



Managing Greenhouse Gas Emissions

2014 Report

About NOVA Chemicals



At NOVA Chemicals, our mission is to enable the development of great plastic products that make everyday life easier, healthier and safer.

- **Easier** includes saving consumers time and increasing convenience.
- **Healthier** includes facilitating access to food, medicine, recreation and other essentials.
- **Safer** includes protection for people, products and the environment.



We take care to conserve, protect and enhance natural resources. Through innovation, operational effectiveness and environmental stewardship, we seek to protect life and to continuously improve our environmental performance.

NOVA Chemicals is headquartered in Calgary, Alberta. We have production facilities located in Canada and the United States and we license proprietary technologies to leading petrochemical manufacturers around the world. We are primarily an ethylene / polyethylene producer.

NOVA 2020 and our commitment to continuous improvement

NOVA Chemicals has always placed an emphasis on continuous improvement in our processes and facilities. Our strategies support aggressive investment in technology and projects that drive step-change improvements in manufacturing capability and energy efficiency — in turn improving our greenhouse gas (GHG) emissions performance.

A key consideration in our growth strategy, NOVA 2020, is to leverage new technologies and equipment advances that result in improved environmental performance.

We recently completed a project to convert our Corunna, Ontario ethylene manufacturing facility from a primarily oil-based feedstock supply to allow it to utilize up to 100% natural gas-based feedstock, and as a result are no longer cracking naphtha. In addition we are incorporating process improvements and new fuel sources.



*NOVA Chemicals
Corunna Site.*

These changes are expected to realize significant emission reductions in oxides of nitrogen, sulphur and carbon dioxide (CO₂) — our largest GHG emission. With the conversion now complete, we are currently running our expected full ethane volumes at Corunna, with propane and butane making up the remainder of our feedstock slate.

At our Joffre Site in Alberta, one of the largest integrated petrochemical complexes in the world, we are already realizing improved production efficiencies as we access new feedstock supplies that allow us to operate our plants at closer to optimal conditions. Operating at optimal conditions improves production efficiency and correspondingly improves overall GHG emissions intensities. To further improve efficiencies, we are also expanding our Polyethylene 1 facility which is to be commissioned in 2016.

As we pursue our NOVA 2020 activities, we are reviewing GHG improvement opportunities and performance targets. In future reports we will provide these updates.

Our approach to managing greenhouse gas emissions



NOVA Chemicals believes that GHG solutions must both protect the environment and enable economic growth and its benefits — including investment in new technology.

Our strategy to reduce our GHG emissions intensity reflects our commitment to sustainable operations and Responsible Care®. Careful management of our natural resources simply makes good business sense.

Our strategy focuses on:

1. New technology to drive step-change in energy efficiency and GHG intensity reduction. We believe the most effective solutions to climate change will be achieved through transformational technology that drives step-change improvements in energy efficiency around the world.

Our research and technology sites work with our manufacturing facilities to develop innovative solutions and step-change improvements to our manufacturing processes that in turn reduce our GHG footprint.

By developing innovative polymers, we help our customers achieve their sustainability goals including improved recyclability and energy efficiency.

2. Continuous process improvements in our facilities.

As part of our multi-year growth strategy, we will invest in projects that improve

manufacturing capability and energy efficiency, and in turn our GHG emissions profile.

3. NOVA Chemicals supports the creation of GHG offset markets. GHG offset markets, as well as technology funds, are critical tools to allow us to achieve our reduction requirements without limiting production.

Offsets are reductions of GHG emissions by parties who are not regulated, such as agricultural producers. We have purchased GHG offsets for our Joffre Site to meet our provincial compliance obligations. These offsets support the building of organic carbon in soil through low and zero-tillage practices and assist the agricultural community in advancing sustainable practices.

We continue to work with provincial and federal governments to advance offset and other opportunities related to flexible compliance options.

4. Working with Partners to manage GHG emissions. NOVA Chemicals has a long tradition of working with academic, industry and government partners in the development of new technologies, products and processes that reduce direct and indirect GHG emissions intensity. We continue to challenge ourselves to identify and submit research proposals to the Alberta Climate Change and Emissions Management Corporation (CCEMC) in support of their — and our own — technology-related strategies.

About this report

In this report, we provide 2013 GHG performance data from all of our chemical manufacturing, research and technical facilities worldwide. We also report GHG emissions from our joint-venture facilities.

