 36.8* | 52.0* | | |

*Figures may not add due to rounding

**Table A2: EPA Methane Leakage Rate Estimates from 2017 U.S. GHG Inventory**

| Lifecycle Stage | Leakage Rate |
|---|---|
| **Field Production leakage** | 0.79% |
| **Processing leakage** | 0.08% |
| **Transmission and Storage leakage** | 0.25% |
| **Distribution leakage** | 0.08% |
| **Total leakage** | 1.20% |

Source: Oil Change International

**Table A3: Reference Methane Leakage Rate for Jordan Cove GHG Lifecycle Analysis**

| Lifecycle Stage | Leakage Rate |
|---|---|
| **Field Production leakage** | 1.36% |
| **Processing leakage** | 0.08% |
| **Transmission and Storage leakage** | 0.25% |
| **Distribution leakage** | 0.08% |
| **Total leakage** | 1.77% |

Source: Oil Change International

**Table A4: High-End Methane Leakage Rate for Jordan Cove GHG Lifecycle Analysis**

| Lifecycle Stage | Leakage Rate |
|---|---|
| **Field Production leakage** | 3.66% |
| **Processing leakage** | 0.08% |
| **Transmission and Storage leakage** | 0.25% |
| **Distribution leakage** | 0.08% |
| **Total leakage** | 4.08% |

Source: Oil Change International

For stages of the process for which we did not have access to project-specific estimates for leakage – Processing, Foreign Transportation and Storage, and Foreign Distribution (see Table A1) – we used national level data from the U.S. EPA. Data from the EPA's latest GHG inventory would indicate that the U.S. national methane leakage rate is 1.2%.[36] That figure is a blended composite of all fossil gas production nationally, and does not account for regional variation. Table A2 shows the breakdown of EPA's methane emission estimates from all stages of the domestic fossil gas lifecycle.

For U.S. Rocky Mountain-specific methane leakage figures, this analysis looked to a recent peer-reviewed study published in *Environmental Science & Technology* in June 2017. The study was conducted by researchers from University of Wyoming and Colorado State University and quantified atmospheric methane emissions from active gas production sites in normal operation in four major U.S. basins/plays: Upper Green River (Wyoming), Denver-Julesburg (Colorado), Uintah (Utah), and Fayetteville (Arkansas) (Robertson et al. 2017).[37]

The emissions were measured within the basins on randomly chosen days in 2014 and 2015 from the University of Wyoming Mobile Laboratory utilizing the EPA's Other Test Method (OTM) 33a. The median methane leakage rates measured from the three Rocky Mountain basins during the field production stage were 0.18 percent (0.12–0.29%) in Wyoming, 2.1 percent (1.1–3.9%) in Colorado, and 2.8 percent (1.0–8.6%) in Utah.

The mean average of those field production leakage rates is 1.69 percent, with a high-end average of 4.26 percent, but it was determined for this study to make an adaptation. Since 2014, Colorado has implemented rules to reduce oil and gas methane emissions through air pollution control practices and technologies, including leak detection and repair (LDAR) requirements.[38] Therefore, the low-end of the range measured by the study in Colorado may be a fairer assessment of expected methane emissions for fossil gas production in the Denver-Julesburg basin than the median rate used for the other two states. Using the low end of the methane leakage range for Colorado, the average field production leakage rate in the Rocky Mountain states, as reported in Robertson et al., would be 1.36 percent, with a high-end average of 3.66 percent. The high end for Colorado was assumed to be the median leakage rate in the study (2.1 percent).

Based on national EPA data, but regionalized to account for field production methane emissions measured in the Rocky Mountains, the reference methane leakage rate for gas exported from Jordan Cove is 1.77 percent. The high-end methane leakage rate for gas exported from Jordan Cove is 4.08 percent.

## CONSERVATIVE ASSUMPTIONS BAKED INTO LEAKAGE ESTIMATE

The leakage rate estimates presented in the preceding section are conservative in at least two ways. First, several studies have found that EPA emissions factors for leakage from existing fossil gas systems are too low. For example, a July 2015 study published in *Environmental Science & Technology* by researchers from University of Arkansas – Fayetteville, University of Houston, Purdue University, Aerodyne Research, Inc., Colorado State University, Carnegie Mellon University, and Environmental Defense Fund found that anthropogenic methane emissions from the oil and gas industry were 50 percent higher than estimates derived from the EPA inventory.[39]

More recent studies have measured leakage rates of between 4.2 and 8.4 percent in the Bakken shale region.[40] If domestic fossil gas processing and transmission emissions are higher than EPA estimates, the lifecycle leakage rate for Jordan Cove's LNG would be higher than this paper presents.

Second, this analysis used EPA's relatively low domestic leakage rate estimates for the transmission and storage and distribution stages, rather than rates in Asia, where those two stages of the fossil gas lifecycle would take place in the case of the Jordan Cove project. If the pipelines in Asian countries importing Jordan Cove's gas leak at higher rates than the EPA estimates for U.S. pipelines, the actual lifecycle leakage rate for Jordan Cove's LNG would be higher than our estimate.

