

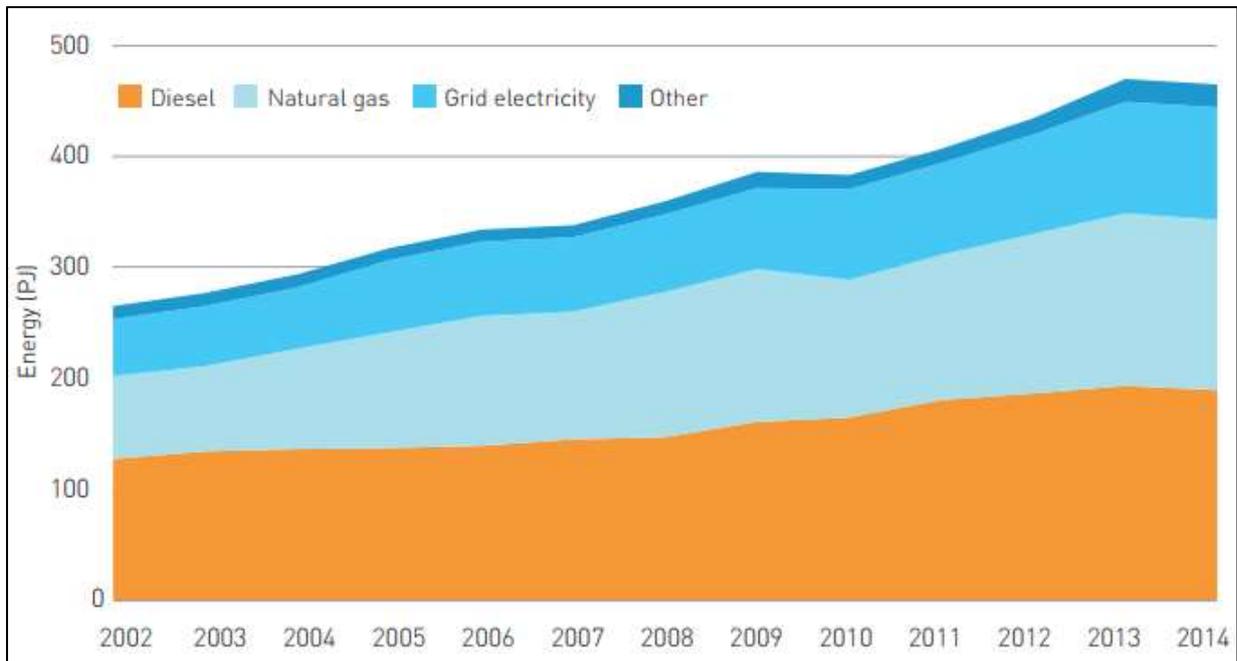
RESEARCH ON FUEL IN MINING INDUSTRY

Fuel consumption in the mining industry in Australia

Fuel consumption in the Australian mining sector has been increasing more rapidly than in any other sector. Loading, hauling and dumping operations consume up to 26% of the energy in underground mines.¹

The mining sector accounts for roughly 10% of Australia's total energy use. Its energy is mainly supplied by diesel (41%), natural gas (33%), and grid electricity (21%). Energy is primarily consumed as electricity for beneficiation operations and as diesel for vehicles and machinery.²

The Australian Mining Sector's energy consumption by source



In the above graph 'Other' includes petrol, coal, LNG, renewables, and biofuels

Fuel supply to mine sites without fixed pipeline infrastructure relies on heavy vehicle road transport – a fuel road train only provides sufficient energy to mine 7,900 tonnes of coal, 7,300 tonnes of metals, and 37,400 tonnes of minerals.