Our Joffre facilities began reporting GHG data in keeping with Alberta's *Climate Change and Emissions Management Act (2007)* in 2008. In 2010 we met new Ontario provincial requirements for mandatory GHG reporting. Our data is verified by a third-party in keeping with both Alberta and Ontario (as of 2011) GHG regulatory requirements. Previous to the required reporting requirements, NOVA Chemicals has been reporting our performance publicly since 1994.

NOVA Chemicals is a Responsible Care company. We are committed to Responsible Care® and sustainability in our daily operations as well as our future growth.

2013 performance

Reporting overview

- NOVA Chemicals reports GHG emissions of carbon dioxide (CO₂), methane and nitrous oxide.
- The mass of each gas is converted to carbon dioxide equivalents (CO₂E) using the global warming potentials mandated by provincial and state regulatory reporting requirements (References 1 and 2).
- More than 99% of our direct GHG emissions are CO₂.
- This report provides an overview of GHG emissions and intensity from all of our chemical manufacturing, research and technical facilities for the period 2004 to 2013.
- Direct and indirect emissions and associated GHG emission intensities (CO₂E / kilotonne [kt] of high value chemicals [HVC] produced) are reported. (See definitions on page 11.)
- Data in this report, current and historic, does not include assets no longer owned by NOVA Chemicals.



For more than 30 years, we have captured and provided up to 100 kt of CO₂ per year for enhanced oil recovery — the equivalent of removing more than 20,000 passenger cars from our highways each year.

In 2013, the total (direct and indirect) GHG emissions from our chemical manufacturing facilities increased slightly from 2012 levels (an increase of almost 2.5%). This corresponded with a similar increase in overall HVC production of almost 3%. As a result, there was little change in our total GHG emissions intensity with a decrease of approximately 0.1% from 2012.

Emission intensity and overall emissions improvements were seen at our polyethylene sites. The Moore Site had more than a 31% increase in production from 2012; this coincided with almost a 5% reduction in emissions. This was due to reduced flaring in 2013 and the facility operating closer to, or at, rates for which optimal operating conditions are achieved. Operating near capacity, the St. Clair River Site saw a slight drop in production (0.3%) from 2012 and almost a 10% decrease in direct emissions. This drop was due to fuel switching: pyrolysis fuel oil was phased out as we switched to natural gas which is less carbon intensive.

At the Corunna Site, HVC production (up 1.2%) and direct emissions (up 2.2%) changed little from 2012. The Joffre Site in 2013 had a similar profile to the Corunna Site, with a small increase in

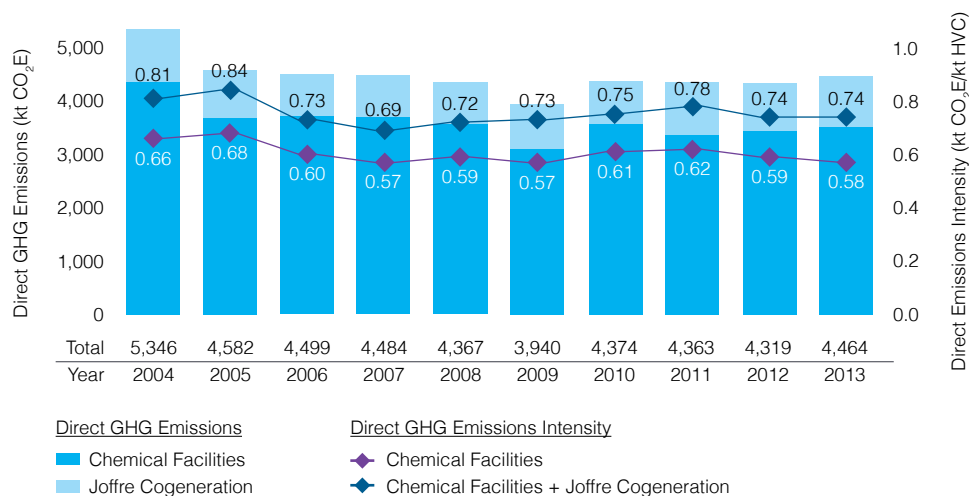


Operating near capacity, the St. Clair River Site saw a 10% decrease in direct emissions from 2012.

production (1.5%) and emissions (2.5%) compared to 2012. Ethylene 2 at Joffre was in a planned maintenance shutdown in the spring of 2013 and Corunna had a planned shutdown in August 2013.

Cogeneration at the Joffre Site continues to provide emission and operational benefits. The GHG emissions associated with generating steam and electrical energy from cogeneration were about 850 kt CO₂E less than if the same energy had been produced from conventional gas-fired steam boilers and the typical Alberta Interconnected Energy System (AIES) power generator. Electricity exported to the AIES also delivers an indirect emissions benefit to third parties.