Tanker emissions estimates were based on a paper from the Civil and Environmental Engineering Faculty at Carnegie Mellon University and amended based on the shipping distance between Jordan Cove and Shanghai and Tokyo. We assumed a 50/50 split of shipments between these two ports.

# ENDNOTES


1 Rogue Climate. FERC Interventions for Jordan Cove Energy Project and Pacific Connector Pipeline. http://www.rogueclimate.org/over_400_people_intervene_in_ferc_process
2 Federal Energy Regulatory Commission, "Jordan Cove Energy Project, L.P. and Pacific Connector Gas Pipeline, LP, Docket Nos CP13-483-000 and CP13-492-000. Order Denying Applications for Certificate and Section 3 Authorization," March 11, 2016. https://www.ferc.gov/CalendarFiles/20160311154932-CP13-483-000.pdf
3 Oil Change International, "The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production," September 2016. http://www.priceofoil.org/content/uploads/2016/09/OCI_the_skys_limit_2016_FINAL_2.pdf
4 For the full details of the following five key points, please see: Oil Change International, "Burning the Gas 'Bridge Fuel' Myth," November 2017. http://priceofoil.org/content/uploads/2017/11/gas-briefing-nov-2017-v5.pdf
5 Jordan Cove Energy Project L.P., Pacific Connector Gas Pipeline L.P., "Abbreviated Application for Certificate of Public Convenience and Necessity and Related Authorizations," September 21, 2017. http://pacificconnectorgp.com/wp-content/uploads/2017/09/1.1-PCGP-Application-and-Exhibit.pdf
6 Ibid.
7 Oregon Department of Environmental Quality, "PGE Boardman," http://www.oregon.gov/deq/Programs/Pages/PGE-Boardman.aspx
8 Robertson, Anna M., et al., "Variation in Methane Emission Rates from Well Pads in Four Oil and Gas Basins with Contrasting Production Volumes and Compositions," Environmental Science & Technology, vol. 51, no. 15, June 12, 2017, pp. 8832–8840, doi:10.1021/acs.est.7b00571. http://pubs.acs.org/doi/abs/10.1021/acs.est.7b00571
9 Ibid.
10 Colorado Department of Public Health and Environment, "Fact Sheet: Revisions to Colorado Air Quality Control Commission's Regulation Numbers 3, 6, and 7," October 5, 2014. http://www.colorado.gov/pacific/sites/default/files/AP_Regulation-3-6-7-FactSheet.pdf
11 Jordan Cove Energy Project L.P., Pacific Connector Gas Pipeline L.P., "Abbreviated Application for Certificate of Public Convenience and Necessity and Related Authorizations," September 21, 2017. http://pacificconnectorgp.com/wp-content/uploads/2017/09/1.1-PCGP-Application-and-Exhibit.pdf
12 Oil Change International, "Burning the Gas 'Bridge Fuel' Myth," November 2017. http://priceofoil.org/content/uploads/2017/11/gas-briefing-nov-2017-v5.pdf
13 U.S. Department of Energy, "Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States," May 29, 2014. https://www.netl.doe.gov/energy-analyses/temp/LCAGHGReportLNG%20Report_052914.pdf
14 Steven Hamburg, "Methane: A Key to Dealing With Carbon Pollution?," Energy Exchange. Environmental Defense Fund, November 5, 2013. http://blogs.edf.org/energyexchange/2013/11/05/methane-a-key-to-dealing-with-carbon-pollution/
15 PSE Healthy Energy, "Climate Impacts of Methane Losses from Modern Natural Gas and Petroleum Systems," Science Summary, PSE Healthy Energy, November 2015. https://www.psehealthyenergy.org/wp-content/uploads/2015/11/Methane-Science-Summary.pdf
16 Federal Energy Regulatory Commission, "Natural Gas." https://www.ferc.gov/industries/gas.asp
17 United States Court of Appeals For The District of Columbia Circuit, "Sierra Club, Et Al., Petitioners V. Federal Energy Regulatory Commission, Respondent Duke Energy Florida, LLC, Et Al., Intervenors," August 22, 2017. https://www.cadc.uscourts.gov/internet/opinions.nsf/2747D72C97BE12E285258184004D1D5F/$file/16-1329-1689670.pdf
18 Federal Energy Regulatory Commission - Office of Energy Projects, "Southeast Market Pipelines Project Draft Supplemental Environmental Impact Statement," September 27, 2017. https://www.ferc.gov/industries/gas/enviro/eis/2017/09-27-17-DEIS/supplemental-DEIS.pdf
19 Sierra Club, Comments on September 27, 2017 Draft Supplemental Environmental Impact. http://bit.ly/SC-ST-DSEIS-Cmnt
20 Ibid., p. 6.
21 Gilbert, A. Q. & Sovacool, B. K., "US liquefied natural gas (LNG) exports: Boom or bust for the global climate?," Energy, Volume 141,December 15, 2017, pp. 1671-1680. https://doi.org/10.1016/j.energy.2017.11.098
22 Ibid.
23 Jordan Cove LNG, "LNG 101 — what you need to know." http://jordancovelng.com/lng-101/
24 Oregon House Bill 3543 was passed by the legislature and signed into law by Governor Ted Kulongoski in 2007. https://olis.leg.state.or.us/liz/2007R1/Downloads/MeasureDocument/HB3543/Enrolled
