

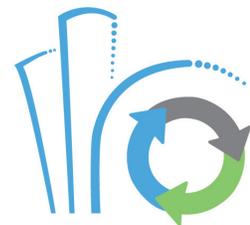


2016

PCI SUSTAINABLE PLANT PERFORMANCE REPORT



PCI SPP 16-04



**NORTH AMERICAN
PRECAST CONCRETE**
SUSTAINABLE PLANT PROGRAM

INTRODUCTION

The goal of the North American Precast Concrete Sustainable Plant Program (NAPCSPP) is to benchmark the precast industry's impact on the environment in the areas of global warming, energy, water use, waste, dust and noise generation. Ultimately, the precast industry is striving to reduce the environmental impact at the manufacturing level while creating a culture of sustainability. The PCI Life Cycle Assessment study for Commercial Buildings (2013) helped identify where the industry can improve its impacts at the manufacturing stage of the life cycle, with a goal to positively influence the impacts at the end of a project's life.

The benefits of sustainable business practices are well documented. As the leading technical resource for the precast concrete industry in the United States, the PCI has provided the tools for its member plants to measure and implement improvements that will have a measurable impact on their environmental and economic performance, using the customized industry software, *North American Plant Sustainability Tracking Program*.

The software program, developed by the Athena Sustainable Materials Institute (ASMI), enables individual manufacturers to measure their "cradle to gate" environmental footprint (with cradle being raw material resource extraction and gate being the finished product leaving the precast plant for the construction site).

Once a manufacturing facility enters their raw data for material usage, electricity, natural gas, gas, diesel, heavy fuel oil and liquefied propane gas usage the software uses the ASMI database to calculate the sustainability indicators – global warming potential (GWP), total primary energy (TPE) and water usage for the plant. The facility also self-evaluates and reports their environmental performance indicators – dust, noise and waste materials.

Participating plants report their tracked results to PCI on a quarterly basis, the results of which are presented in this report along with the year to date results. Because of the number of plants reporting, data presented in Fig. 1-9 and Table 1-9 are meant to show trends. Raw data reported per quarter per plant are presented in the Appendixes. Individual plants are also provided a customized report on a quarterly basis for their own internal benchmarking. Specifiers and owners can request the sustainability impacts on a project-to-project basis and are also encouraged to include this requirement in their contract specifications.

The industry has now been reporting for 30 months, beginning first quarter 2015. The following report reflects the first 2 years ending December 2016; the report includes moving averages for the industry during this period. All participating plants are assigned unique identification numbers in order to maintain confidentiality.

For more information on the NAPCSPP, contact Emily Lorenz at elorenz@pci.org.

A. SUSTAINABILITY IMPACT MEASURES

A.1 Global Warming Potential

Global warming potential (GWP) is reported in kg CO₂equivalent (eq.) and is the reference measure used to report the amount of greenhouse gases created in the extraction, processing and transportation of each material. The following figures and tables express GWP as kg CO₂eq per metric ton (tonne) of precast concrete produced.

Table 1: Global Warming Potential - Eight Quarter Average (January 2015 to December 2016)

Sample Size: 485

Average GWP (kgCO ₂ /tonne precast)	Standard Deviation (kgCO ₂ /tonne precast)	Coefficient of Variation (%)	High (kgCO ₂ /tonne precast)	Low (kgCO ₂ /tonne precast)
384	298	77.6	4406	30

Table 2: Global Warming Potential - Most-recent Quarter Average (4th Quarter 2016)

Sample Size: 43

Average GWP (kgCO ₂ /tonne precast)	Standard Deviation (kgCO ₂ /tonne precast)	Coefficient of Variation(%)	High (kgCO ₂ /tonne precast)	Low (kgCO ₂ /tonne precast)
341	114	33.3	869	123

Table 3: Global Warming Potential – By Contribution (as a percentage of total) – 4th Quarter 2016

Sample Size: 43

Average GWP (kgCO ₂ /tonne precast)	Contribution from Raw Materials	Contribution from Raw Material Transportation	Contribution from Precast Plant Operations
Industry Average	83.1%	4.9%	12.0%
High	95.7%	15.9%	45.1%
Low	48.0%	1.4%	1.3%