Direct greenhouse gas emissions CO₂E



2013 performance data

Please note, in keeping with our commitment to data quality and assurance, there may be minor adjustments to numbers previously reported. For all tables, totals may not match due to rounding.

Table 1: NOVA Chemicals' Company-wide Greenhouse Gas Emissions

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Chemical Facilities										
Direct (kt CO ₂ E) ^a	4,355	3,678	3,700	3,696	3,558	3,097	3,572	3,469	3,437	3,501
Indirect (kt CO ₂ E)	848	831	827	819	824	808	768	766	760	798
TOTAL (kt CO ₂ E)	5,203	4,509	4,527	4,515	4,382	3,904	4,339	4,235	4,198	4,300
Direct Emissions Intensity (kt CO ₂ E/kt chemical product) ^b	0.66	0.68	0.60	0.57	0.59	0.57	0.61	0.62	0.59	0.58
Total Emissions Intensity (kt CO ₂ E/kt chemical product) ^b	0.79	0.83	0.74	0.70	0.72	0.72	0.75	0.75	0.71	0.71
Total Production	6,597	5,429	6,142	6,471	6,050	5,414	5,820	5,629	5,875	6,042
Chemical Facilities + Joffre Cogeneration										
Direct (kt CO ₂ E) ^c	5,346	4,582	4,499	4,484	4,367	3,940	4,374	4,363	4,319	4,464
Direct Emissions Intensity (kt CO ₂ E/kt chemical product) ^c	0.81	0.84	0.73	0.69	0.72	0.73	0.75	0.78	0.74	0.74

(a) Numbers do not include direct emissions from the Joffre Cogeneration facility.

(b) Chemical production includes the range of materials considered to be high value chemicals (HVC), generated in the chemical manufacturing process and for which plant operations are generally optimized to produce for off-site export and sale to third parties.

(c) Direct emissions include those from the Joffre Cogeneration facility.

Table 2: NOVA Chemicals' Greenhouse Gas Emissions from the Joffre Joint Venture Cogeneration Facility

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Energy Produced (terajoules [TJ])										
Electrical	7,257	6,520	5,622	5,712	5,690	6,017	5,622	6,454	6,145	6,866
Steam	4,460	4,215	3,615	3,376	3,398	3,418	3,207	3,871	4,066	4,296
Direct CO ₂ E Emissions (kt) ^a	991	903	799	789	808	844	803	894	882	963
% Emissions Claimed as NOVA Chemicals' Site Indirects	55	57	63	61	60	62	60	54	57	52
% Emissions as Exports to non-NOVA Chemicals' Customers	45	43	37	39	40	38	40	46	43	48
Benefit of Generating Cogen Energy in Place of Energy from Conventional Sources (kt CO ₂ E reduction) ^b	1,021	915	761	780	756	802	776	891	858	850

(a) Average CO₂ emission factors were calculated for individual steam and electricity energy streams produced at the Joffre Cogeneration facility as in WBCSD / WRI (Reference 3, Option 1) for combined heat and power production.

(b) Based on assumed boiler thermal efficiency of 90% and Alberta CO₂E emission factor for electricity from NRC (Reference 4).

In 2010, we received a \$700,000 research grant from the Alberta CCEMC in support of a \$1.5-million project with the potential to reduce the energy footprint for ethylene manufacturing through the application of advanced micro-porous molecular sieves.



2013 performance data

Table 3: Direct Greenhouse Gas Emissions at NOVA Chemicals' Chemical Facilities (kt CO₂E)^a

	1999	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Corunna	1,745	1,995	1,434	1,640	1,633	1,504	1,186	1,462	1,345	1,407	1,438
Joffre	1,550	2,191	2,097	1,894	1,898	1,899	1,769	1,963	1,991	1,887	1,935
Moore	61	63	61	66	66	68	56	57	52	59	56
Centre for Performance Applications ^b	1	1	1	1	1	1	1	1	1	1	1
Centre for Applied Research ^c	2	2	2	2	2	2	2	2	2	2	2
SCRS ^d	109	91	71	85	83	72	71	73	63	66	60
Beaver Valley	7	8	8	7	6	6	6	8	8	9	8
Painesville	11	1	1	1	1	1	1	1	1	1	1
TOTALS	3,485	4,351	3,675	3,697	3,690	3,552	3,092	3,568	3,464	3,432	3501

(a) Numbers do not include direct emissions from the Joffre Cogeneration facility.

(b) Formerly NOVA Chemicals Technical Centre (NCTC).