25 Based on: Joeri Rogelj et al., "Energy system transformations for limiting end-of-century warming to below 1.5°C," Nature Climate Change, Vol.5, June 2015. https://www.nature.com/articles/nclimate2572 Figures used assume a 50% chance of achieving the 1.5°C goal and a 66% chance of limiting warming below 2°C. Also see: Oil Change International, "The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production," September 2016. http://www.priceofoil.org/content/uploads/2016/09/OCI_the_skys_limit_2016_FINAL_2.pdf
26 "Oregon Global Warming Commission Biennial Report to the Legislature 2017," February 2017. http://www.keeporegoncool.org/sites/default/files/ogwc-standard-documents/OGWC%202017%20Biennial%20Report%20to%20the%20Legislature_final.pdf
27 Jeff Mapes, 'Oregon Will Join Climate Change Coalition To Meet Paris Goals'. OPB, June 02, 2017. https://www.opb.org/news/article/oregon-paris-climate-change-goals-kate-brown/
28 U.S. Energy Information Administration, "Carbon Dioxide Emissions Coefficients," February 2, 2016. https://www.eia.gov/environment/emissions/co2_vol_mass.php
29 Joeri Rogelj et al., "Energy system transformations for limiting end-of-century warming to below 1.5°C," Nature Climate Change, Vol.5, June 2015. https://www.nature.com/articles/nclimate2572
30 See IPCC AR5 WG1 sec.12.5.4, p.1108, http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter12_FINAL.pdf AND sec.8.7.1.12, pp.711-712, http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf
31 IPCC AR5 WG, sec.8.7.1.12, pp.711-712 http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf
32 U.S. Environmental Protection Agency, "Greenhouse Gas Emissions. Understanding Global Warming Potentials," Accessed December 11, 2017. https://www.epa.gov/ghgemissions/understanding-global-warming-potentials
33 Robertson, Anna M., et al., "Variation in Methane Emission Rates from Well Pads in Four Oil and Gas Basins with Contrasting Production Volumes and Compositions." Environmental Science & Technology, vol. 51, no. 15, June 12, 2017, pp. 8832–8840., doi:10.1021/acs.est.7b00571. http://pubs.acs.org/doi/abs/10.1021/acs.est.7b00571
34 Ruby Pipeline, L.L.C. FERC Order CP09-54-000 and CP09-54-00 issuing Certificate Granting in Part and Denying in Part Request for Rehearing and Clarification, April 5, 2010. If the fossil gas for Jordan Cove were sourced from Canada passing through the Gas Transmission Northwest (GTN) Pipeline, the Oregon in-state emissions could increase by approximately 400,000 MMT of $CO_2e$ per year due to six of twelve compressor stations on the GTN being located in Oregon. The GTN pipeline currently operates well below capacity and demand from Jordan Cove could increase flows and consequent compressor use along its route.
35 U.S. Energy Information Administration, "Natural Gas Gross Withdrawals and Production," August 31, 2017. www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FPD_mmcf_a.htm
36 The leakage rate was calculated by comparing EPA's reported methane emissions in 2015 for natural gas systems from each of the production, processing, transmission and storage, and distribution stages (U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2015," April 15, 2017, www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf) to the EIA's gross natural gas withdrawal figures for 2015 ( U.S. Energy Information Administration, "Natural Gas Gross Withdrawals and Production," August 31, 2017. www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FPD_mmcf_a.htm). EPA's methane emissions were converted to billion cubic feet of natural gas based on assumptions that natural gas is 87% methane by volume on average throughout the lifecycle, and that the density of methane is 0.04246 lbs/scf.
37 Robertson, Anna M., et al., "Variation in Methane Emission Rates from Well Pads in Four Oil and Gas Basins with Contrasting Production Volumes and Compositions." Environmental Science & Technology, vol. 51, no. 15, June 12, 2017, pp. 8832–8840., doi:10.1021/acs.est.7b00571. http://pubs.acs.org/doi/abs/10.1021/acs.est.7b00571
38 Colorado Department of Public Health and Environment, "Fact Sheet: Revisions to Colorado Air Quality Control Commission's Regulation Numbers 3, 6, and 7," October 5, 2014. www.colorado.gov/pacific/sites/default/files/AP_Regulation-3-6-7-FactSheet.pdf
39 David R. Lyon, "Constructing a Spatially Resolved Methane Emission Inventory for the Barnett Shale Region," Environmental Science & Technology, 2015 49 (13), 8147-8157, July 7, 2015. http://pubs.acs.org/doi/abs/10.1021/es506359c
40 Peischl, J., et al., "Quantifying Atmospheric Methane Emissions from Oil and Natural Gas Production in the Bakken Shale Region of North Dakota," Journal of Geophysical Research: Atmospheres, vol.121, no.10, May 25, 2016, pp. 6101–6111., doi:10.1002/2015jd024631. http://onlinelibrary.wiley.com/doi/10.1002/2015JD024631/abstract