¹ <https://www.mining3.com/wp-content/uploads/2016/11/Full-Paper.pdf>

² http://energyandmines.com/wp-content/uploads/2017/06/SunSHIFT_Whitepaper_v2_single.pdf

Consumption & Expenditure on Electricity, Natural Gas and other energy inputs, by selected industries, Australia 2014-15³

		Mining	Manufacturing	Electricity, Gas, Water and Waste Services	Transport, Postal and Warehousing	Other selected industries(c)	Total selected industries
Energy or fuel type							
Electricity	Expenditure \$m	1 980.6	4 149.0	683.9	903.3	11 288.3	19 005.0
	Consumption GJ	77 778 000.0	183 102 840.0	23 348 880.0	20 604 600.0	198 092 880.0	502 927 200.0
Natural gas	Expenditure \$m	601.3	1 947.6	1 326.1	50.8	^1 029.0	4 954.9
	Consumption GJ	70 223 941.5	326 647 084.5	335 585 061.5	13 714 973.6	^56 314 719.6	802 485 780.6
LPG	Expenditure \$m	31.4	119.7	4.5	*119.0	*263.6	^538.3
	Consumption GJ	1 968.9	6 449.1	216.2	*6 413.8	*13 267.7	^28 315.7
Diesel(a)	Expenditure \$m	7 257.4	838.4	753.4	6 211.6	^4 773.7	19 834.7
	Consumption GJ	261 897 140.0	26 799 980.0	23 584 600.0	204 873 360.0	^148 498 665 653 140.0	665 653 140.0
Petrol(b)	Expenditure \$m	23.3	206.3	^58.4	^210.9	^1 637.1	2 136.0
	Consumption GJ	^615 760.0	5 462 720.0	^1,541,120.0	^5 497 120.0	^41 785 680.0	54 902 400.0

Note: All product consumption data is presented in Gigajoules (GJ) to provide comparability.

(a) Includes biodiesel blends.

(b) Includes E10.

(c) Includes divisions A, E, F, G, H, J, K, L, M, N, O, P, Q, R and S. Refer to the Explanatory Notes for a description of ANZSIC.

^ estimate has a relative standard error of 10% to less than 25% and should be used with caution.

* estimate has a relative standard error of 25% to less than 50% and should be used with caution.

Australian businesses consumed 666m GJ of diesel in 2014–15. The Mining and Transport, Postal and Warehousing industries combined accounted for 70% of the total consumption.⁴

New Zealand

Fossil fuel energy consumption (% of total) in New Zealand was reported at 59.37 % in 2015, according to the World Bank collection of development indicators, compiled from officially recognized sources.⁵

³ <http://www.abs.gov.au/ausstats/abs@.nsf/mf/4660.0>

⁴ <http://www.abs.gov.au/ausstats/abs@.nsf/mf/4660.0>

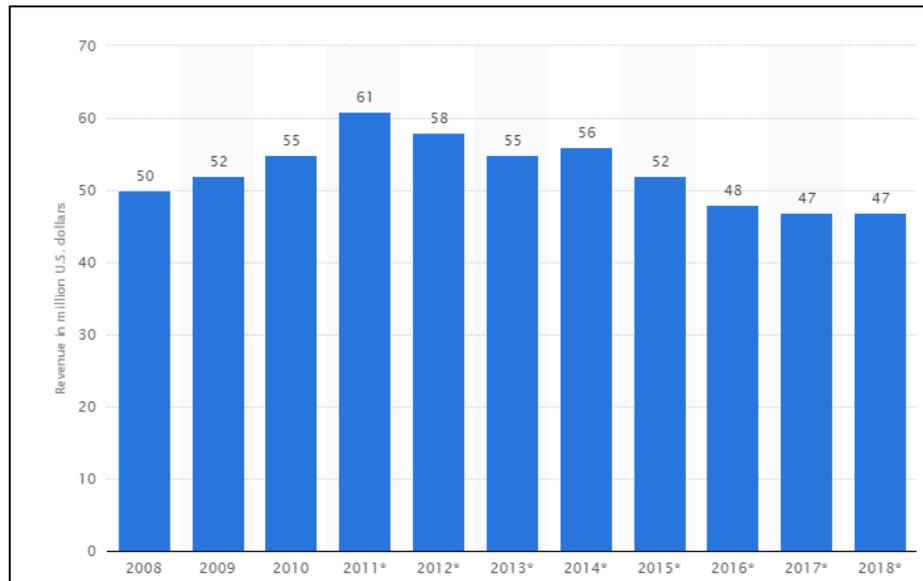
⁵ <https://tradingeconomics.com/new-zealand/fossil-fuel-energy-consumption-percent-of-total-wb-data.html>