(c) Formerly NOVA Chemicals Research & Technology Centre (NRTC).

(d) St. Clair River Site.

Table 4: Indirect Greenhouse Gas Emissions at NOVA Chemicals' Chemical Facilities (kt CO₂E)^a

	1999	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Corunna	48	48	40	45	47	54	41	45	37	43	40
Joffre	436	551	524	520	508	510	549	525	541	520	526
Moore	50	52	42	44	45	56	40	42	41	47	50
Centre for Performance Applications	3	3	3	3	3	3	3	3	3	3	3
Centre for Applied Research	6	6	6	6	6	6	6	6	5	6	6
SCRS	25	21	17	17	18	20	17	18	15	16	15
Beaver Valley	186	161	192	185	186	168	146	123	117	116	153
Painesville	5	5	5	5	6	5	5	5	6	6	6
TOTAL	760	847	830	826	818	822	807	766	764	758	797

(a) Indirect emissions were calculated using provincial average emission factors (based on data from NRC [Reference 4] or Cogeneration facility specific emission factors, as appropriate).



ANK400 technology, developed more than a decade ago by NOVA Chemicals, has been retrofitted on 66 furnace facilities in North America, Asia, the Middle East and Europe. This anti-coking furnace tube technology results in GHG emissions reduction of approximately 50 kt per year.



Our Painesville, Ohio, manufacturing site utilizes landfill gas (LFG) as a fuel source. Previously the methane, a high intensity GHG, was released to the atmosphere. About 60% to 80% of the gas we use in our boilers at Painesville comes from LFG. In a year this amounts to about 106 TJ of energy.

Definitions and references

Definitions

Greenhouse Gases (GHG) reported by NOVA Chemicals are carbon dioxide, methane and nitrous oxide. The total masses of these gases are converted to carbon dioxide equivalents (CO₂E) using the global warming potentials mandated by provincial and state regulatory reporting requirements (References 1 and 2).

High Value Chemical (HVC) production includes the primary products and co-products for which NOVA Chemicals' chemical plant operations are generally optimized to produce. These may be consumed in further processing or sold to third parties.

Direct emissions are GHG emissions generated at NOVA Chemicals' sites as a result of chemical manufacturing and power cogeneration activities.

Indirect emissions are GHG emissions generated off-site in the production of energy that is imported to,

and consumed at, a NOVA Chemicals' chemical manufacturing site. These include emissions from steam and electricity produced by cogeneration facilities and exported to NOVA Chemicals' facilities.

Total GHG emissions are the sum of direct and indirect emissions.

Emissions intensity is the mass of GHG emissions generated to produce a unit mass of HVC products (mass of CO₂E per mass of product or output).

Cogeneration benefits claimed by NOVA Chemicals in this document are defined as the difference between the GHG emissions that would have been produced by generating electricity from conventional sources supplying the Alberta Interconnected Electric System (AIES) and the GHG emissions produced to generate the same amount of electricity from the Joffre Cogeneration facility.

References

1. **Alberta Regulation 139/2007**, *Climate Change and Emissions Management Act, Specified Gas Emitters Regulation*
2. **Ontario Regulation 452/09**, *Greenhouse Gas Emissions Reporting*
3. **WBCSD/WRI; 2001**; *The Greenhouse Gas Protocol: Guide to Calculation Worksheets — Calculating CO₂ Emissions from the Combustion of Standard Fuels and from Electricity/ Steam Purchase (Option 1)*; World Business Council for Sustainable Development/World Resources Institute; Switzerland; October 2001; 13pp.
4. **Natural Resources Canada; 2005**; *Comprehensive Energy Use Database Tables: Electricity Generation Energy Use, Generation and GHG Emissions by Energy Source*, 2005/05/24.



About our cover

NOVA Chemicals Joffre Site in Central Alberta: Since 60% to 80% of our manufacturing costs are fuel and feedstock related, energy efficiency measures make business as well as environmental sense.



Our high-density polyethylene barrier film resins offer industry-leading moisture-barrier performance and can deliver up to a 30% reduction in film gauge. For the North American barrier-film market, a 10% reduction in film thickness would eliminate 11kt of Polyethylene resin per year — reducing carbon dioxide emissions equivalent to those produced from 34 million litres of gasoline. This helps our customers — and their customers — to achieve sustainability goals.



NOVA Chemicals' researchers are working to improve the design of ethylene cracking furnace coils by changing the external surface to improve heat transfer. Improvements to furnace coil design may allow for up to a 15% reduction in fuel use and the associated GHG emissions.

If you have any questions, please contact

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