OILCHANGE INTERNATIONAL

**The full calculations can be found in the spreadsheet available at http://bit.ly/JCLNG-GHGs.**


**Researched and written by Lorne Stockman of Oil Change International. Lifecycle emissions estimate by James McGarry.**

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**For questions on the campaign to stop the Jordan Cove LNG Export Terminal and the Pacific Connector Pipeline, contact:**
**Allie Rosenbluth: Allie@RogueClimate.org or impacted landowner Deb Evans: debron3@gmail.com**

# Economic Cost of Greenhouse Gas Emissions

Briefing by Deb Evans for Hair on Fire Oregon

In the historic 2015 Paris Climate Agreement[1], countries agreed to work together to reduce greenhouse gas (GHG) emissions to hold the increase in global average temperatures to well below 2 degrees Celsius (C) as well as pursue efforts to keep temperatures below 1.5 degrees Celsius (C) above pre-industrial levels to significantly reduce the risks and impacts of climate change. Current science says that to have a 50% chance of reaching the 1.5 degree C goal we must strive for zero emissions by 2050. In light of this, public interest determinations for new large fossil fuel infrastructure projects at the local, state and federal levels must consider the negative impacts and costs to society associated with adding GHG emissions for a 20-40 year predicted life of these projects.

A flurry of reports released in late 2017 paint a sobering picture of the increased impacts and economic costs attributed to greenhouse gas emission-caused climate change. The Governmental Accounting Office reported that more than $350 billion dollars were spent by the United States Government over the past decade in response to extreme weather and fire events. These costs are estimated to rise far higher if global emission rates do not go down.[2]

A separate study found that "[e]conomic losses from weather events influenced by human-induced climate change and health damages due to air pollution caused by fossil fuel energy production are currently causing an average of $240 billion a year—or about 40% of the current economic growth of the United States economy."[3] These costs are predicted to rise to $360 billion in the next 10 years and are largely born by individuals, not Government or the private sector.

Data collected in the United States show a steady climb in extreme weather events triggering $1 billion dollars or more of damage rising from **21** events in the 1980s, **38** in the 1990s to **92** this past decade (2007-2016).

> During 2017, the U.S. experienced a historic year of weather and climate disasters. In total, the U.S. was impacted by 16 separate billion-dollar disaster events tying 2011 for the record number of billion-dollar disasters for an entire calendar year. In fact, 2017 arguably has more events than 2011 given that our analysis traditionally counts all U.S. billion-dollar wildfires, as regional-scale, seasonal events, not as multiple isolated events.
>
> More notable than the high frequency of these events is the cumulative cost, which **exceeds $300 billion in 2017** — a new U.S. annual record. The cumulative damage of these 16 U.S. events during 2017 is $306.2 billion, which shatters the previous U.S. annual record cost of $214.8 billion (CPI-adjusted), established in 2005 due to the impacts of Hurricanes Dennis, Katrina, Rita and Wilma. [4]

Overall, the 16 disaster events in 2017 claimed the lives of 362 people. Table 1 below shows the number of billion-dollar or greater disasters from 1980 through 2017. The annual average over the entire time span is 5.8 events (CPI-adjusted) and the annual average for 2013-2017 is 11.6 events (CPI-adjusted).