Energy Supply and Demand balance of New Zealand calendar year 2015⁶

	Converted into Petajoules using Gross Calorific Values	COAL			OIL							Total	
		Bituminous & Sub-bitum.	Lignite	Total	Crudes/ Feed-stocks/ NGL	LPG	Petrol	Diesel	Fuel Oil	Av. Fuel/ Kero	Others		
SUPPLY	Indigenous Production	80.36	4.94	85.30	87.59	9.59							97.18
	• Imports	9.67	0.00	9.67	243.10	0.37	48.55	33.72	-	3.19	6.81		335.75
	• Exports	43.06	-	43.06	84.58	1.83	-	0.96	5.56	-	-		92.93
	• Stock Change	-8.40	-0.04	-8.44	-14.61	-0.13	7.85	0.78	1.71	-0.17	-1.21		-5.78
	• International Transport						0.00	1.63	12.41	40.36	-		54.39
	TOTAL PRIMARY ENERGY	55.38	4.99	60.36	260.73	8.26	40.69	30.35	-19.67	-37.00	8.02		291.38
	ENERGY TRANSFORMATION	-33.81	-0.28	-34.09	-257.93	-0.01	68.23	93.16	26.42	49.74	4.73		-15.66
	• Electricity Generation	-11.99	-	-11.99				-0.01	-				-0.01
	• Cogeneration	-7.74	-0.25	-7.99									
	• Fuel Production				-257.80		68.05	92.92	26.42	49.76	13.17		-7.48
	• Other Transformation	-11.84	-	-11.84									
• Losses and Own Use	-2.23	-0.03	-2.26	-0.13	-0.01	0.18	0.26	0.01	-0.02	-8.44		-8.16	
Non-energy Use												-12.75	
CONSUMER ENERGY (calculated)	21.57	4.70	26.27	2.80	8.25	108.92	123.51	6.75	12.74	-		262.98	
DEMAND	Agriculture, Forestry and Fishing	2.08	0.02	2.10		0.08	1.43	16.54	1.61	-		19.66	
	• Agriculture	2.07	0.02	2.09		0.08	1.32	12.04	-	-		13.43	
	• Forestry and Logging	0.01	-	0.01			0.01	3.07	-	-		3.08	
	• Fishing	-	-	-			0.11	1.43	1.61	-		3.15	
	Industrial	18.43	4.16	22.58		3.09	0.41	13.82	1.22	-		18.54	
	• Mining	-	-	-			0.00	2.90	-	-		2.91	
	• Food Processing	13.13	4.14	17.28			-	-	-	-		-	
	• Textiles	0.10	-	0.10									
	• Wood, Pulp, Paper and Printing	0.42	0.01	0.43									
	• Chemicals	0.00	-	0.00									
	• Non-metallic Minerals	4.52	0.00	4.52									
	• Basic Metals	0.07	-	0.07				-	-	-	-		-
	• Mechanical/Electrical Equipment	0.00	-	0.00									
	• Building and Construction	-	-	-				0.01	3.72	0.02	-		3.75
	• Unallocated	0.17	-	0.17		3.09	0.41	7.19	1.20	-			11.88
	Commercial	0.61	0.38	1.00		1.32	0.32	4.62	0.01	-			6.27
	Transport	0.01	-	0.01		0.36	107.44	87.51	5.86	12.41	-		213.59
Residential	0.19	0.21	0.39		3.03	-	0.11	-	-	-		3.13	
CONSUMER ENERGY (observed)	21.32	4.77	26.09	-	7.88	109.61	122.59	8.70	12.41	-		261.19	
Statistical Differences	0.25	-0.06	0.19	2.80	0.37	-0.69	0.92	-1.95	0.33	-		1.78	

⁶ <https://www.mbie.govt.nz/info-services/sectors-industries/energy/energy-data-modelling/publications/energy-in-new-zealand/energy-in-nz-2016.pdf>

Revenue of hard coal mining, New Zealand, 2008 - 2018 (USD Mn)⁷



Fuel management system⁸

When it comes to large vehicles they quite easily consume fuel, for instance a mining haul truck's average consumption rate, on the normal gradients of ten per cent found a on a mine haul road, with a typical payload of **182 tonnes** goes through approximately **350 litre** of diesel fuel an hour which goes up dramatically if drivers speed or put the vehicle under undue stress.