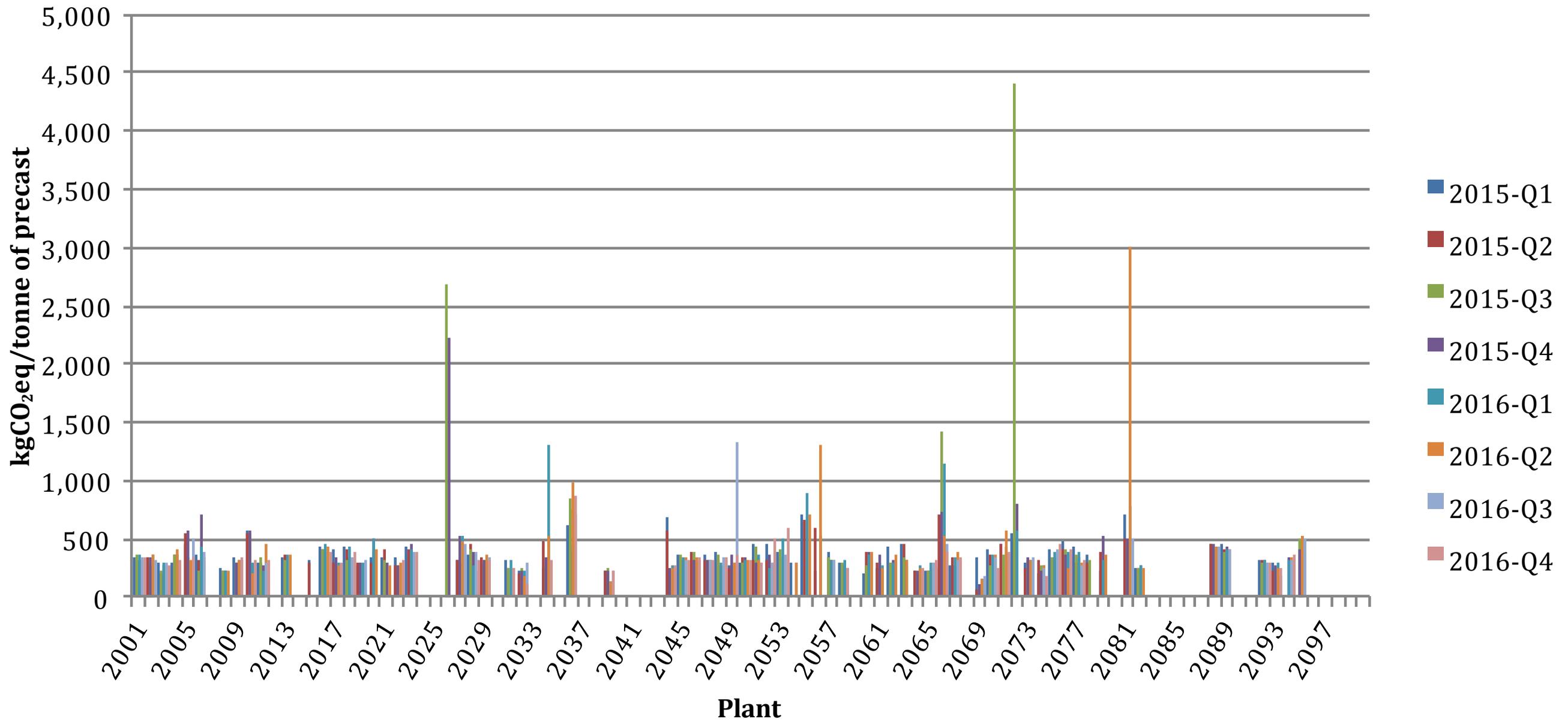


Figure 1: Global Warming Potential by Quarter for Each Plant

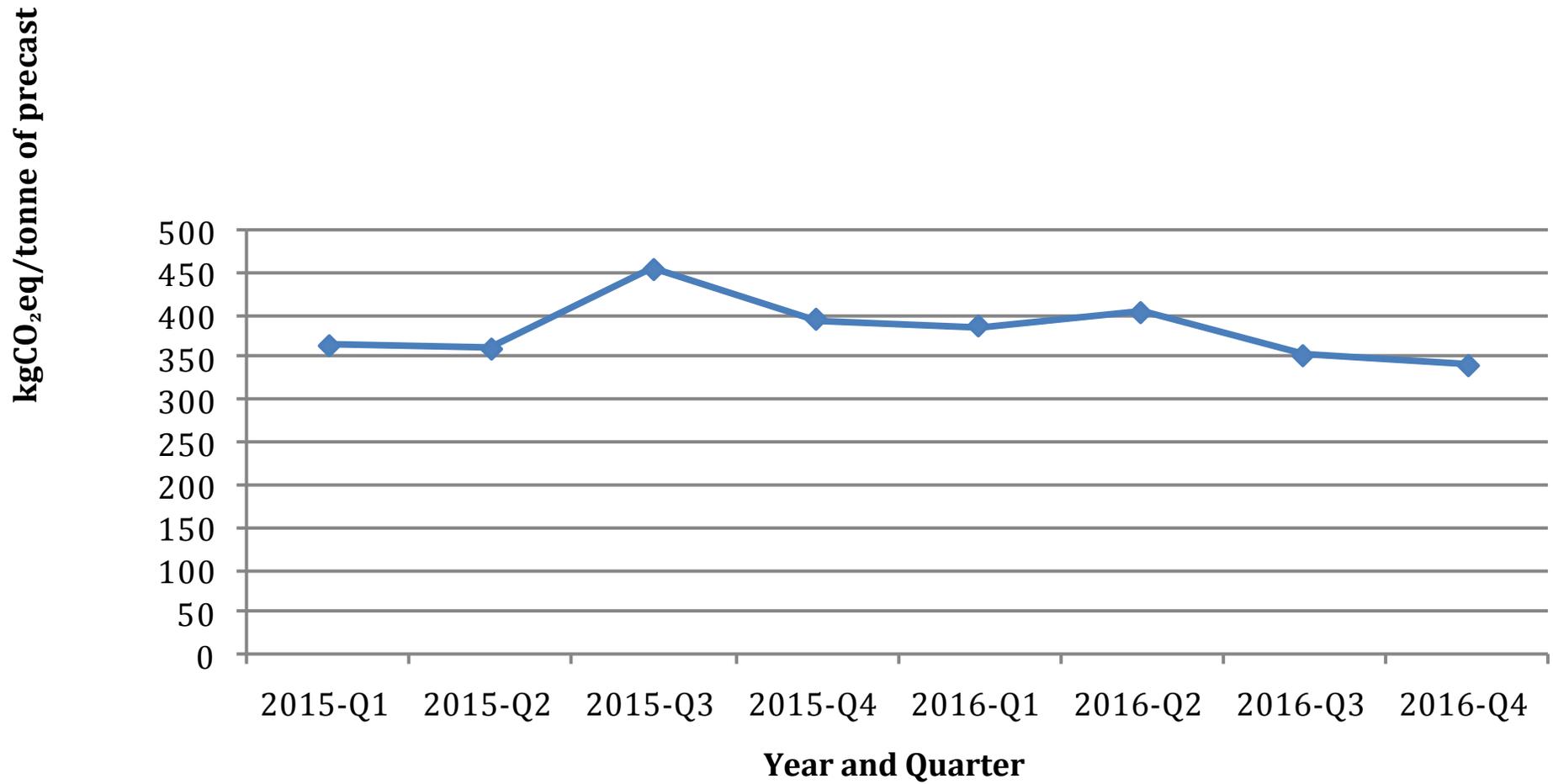


Figure 2: Global Warming Potential - 24 Month Industry Moving Average

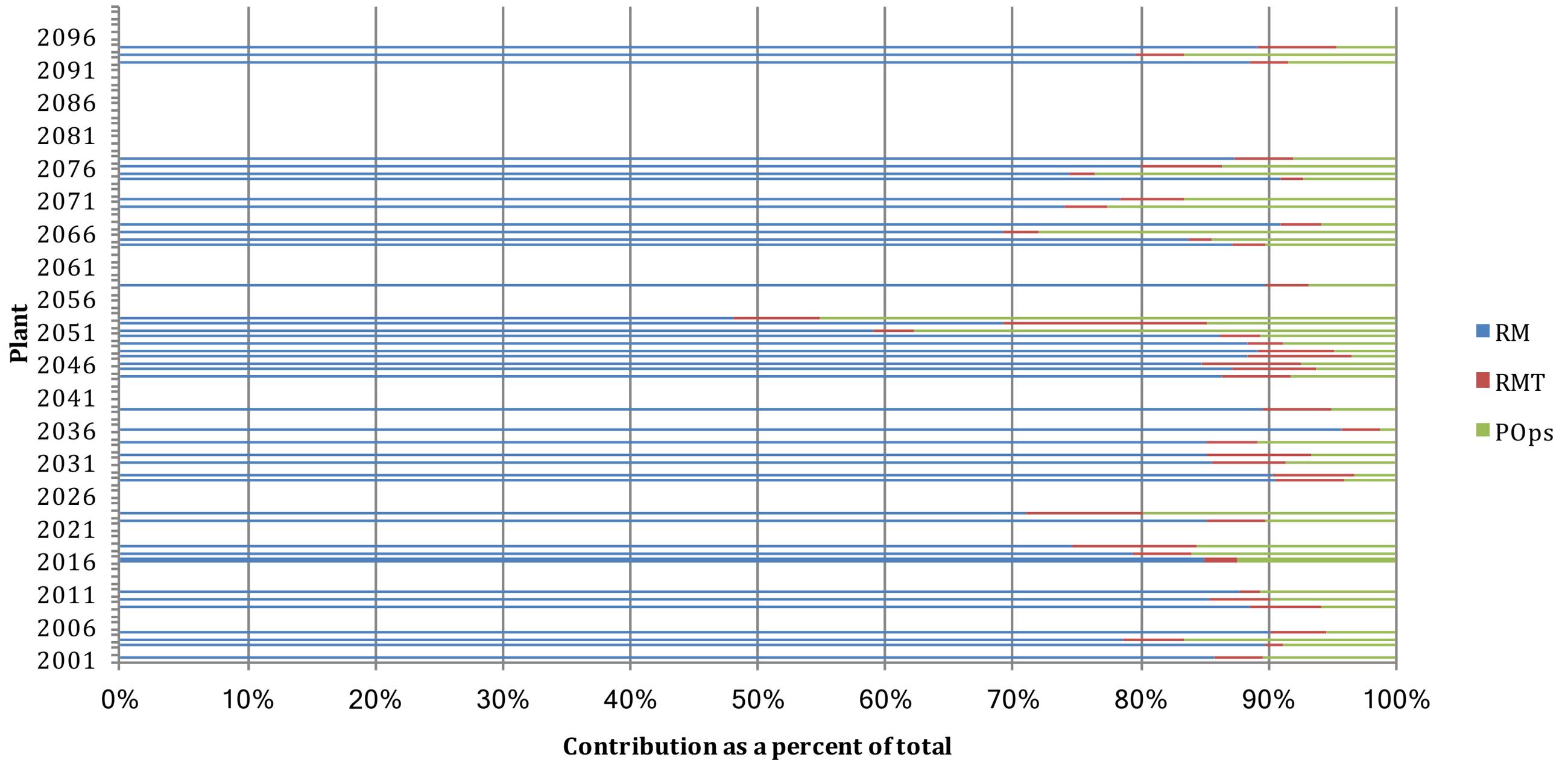


Figure 3: Global Warming Potential by Contribution – 4th Quarter 2016.

Note: POps = precast plant operations; RM = raw materials; RMT = raw materials transportation.

B. RESOURCE MEASURES

B.1 Total Primary Energy

Total Primary Energy (TPE) is reported in mega-joules (MJ) and is a measure of all primary energy consumed (direct and indirect) to transform or transport raw materials into products. This includes inherent energy in raw or feedstock materials that are also used as common energy sources. In addition, the measure also captures the pre-combustion (indirect) energy associated with processing, transporting, converting and delivering fuel and energy. The following tables and figures show the TPE expressed as MJ per metric ton (tonne) of precast produced.

Table 4: Total Primary Energy - Eight Quarter Average (January 2015 to December 2016)

Sample Size: 485

Average TPE (MJ/tonne precast)	Standard Deviation (MJ/tonne precast)	Coefficient of Variation(%)	High (MJ/tonne precast)	Low (MJ/tonne precast)
3608	3311	91.8	41061	323

Table 5: Total Primary Energy - Most-recent Quarter Average (4th Quarter 2016)

Sample Size: 43

Average TPE (MJ/tonne precast)	Standard Deviation (MJ/tonne precast)	Coefficient of Variation(%)	High (MJ/tonne precast)	Low (MJ/tonne precast)
3248	2000	61.6	13792	1229

Table 6: Total Primary Energy – By Contribution (as a percentage of total) – 4th Quarter 2016

Sample Size: 43

Average TPE (MJ/tonne precast)	Contribution from Raw Materials	Contribution from Raw Material Transportation	Contribution from Precast Plant Operations
Industry Average	70.1%	7.6%	22.3%
High	96.0%	23.7%	64.9%
Low	28.0%	2.6%	1.4%