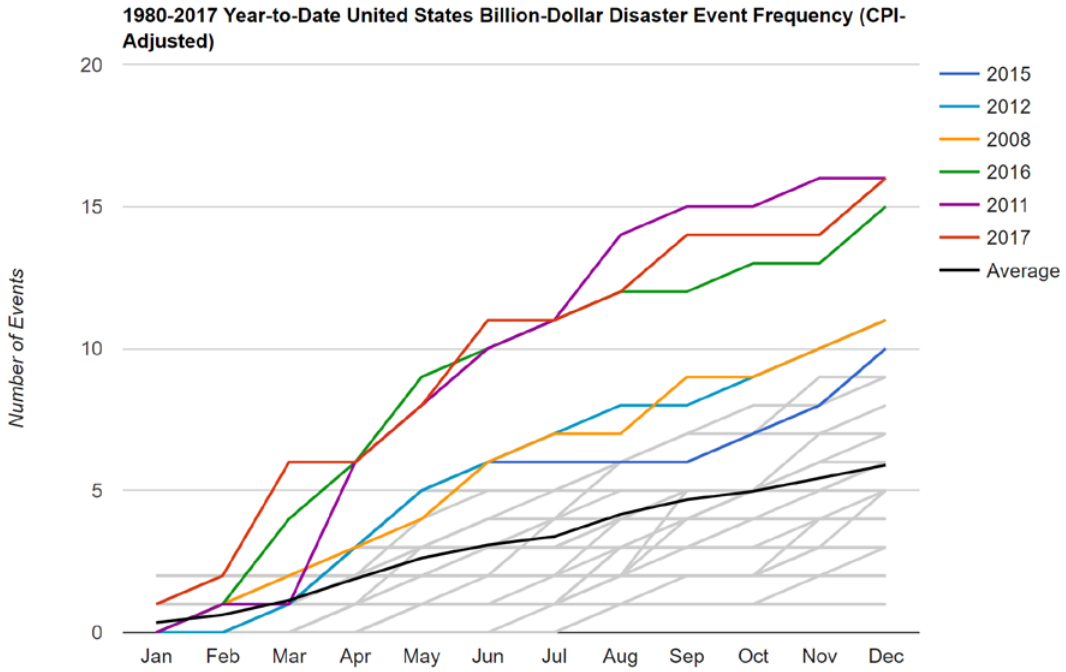
[1] Text of Paris Climate agreement 2015 - https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf

[2] Information on Potential Economic Effects Could Help Guide Federal Efforts to Reduce Fiscal Exposure GAO-17-720: Published: Sep 28, 2017. Publicly Released: Oct 24, 2017. https://www.gao.gov/products/GAO-17-720

[3] The Economic Case for Climate Action in the United States. Robert Watson, James McCarthy, Liliana Hisas. Sept 2017. https://feu-us.org/case-for-climate-action-us/

[4] NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2017). https://www.ncdc.noaa.gov/billions/

**Table 1 – 1980-2017 Year-to-Date United States Billion-Dollar Disaster Event Frequency**[5]




*Event statistics are added according to the date on which they ended.*

Oregon did not escape unscathed. The state was challenged with its own climate-related disasters in 2017 with over 2000 wildfires burning a total of 665,000 acres and costing $454 million dollars—triple the 2010-2015 average annual cost of $146 million for Oregon wildfires.[6] The bottom line is that greenhouse gas emissions world-wide are increasing and that increase is influencing costly extreme weather events – like drought and wildfire-related economic losses experienced in Oregon.

In a presentation given to Oregon legislators on November 13, 2017[7], Oregon DEQ director Richard Whitman presented data based on modeling of two scenarios: a steady increase in GHG emissions through 2100 and a more successful peak and then lowering of emissions on a global scale by 2040.[8] Increased temperatures along with increased rain in the winter and decreased rain in the summer will be the drivers for impacts in Oregon resulting in far less snowpack and water shortages negatively impacting forestry, agriculture and fisheries, increased acidification threatening shellfish, and a significant change in Oregon vegetation. Models show shifts away from Douglas Fir, the softwood dominated lumber that Oregon leads the nation in producing, to a mixed conifer and

[5] NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2017). https://www.ncdc.noaa.gov/billions/

[6] https://www.opb.org/news/article/oregon-2017-wildfire-costs/

[7] Richard Whitman, DEQ director Presentation before the Oregon Senate Interim Energy and Natural Resources Committee and the Oregon House Interim Energy and Environment Committee Meeting. Nov. 13 2017. http://oregon.granicus.com/MediaPlayer.php?clip_id=24257

[8] Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, B. DeAngelo, S. Doherty, K. Hayhoe, R. Horton, J.P. Kossin, P.C. Taylor, A.M. Waple, and C.P. Weaver, 2017: Executive summary. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 12-34, doi: 10.7930/J0DJ5CTG.

hardwood forest the length of the coastal range similar to California which is much less productive. Douglas fir is projected to shift North and inland which will have a significant effect on Oregon's economy.

These changes in Oregon's natural resources will have negative consequences on public health (smoke, heat and disease), private and public property damage (fires and floods); economic implications of less productive and more fire-prone forests, particularly for rural communities; economic implications of less productive shellfish and crab industries; significant reduction in water supplies during the summer and early fall – economic implications for agriculture; deteriorating water quality and aquatic habitat (warmer streams, algal blooms); and impacts to resources will affect rural communities disproportionately and lead to intergenerational inequality.