The key to ensuring these losses due to ineffective driving aren't occurring for your businesses is to have accurate **fuel management systems** in place which monitor usage and delivery.

Along with this there are many advantaged of having a proper fuel management system:

- Data that can be collected generically by these systems include trucks' odometers, engine hours, user ID, vehicle ID, and pin numbers.
- Fuel management systems can also be integrated with automatic tank gauging systems (ATG) to provide a fully integrated system.
- These electronic systems also allow for the production of reports, such as vehicle fuel transaction reports; site fuel usage reports; tank inventory reports; and fuel stock reconciliation reports.
- This knowledge is crucial to operators in the current economic and cost-conscious environment.
- An added bonus is a reduced environmental footprint, as the electronic systems are also able to monitor fuel loss through leakage, and aid operators in recognizing the potential problem and halting the leak before both fuel is lost and damage to the environment is caused.
- The electronic system, which can be limited to keys and pin numbers, also helps monitor theft, which is a growing issue on site.
- An automated fuel management system not only ensures vehicles are using fuel in the most efficient manner possible, but also ensure operators peace of mind that their fuel is secure.

Examples of companies that provide fuel management devices are:

⁷ <https://www.statista.com/forecasts/342527/new-zealand-hard-coal-mining-revenue-forecast-sic-0510>

⁸ <https://www.australianmining.com.au/news/fuel-management-systems-that-go-the-extra-mile-2/>

Datafuel: ⁹Datafuel designs and manufactures a range of electronic consoles and software that provide security and management control over bulk fuel facilities. It has worked with all Australia's major oil companies on a wide range of fuel management projects across a number of industries including mining, transport, manufacturing and government. Datafuel assist customers by providing bulk fuel equipment, turnkey solutions, undertaking special projects and providing value added services.

FluidIntel: ¹⁰Adapt Fuel Management System (AdaptFMS) represents the benchmark in hydrocarbon management solutions. AdaptFMS provides the mining enterprise with comprehensive fuel and oil management by monitoring and controlling deliveries, transfers, storage and dispensing from a central web application, AdaptIQ.

Overview of mineral mining industry in Australia ¹¹

In recent years, the Australian minerals industry has accounted directly for up to 8 per cent of GDP (significantly more when account is taken of related activity), upwards of 20% of business investment and around 50% of national exports. The rise in global demand for mineral commodities over the last decade has helped to propel growth in living standards with benefits spread broadly across Australian society. (Minerals Council of Australia 2012-13)

Overview of mineral mining industry in New Zealand

Despite having a variety of mineral resources, the production of the country's mineral industry is lesser than that of its neighbour Australia. ¹² New Zealand's mineral resources were dominated by aggregates and gold, which together accounted for 80% of the total value of New Zealand's mineral resources. Excluding the petroleum industry, the value of New Zealand's mineral sector accounted for less than 1% of the GDP. The total value of New Zealand's minerals and mineral fuel production accounted for about 2% of the GDP (Statistics New Zealand, 2014b, p. 2). ¹³

Overview of non-metallic mineral mining industry in Australia ¹⁴

Contraction of the Mining industry has led to a fall in demand for construction materials from the Heavy and civil engineering construction industry. This has flowed through to falling demand in the Non-metallic mineral mining and quarrying industry with most key indicators for the Non-metallic mineral mining and quarrying industry declining in 2014-15; sales and service income fell 3.2% and industry value added declined by 2.3%. During 2014-15 total capital expenditure for the Non-metallic mineral mining and quarrying industry was \$598m.