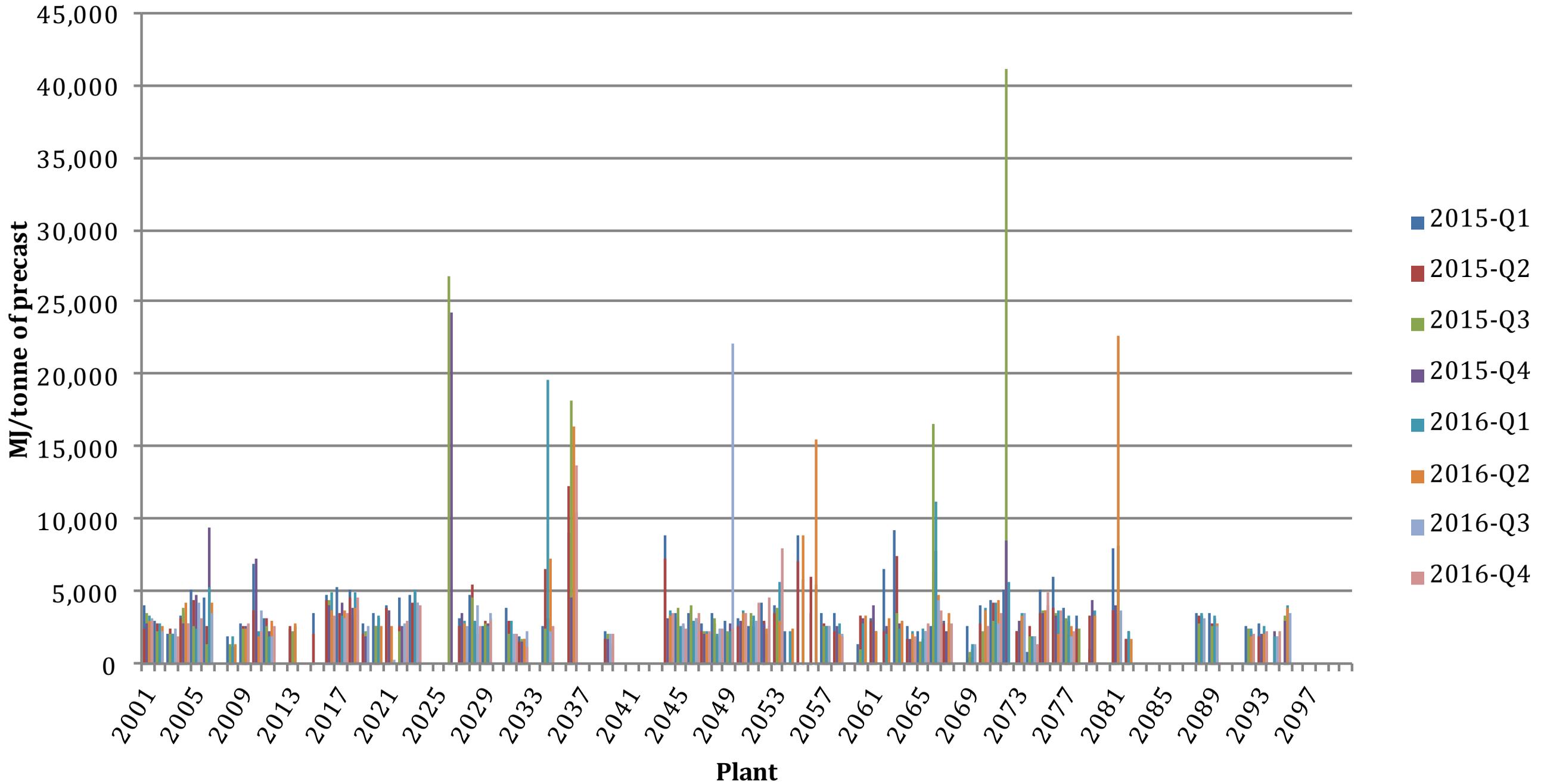


Figure 4: Total Primary Energy by Quarter for Each Plant

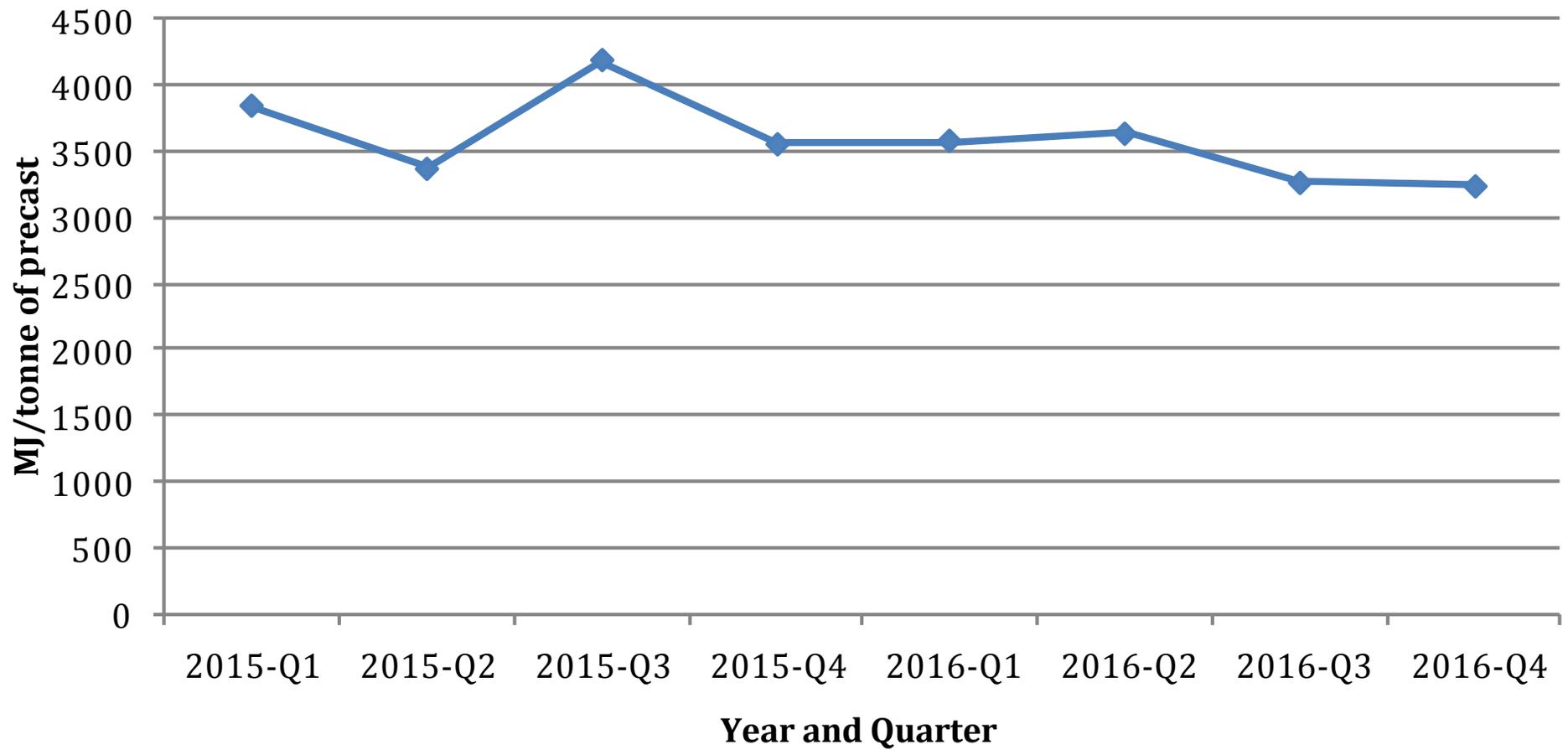


Figure 5: Total Primary Energy - 24 Month Industry Moving Average

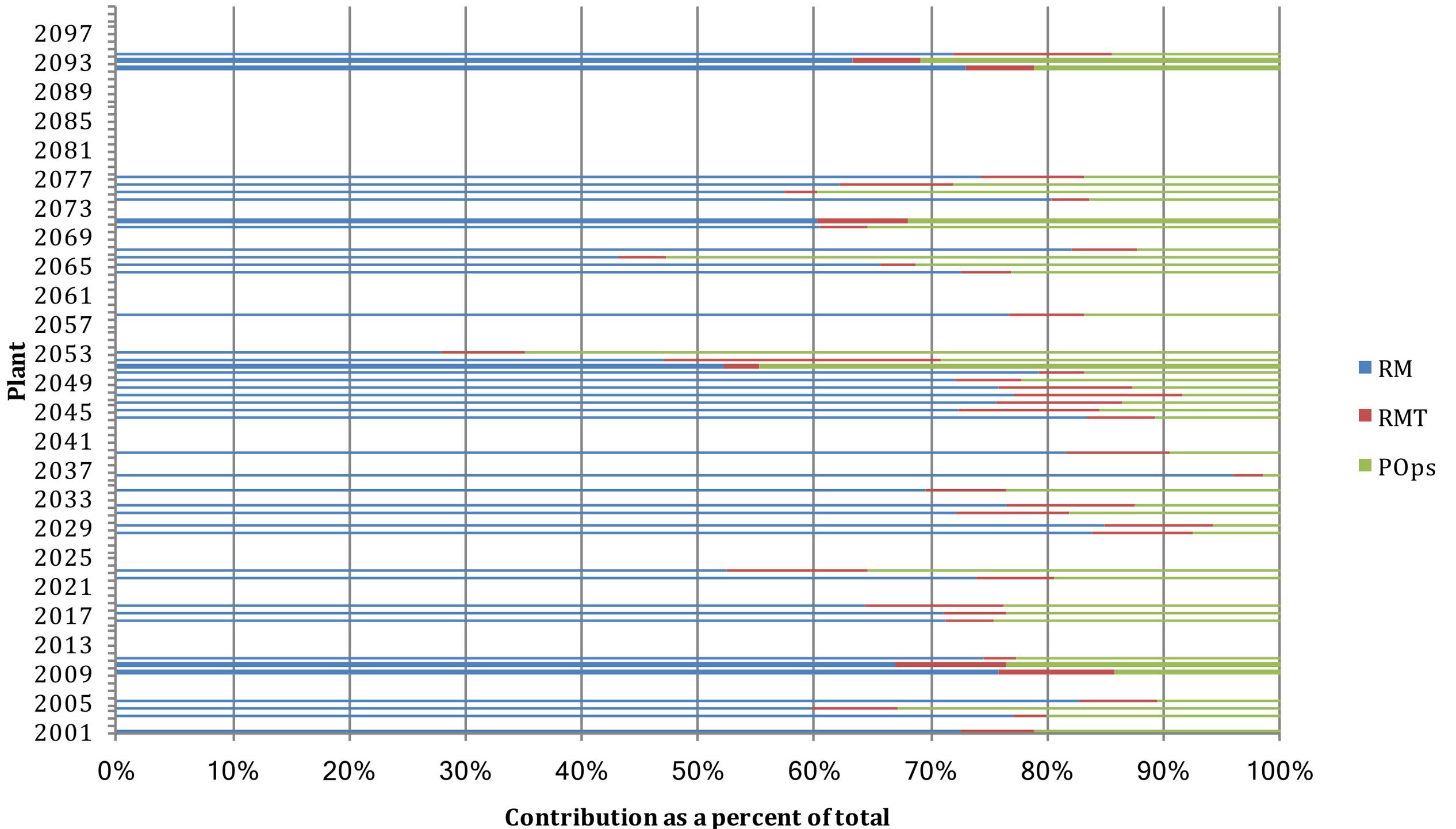


Figure 6: Total Primary Energy by Contribution – 4th Quarter 2016.

Note: POpS = precast plant operations; RM = raw materials; RMT = raw materials transportation.

B.2 Water Use

The water consumption is tracked in the plant as water for batching concrete (also known as mix water) and water used to wash-out mixers and general clean-up in the plant. Included in the total water consumption is the water in upstream processing of all raw materials, for example washing of coarse and fine aggregates. Water is expressed as litres per tonne of precast produced.

Table 7: Water Consumption - Eight Quarter Average (January 2015 to December 2016)

Sample Size: 485

Average Water Consumption (litre/tonne precast)	Standard Deviation (litre/tonne precast)	Coefficient of Variation(%)	High (litre/tonne precast)	Low (litre/tonne precast)
113695	400255	352.0	3632196	183

Table 8: Water Consumption - Most-recent Quarter Average (4th Quarter 2016)

Sample Size: 43

Average Water Consumption (litre/tonne precast)	Standard Deviation (litre/tonne precast)	Coefficient of Variation(%)	High (litre/tonne precast)	Low (litre/tonne precast)
80262	267241	333.0	1212517	828

Table 9: Water Consumption by Contribution (as a percentage of total) – 4th Quarter 2016

Sample Size: 43

Average Water Consumption (litre/tonne precast)	Contribution from In-Plant Fresh Batch Water	Contribution from In-Plant Washing	Contribution from Upstream Raw Material Processing
Industry Average	4.2%	14.9%	80.9%
High	13.0%	99.5%	100.0%
Low	0.0%	0.0%	0.5%