Whether GHG emissions from Jordan Cove LNG Export project occur **in the state**, **upstream from Oregon** where the fracking occurs **or downstream** where the fossil gas is eventually burned, there is an economic cost associated with those GHG emissions. An estimate of these costs, shown in Table 2 and often referred to as the Social Cost of Carbon (SCC), was developed by a federally mandated Interagency Working Group in 2013 and amended in 2016.[9]

**Table 2 – Social Cost of CO2, 2015-2050**

**Social Cost of $CO_2$, 2015-2050 [a] (in 2007 dollars per metric ton $CO_2$)**
Source: Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013, Revised August 2016)

| | Discount Rate and Statistic | | | |
|---|---|---|---|---|
| **Year** | **5% Average** | **3% Average** | **2.5% Average** | **High Impact (95th pct at 3%)** |
| **2015** | $11 | **$36** | $56 | $105 |
| **2020** | $12 | **$42** | $62 | $123 |
| **2025** | $14 | **$46** | $68 | $138 |
| **2030** | $16 | **$50** | $73 | $152 |
| **2035** | $18 | **$55** | $78 | $168 |
| **2040** | $21 | **$60** | $84 | $183 |
| **2045** | $23 | **$64** | $89 | $197 |
| **2050** | $26 | **$69** | $95 | $212 |

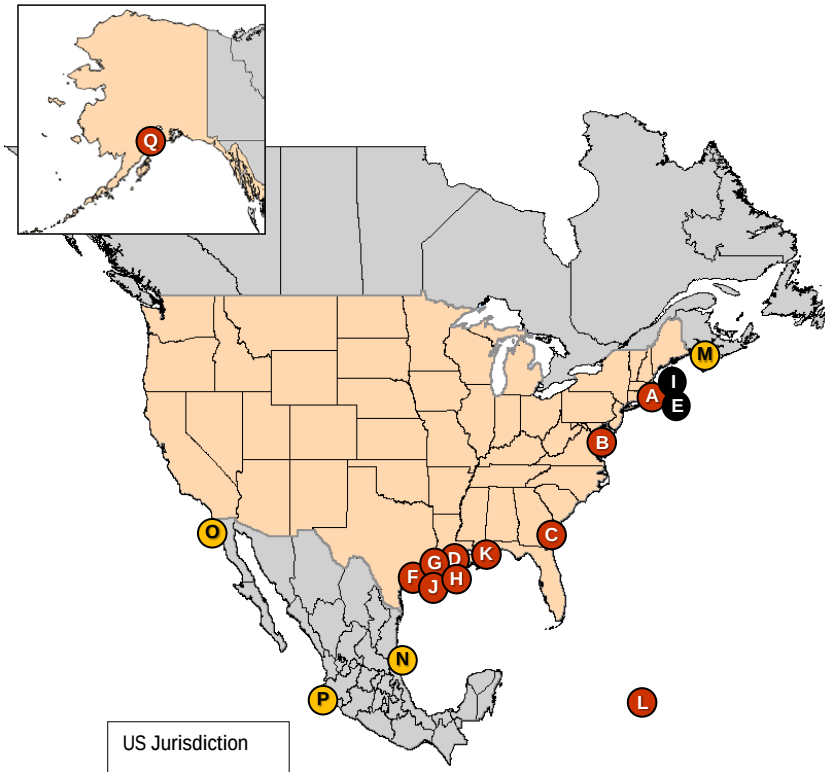
[a]The SC-$CO_2$ values are dollar-year and emissions-year specific.

Using the 3% discounted rate for 2025 shown in Table 2, the cost per metric ton of greenhouse gas emissions (CO2e) is $46/year. In the *Jordan Cove LNG and Pacific Connector Pipeline Greenhouse Gas Emissions Briefing,* Oil Change International estimates the life-cycle emissions to be at least 36.8 million metric tons of CO2e per year which would result in the social cost of Jordan Cove being $1.7 billion dollars annually. Over the projected life-span of the project, these costs dwarf any promised revenue to the state of Oregon and contribute significantly to the increased costs of climate change globally at a time when we need to be reducing, not increasing, greenhouse gas emissions worldwide.

[9] https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

# North American LNG Import/Export Terminals

## *Existing*




**As of April 23, 2018**

★ Authorized to re-export delivered LNG

### Import Terminals

U.S.

A. Everett, MA: 1.035 Bcfd (GDF SUEZ - DOMAC)
B. Cove Point, MD: 1.8 Bcfd (Dominion - Cove Point LNG)
C. Elba Island, GA: 1.6 Bcfd (El Paso - Southern LNG)
D. Lake Charles, LA: 2.1 Bcfd (Southern Union - Trunkline LNG) ★
E. Offshore Boston: 0.8 Bcfd (Excelerate Energy – Northeast Gateway)
F. Freeport, TX: 1.5 Bcfd (Cheniere/Freeport LNG Dev.)★
G. Sabine, LA: 4.0 Bcfd (Cheniere/Sabine Pass LNG)★
H. Hackberry, LA: 1.8 Bcfd (Sempra - Cameron LNG)
I. Offshore Boston, MA: 0.4 Bcfd (GDF SUEZ – Neptune LNG)
J. Sabine Pass, TX: 2.0 Bcfd (ExxonMobil – Golden Pass) (Phase I & II)
K. Pascagoula, MS: 1.5 Bcfd (El Paso/Crest/Sonangol - Gulf LNG Energy LLC)
L. Peñuelas, PR: 0.3 Bcfd (EcoElectrica)

Canada

M. Saint John, NB: 1.0 Bcfd (Repsol/Fort Reliance - Canaport LNG)

Mexico

N. Altamira, Tamulipas: 0.7 Bcfd (Shell/Total/Mitsui – Altamira LNG)
O. Baja California, MX: 1.0 Bcfd (Sempra – Energia Costa Azul)
P. Manzanillo, MX: 0.5 Bcfd (KMS GNL de Manzanillo)

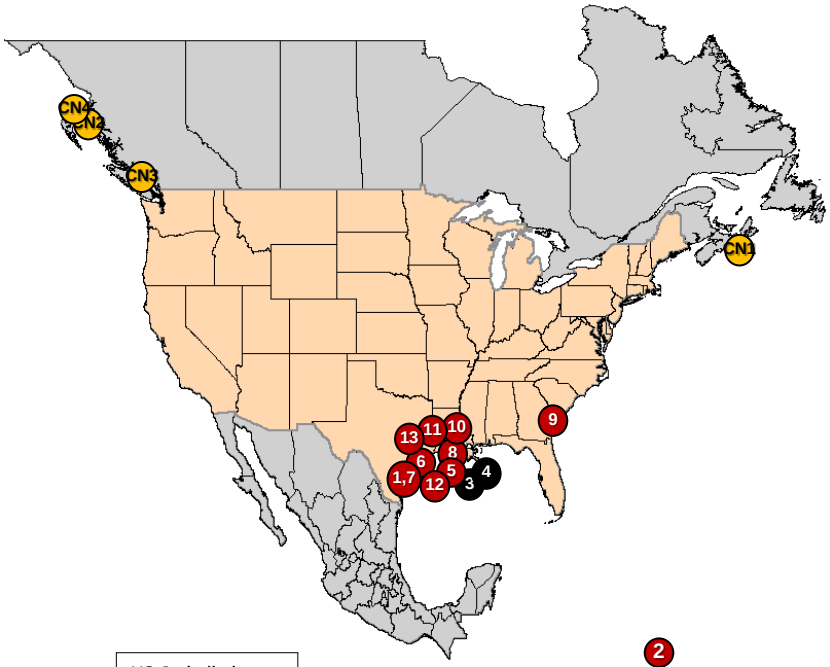
### Export Terminals

U.S.

B. Cove Point, MD: 0.82 Bcfd (Dominion–Cove Point LNG) (CP13-113)
G. Sabine, LA: 2.8 Bcfd (Cheniere/Sabine Pass LNG – Trains 1, 2, 3 & 4)
Q. Kenai, AK: 0.2 Bcfd (ConocoPhillips)

# North American LNG Import/Export Terminals

## *Approved*




**As of April 23, 2018**

### Import Terminals

U.S.

APPROVED - UNDER CONSTRUCTION - FERC

1. Corpus Christi, TX: 0.4 Bcfd (Cheniere – Corpus Christi LNG) (CP12-507)

APPROVED – NOT UNDER CONSTRUCTION - FERC

2. Salinas, PR: 0.6 Bcfd (Aguirre Offshore GasPort, LLC) (CP13-193)

APPROVED - NOT UNDER CONSTRUCTION - MARAD/Coast Guard

3. Gulf of Mexico: 1.0 Bcfd (Main Pass McMoRan Exp.)
4. Gulf of Mexico: 1.4 Bcfd (TORP Technology-Bienville LNG)

### Export Terminals

U.S.

APPROVED - UNDER CONSTRUCTION - FERC

5. Hackberry, LA: 2.1 Bcfd (Sempra–Cameron LNG) (CP13-25)
6. Freeport, TX: 2.14 Bcfd (Freeport LNG Dev/Freeport LNG Expansion/FLNG Liquefaction) (CP12-509) (CP15-518)
7. Corpus Christi, TX: 2.14 Bcfd (Cheniere – Corpus Christi LNG) (CP12-507)
8. Sabine Pass, LA: 1.40 Bcfd (Sabine Pass Liquefaction) (CP13-552)
9. Elba Island, GA: 0.35 Bcfd (Southern LNG Company) (CP14-103) ★

APPROVED – NOT UNDER CONSTRUCTION - FERC

10. Lake Charles, LA: 2.2 Bcfd (Southern Union – Lake Charles LNG) (CP14-120)
11. Lake Charles, LA: 1.08 Bcfd (Magnolia LNG) (CP14-347)
12. Hackberry, LA: 1.41 Bcfd (Sempra - Cameron LNG) (CP15-560)
13. Sabine Pass, TX: 2.1 Bcfd (ExxonMobil – Golden Pass) (CP14-517)