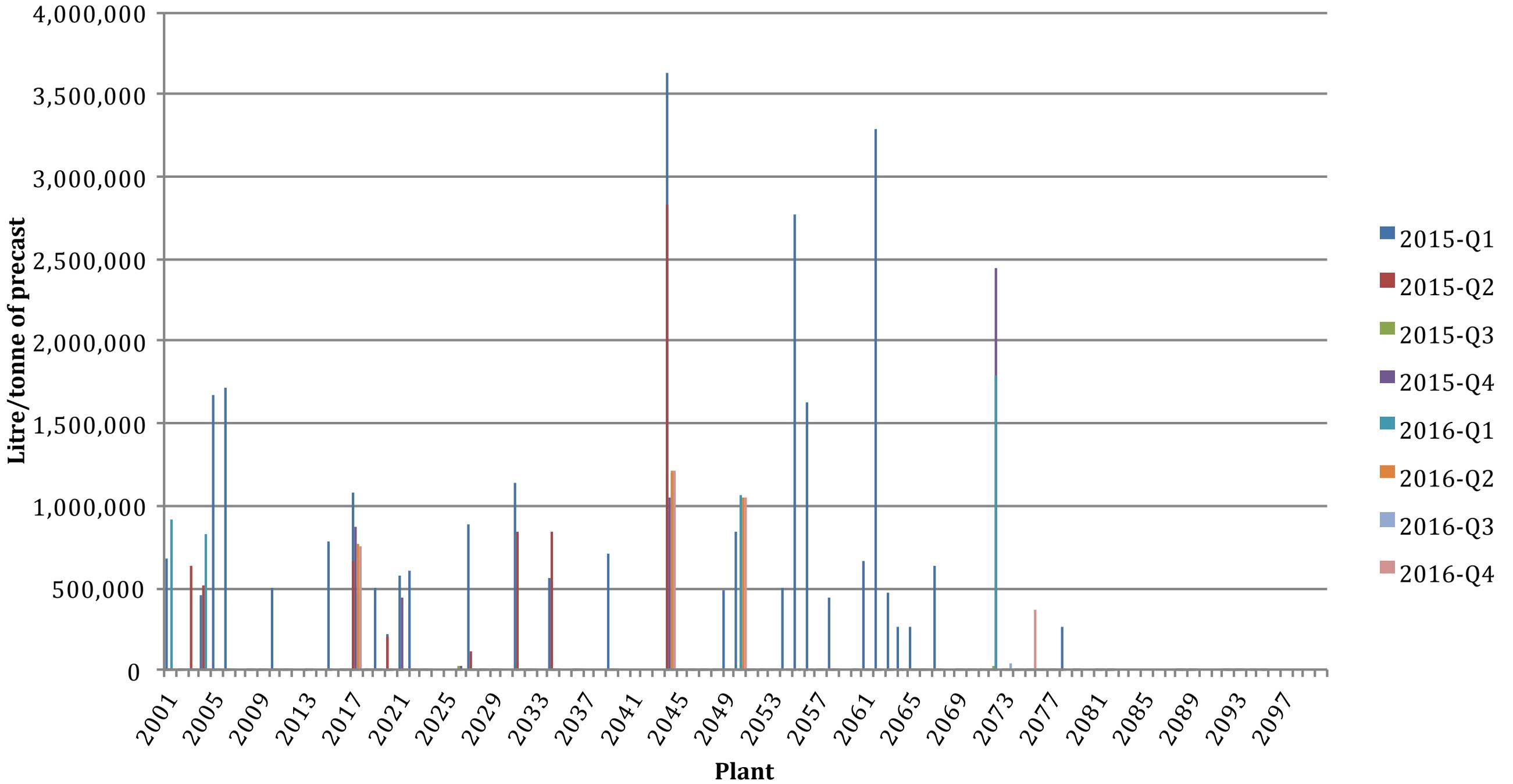


Figure 7: Water Consumption by Quarter for Each Plant

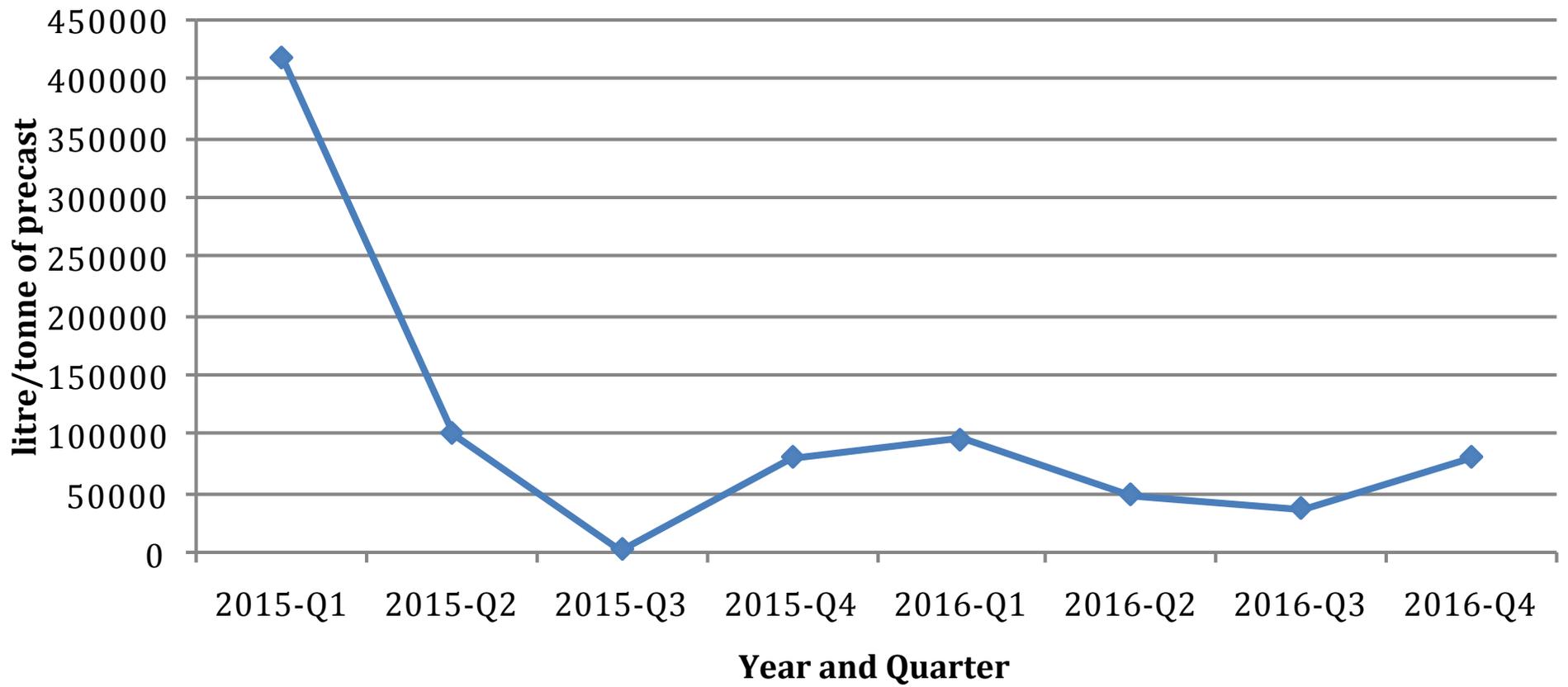


Figure 8: Water Consumption - 24 Month Industry Moving Average

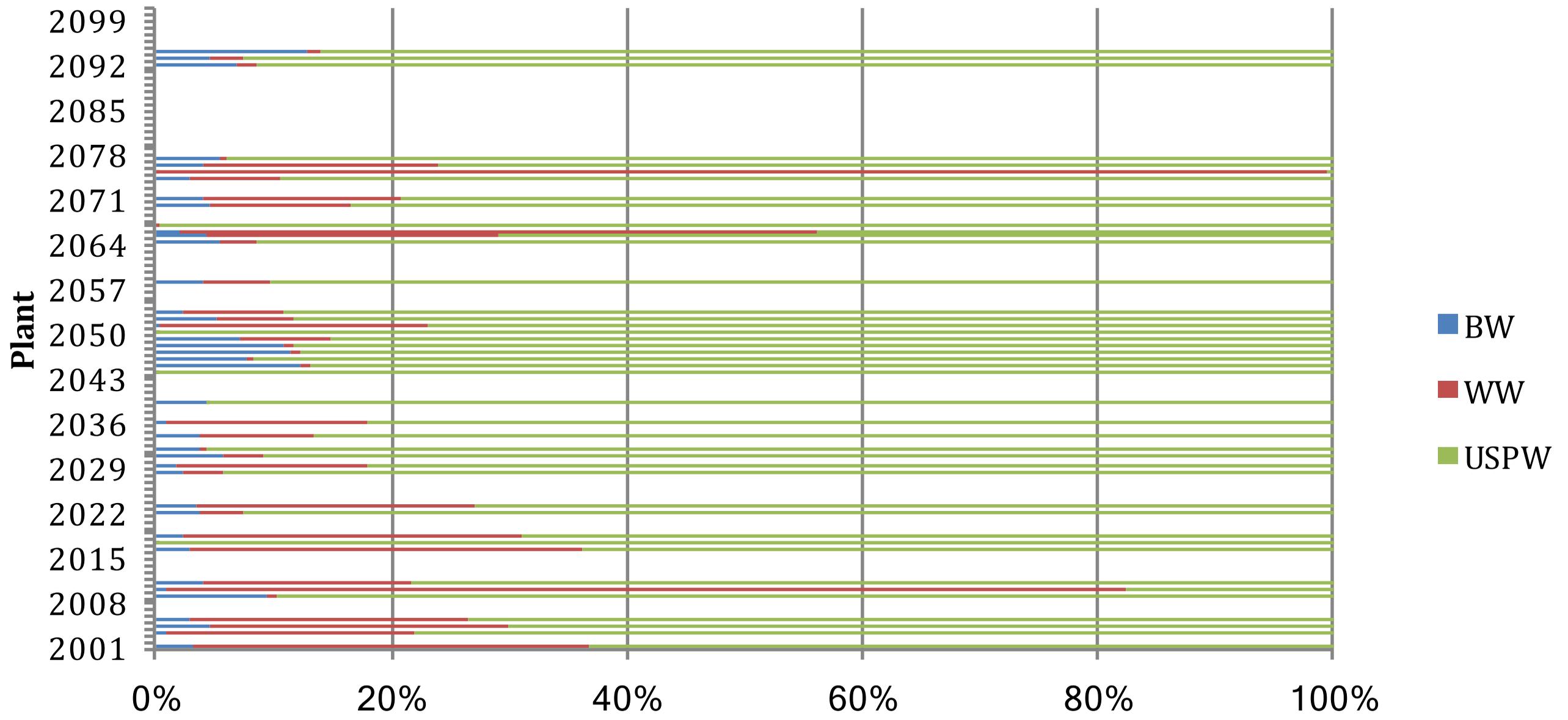


Figure 9: Water Consumption by Contribution – 4th Quarter 2015.

Note: BW = batch water; USPW = upstream processing water; WW = wash water.

Appendix A (cont.)

Global Warming Potential by Quarter (January 2015-December 2016)								
kgCO ₂ eq/tonne of precast								
Plant	2015-Q1	2015-Q2	2015-Q3	2015-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4
2039	221	235	250	230	145	148	238	237
2040	n.d.							
2041	n.d.							
2042	n.d.							
2043	n.d.							
2044	683	564	n.d.	250	282	263	257	271
2045	365	349	372	317	350	354	325	329
2046	323	386	395	328	317	348	328	345
2047	366	315	320	322	327	320	311	310
2048	398	326	362	271	305	294	341	334
2049	278	252	282	362	296	289	1,339	357
2050	290	333	304	349	321	310	n.d.	310
2051	457	330	435	303	370	318	304	298
2052	460	327	331	360	252	295	301	494
2053	394	352	420	n.d.	494	319	378	596
2054	293	n.d.	n.d.	n.d.	300	298	n.d.	n.d.
2055	711	665	n.d.	n.d.	888	712	n.d.	n.d.
2056	237	593	n.d.	n.d.	538	1,307	n.d.	n.d.
2057	381	344	334	329	322	319	317	n.d.
2058	296	284	288	304	311	260	263	260
2059	n.d.							
2060	210	394	266	379	360	394	n.d.	n.d.
2061	255	308	307	378	267	256	n.d.	n.d.
2062	428	287	303	325	288	375	n.d.	n.d.
2063	460	460	337	317	294	322	n.d.	n.d.
2064	238	226	215	226	272	254	227	251
2065	230	238	230	260	299	287	288	319
2066	262	705	1,419	735	1,142	516	466	393
2067	284	347	n.d.	281	347	380	330	351
2068	n.d.							
2069	345	79	97	125	169	162	186	n.d.
2070	416	357	278	n.d.	372	367	339	242
2071	465	449	363	n.d.	435	573	344	394
2072	557	491	4,406	792	584	n.d.	n.d.	n.d.
2073	286	259	332	342	321	325	336	n.d.
2074	208	310	266	234	265	269	260	193
2075	419	352	342	352	392	389	408	456
2076	487	406	423	378	394	248	362	411

Appendix A (cont.)

Global Warming Potential by Quarter (January 2015-December 2016)								
kgCO ₂ eq/tonne of precast								
Plant	2015-Q1	2015-Q2	2015-Q3	2015-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4
2077	443	307	364	351	385	299	273	311
2078	361	308	309	n.d.	n.d.	n.d.	n.d.	n.d.
2079	223	387	324	519	326	375	n.d.	n.d.
2080	n.d.							
2081	710	508	465	501	783	3,012	509	n.d.
2082	240	248	255	271	279	244	n.d.	n.d.
2083	n.d.							
2084	n.d.							
2085	n.d.							
2086	n.d.							
2087	n.d.							
2088	466	465	414	466	443	430	443	n.d.
2089	462	406	391	439	420	418	409	n.d.
2090	n.d.							
2091	n.d.							
2092	317	317	304	319	316	289	296	299
2093	308	236	256	273	309	261	175	250
2094	n.d.	n.d.	n.d.	339	314	334	313	363
2095	n.d.	n.d.	495	419	520	520	502	n.d.

Appendix B (cont.)

Total Primary Energy by Quarter (January 2015-December 2016)								
MJ/tonne of precast								
Plant	2015-Q1	2015-Q2	2015-Q3	2015-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4
2039	2,310	1,779	2,083	1,772	1,356	1,090	2,109	2,007
2040	n.d.							
2041	n.d.							
2042	n.d.							
2043	n.d.							
2044	8,859	7,279	n.d.	3,112	3,620	3,362	3,289	3,447
2045	3,523	3,247	3,849	2,447	2,564	2,550	2,725	2,460
2046	3,482	3,750	3,998	2,778	3,025	3,237	3,139	3,457
2047	2,830	2,205	2,254	2,173	2,255	2,048	2,116	2,350
2048	3,580	2,856	3,175	2,001	2,178	2,036	2,438	2,375
2049	2,954	1,896	2,248	2,764	2,332	2,211	22,188	2,476
2050	3,165	2,685	2,365	3,050	3,714	3,455	n.d.	3,455
2051	2,600	2,934	3,557	2,687	3,281	2,496	3,007	4,198
2052	4,313	2,928	2,656	2,875	2,181	2,504	2,573	4,556
2053	4,090	3,439	3,814	n.d.	5,615	3,016	3,656	8,007
2054	2,235	n.d.	n.d.	n.d.	2,261	2,406	n.d.	n.d.
2055	8,889	7,152	n.d.	n.d.	5,922	8,937	n.d.	n.d.
2056	3,582	6,100	n.d.	n.d.	5,492	15,493	n.d.	n.d.
2057	3,584	2,843	2,713	2,707	2,605	2,550	2,547	n.d.
2058	3,510	2,252	2,308	2,567	2,869	2,056	2,033	1,897
2059	n.d.							
2060	1,436	3,334	1,079	3,107	2,800	3,323	n.d.	n.d.
2061	3,188	2,945	3,087	4,046	2,331	2,289	n.d.	n.d.
2062	6,497	2,295	2,407	2,665	2,056	3,126	n.d.	n.d.
2063	9,194	7,523	3,495	2,864	2,422	2,904	n.d.	n.d.
2064	2,642	1,809	1,522	1,716	2,356	2,018	1,547	1,971
2065	2,248	1,644	1,536	1,699	2,405	2,339	2,277	2,737
2066	2,661	6,354	16,617	7,788	11,285	4,740	4,366	3,717
2067	3,008	2,743	n.d.	2,193	2,738	3,474	2,605	2,813
2068	n.d.							
2069	2,711	549	823	973	1,293	1,247	1,445	n.d.
2070	4,005	2,726	2,211	n.d.	3,800	3,620	2,662	2,721
2071	4,504	4,226	2,972	n.d.	4,192	4,487	2,849	3,541
2072	5,124	4,998	41,061	8,514	5,756	n.d.	n.d.	n.d.
2073	2,251	2,314	3,047	2,980	3,529	3,358	3,592	n.d.
2074	847	2,605	1,871	1,827	1,861	1,904	1,891	1,447
2075	5,115	3,558	3,722	3,460	3,674	3,686	3,987	4,893
2076	5,970	3,885	3,443	3,395	3,656	2,146	3,013	3,621