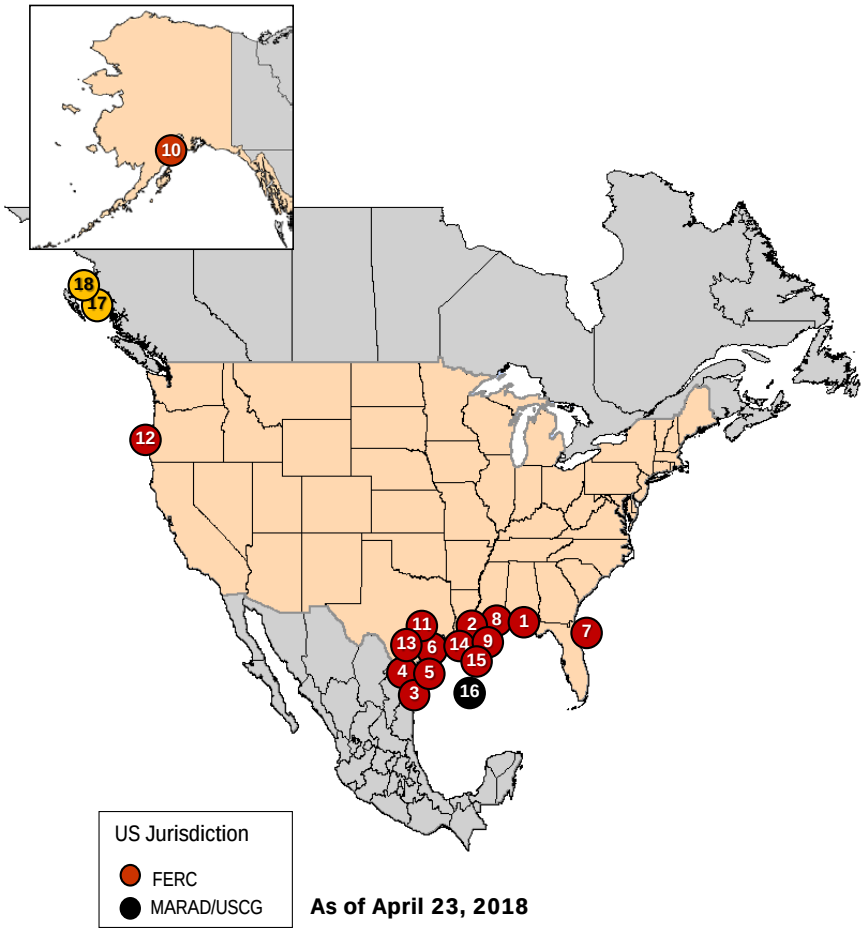
Canada

APPROVED – NOT UNDER CONSTRUCTION

CN1. Port Hawkesbury, NS: 0.5 Bcfd (Bear Head LNG)
CN2. Kitimat, BC: 3.23 Bcfd (LNG Canada)
CN3. Squamish, BC: 0.29 Bcfd (Woodfibre LNG Ltd)
CN4. Prince Rupert Island, BC: 2.74 Bcfd (Pacific Northwest LNG)

★ Trains 5 & 6 with Train 5 under construction

# North American LNG Export Terminals
## *Proposed*




PROPOSED TO FERC
Pending Applications:

1. Pascagoula, MS: 1.5 Bcfd (Gulf LNG Liquefaction) (CP15-521)
2. Cameron Parish, LA: 1.41 Bcfd (Venture Global Calcasieu Pass) (CP15-550)
3. Brownsville, TX: 0.55 Bcfd (Texas LNG Brownsville) (CP16-116)
4. Brownsville, TX: 3.6 Bcfd (Rio Grande LNG – NextDecade) (CP16-454)
5. Brownsville, TX: 0.9 Bcfd (Annova LNG Brownsville) (CP16-480)
6. Port Arthur, TX: 1.86 Bcfd (Port Arthur LNG) (CP17-20)
7. Jacksonville, FL: 0.132 Bcf/d (Eagle LNG Partners) (CP17-41)
8. Plaquemines Parish, LA: 3.40 Bcfd (Venture Global LNG) (CP17-66)
9. Calcasieu Parish, LA: 4.0 Bcfd (Driftwood LNG) (CP17-117)
10. Nikiski, AK: 2.63 Bcfd (Alaska Gasline) (CP17-178)
11. Freeport, TX: 0.72 Bcfd (Freeport LNG Dev) (CP17-470)
12. Coos Bay, OR: 1.08 Bcfd (Jordan Cove) (CP17-494)

Projects in Pre-filing:

13. Corpus Christi, TX: 1.86 Bcfd (Cheniere – Corpus Christi LNG) (PF15-26)
14. Cameron Parish, LA: 1.18 Bcfd (Commonwealth, LNG) (PF17-8)
15. LaFourche Parish, LA: 0.65 Bcfd (Port Fourchon LNG) (PF17-9)

PROPOSED TO U.S.-MARAD/COAST GUARD

16. Gulf of Mexico: 1.8 Bcfd (Delfin LNG)

PROPOSED CANADIAN SITES

17. Kitimat, BC: 1.28 Bcfd (Apache Canada Ltd.)
18. Douglas Island, BC: 0.23 Bcfd (BC LNG Export Cooperative)