Appendix B (cont.)

Total Primary Energy by Quarter (January 2015-December 2016)								
MJ/tonne of precast								
Plant	2015-Q1	2015-Q2	2015-Q3	2015-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4
2077	3,937	2,098	3,135	3,060	3,348	2,626	2,004	2,230
2078	3,382	2,521	2,518	n.d.	n.d.	n.d.	n.d.	n.d.
2079	990	3,284	2,511	4,493	3,668	3,342	n.d.	n.d.
2080	n.d.							
2081	7,933	3,789	3,589	3,993	8,116	22,609	3,725	n.d.
2082	1,650	1,786	1,890	2,188	2,358	1,708	n.d.	n.d.
2083	n.d.							
2084	n.d.							
2085	n.d.							
2086	n.d.							
2087	n.d.							
2088	3,550	3,388	2,877	3,376	3,485	3,047	3,082	n.d.
2089	3,569	2,871	2,549	3,134	3,392	2,850	2,719	n.d.
2090	n.d.							
2091	n.d.							
2092	2,670	2,520	2,418	2,258	2,426	1,934	1,840	2,159
2093	2,859	1,861	1,967	2,038	2,632	2,031	1,522	2,317
2094	n.d.	n.d.	n.d.	2,283	1,967	1,975	1,966	2,248
2095	n.d.	n.d.	3,277	3,019	4,104	3,884	3,515	n.d.

Appendix C (cont.)

Total Water Consumption by Quarter (January 2015-December 2016)								
L/tonne of precast								
2015-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4
2039	711,634	981	1,105	986	613	540	842	940
2040	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2041	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2042	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2043	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2044	3,632,196	2,837,604	n.d.	1,043,308	1,204,704	1,216,823	1,191,923	1,212,517
2045	1,334	1,142	1,534	1,125	1,150	1,224	1,083	1,061
2046	988	1,311	1,293	1,288	1,341	1,445	1,477	1,708
2047	1,490	1,123	1,187	1,061	1,205	1,113	1,066	1,144
2048	1,478	1,032	1,199	1,076	1,076	1,089	1,160	1,205
2049	485,448	1,148	1,270	1,380	1,208	1,153	17,543	1,226
2050	838,791	2,098	1,807	1,968	1,063,210	1,055,795	n.d.	1,055,795
2051	1,240	1,666	2,247	1,678	1,554	1,489	2,022	2,498
2052	1,609	1,324	1,361	1,046	676	959	1,053	1,548
2053	1,225	1,679	1,755	n.d.	1,774	1,335	1,620	1,614
2054	507,035	n.d.	n.d.	n.d.	1,639	2,162	n.d.	n.d.
2055	2,769,504	3,144	n.d.	n.d.	1,037	2,953	n.d.	n.d.
2056	1,627,139	3,983	n.d.	n.d.	2,472	6,184	n.d.	n.d.
2057	2,054	1,728	1,569	1,530	1,435	1,595	1,682	n.d.
2058	443,589	1,236	1,194	1,209	1,270	1,284	1,172	1,121
2059	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2060	1,972	2,739	1,444	2,636	2,867	3,230	n.d.	n.d.
2061	660,039	1,755	2,673	2,489	1,499	1,600	n.d.	n.d.
2062	3,296,806	1,412	1,439	1,438	1,431	1,670	n.d.	n.d.
2063	465,591	1,690	1,561	1,869	1,527	1,821	n.d.	n.d.
2064	263,199	1,046	1,095	1,070	1,145	1,114	1,107	1,147
2065	267,057	1,085	1,085	1,173	1,285	1,010	1,237	1,730
2066	1,118	3,043	5,947	5,614	4,857	2,468	2,488	2,618
2067	628,189	4,560	n.d.	3,362	4,584	6,653	1,365	1,525
2068	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
2069	1,807	401	605	672	891	827	949	n.d.
2070	1,633	1,716	1,453	n.d.	1,588	1,993	1,704	1,547
2071	2,014	2,000	1,757	n.d.	1,995	1,980	1,616	1,696
2072	2,614	5,135	26,675	2,439,628	1,787,179	n.d.	n.d.	n.d.
2073	1,474	1,306	2,178	1,668	1,405	42,379	46,601	n.d.
2074	258	1,583	1,094	1,073	902	1,053	1,113	828
2075	3,798	2,619	2,163	2,360	2,215	2,133	1,985	367,708
2076	1,494	1,489	1,713	1,315	1,570	1,226	1,536	1,574

Appendix C (cont.)

Total Water Consumption by Quarter (January 2015-December 2016)								
L/tonne of precast								
2015-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4
2077	1,878	1,143	2,007	2,004	1,153	1,378	1,075	1,054
2078	258,652	1,845	1,769	n.d.	n.d.	n.d.	n.d.	n.d.
2079	376	1,409	1,314	2,045	1,755	1,761	n.d.	n.d.
2080	n.d.							
2081	2,904	1,511	1,515	2,017	2,456	9,234	1,647	n.d.
2082	854	978	1,165	1,775	1,407	947	n.d.	n.d.
2083	n.d.							
2084	n.d.							
2085	n.d.							
2086	n.d.							
2087	n.d.							
2088	1,706	1,930	1,678	1,698	1,845	1,569	1,597	n.d.
2089	1,701	1,729	1,594	1,628	1,786	1,406	1,462	n.d.
2090	n.d.							
2091	n.d.							
2092	1,395	1,499	1,439	1,228	1,170	1,072	1,027	1,111
2093	1,315	1,129	1,248	1,184	1,283	1,224	930	1,104
2094	n.d.	n.d.	n.d.	836	878	944	904	998
2095	n.d.	n.d.	2,031	1,993	2,345	1,669	1,958	n.d.