⁹ <http://www.datafuel.com.au/about/about>

¹⁰ <http://www.mining-technology.com/contractors/resource/fluidintel>

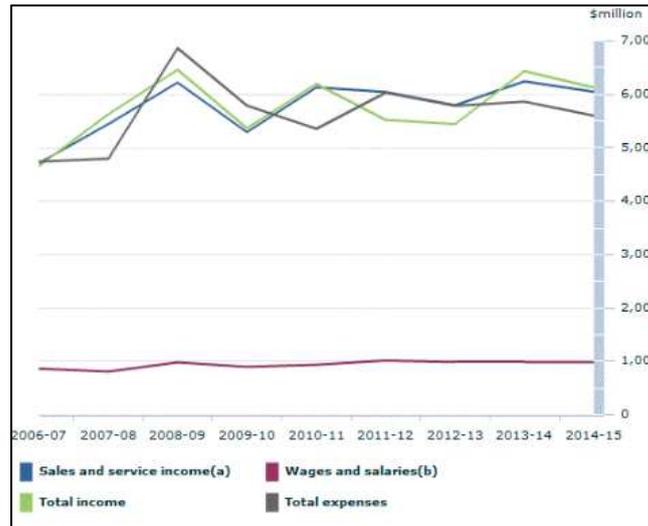
¹¹ http://www.minerals.org.au/corporate/about_the_minerals_industry

¹² <https://www.azomining.com/Article.aspx?ArticleID=98>

¹³ <https://minerals.usgs.gov/minerals/pubs/country/2013/myb3-2013-nz.pdf>

¹⁴ <http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/8415.0Main%20Features62014-15?opendocument&tabname=Summary&prodno=8415.0&issue=2014-15&num=&view=>

Non-metallic mineral mining & quarrying of New Zealand: 2006-15

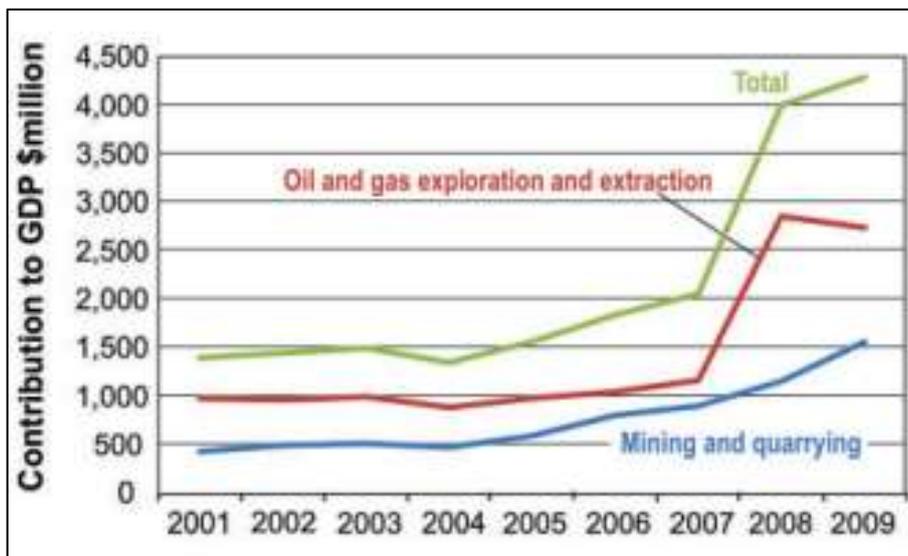


Overview of non-metallic mineral mining industry in New Zealand

Gas is currently produced from 14 fields, with the majority coming from two offshore fields: the recent Pohokura development and the mature Maui field. The two newest offshore oil fields, Tui and Maari, have boosted oil production in recent years. Together they contributed 49% of New Zealand's oil production in 2010, while Pohokura contributed a further 22% (Ministry of Economic Development, 2011a). In total, 16 fields in the Taranaki region produced 19.3 million barrels of crude oil (116 Petajoules (PJ)) and 0.157 trillion cubic feet of gas (173 PJ) in 2010 (Ministry of Economic Development, 2011a).¹⁵

The mining sector contracted 2.5 percent in the June quarter, due to lower production of oil and gas, and coal, and 6.6 percent for the year in 2016.¹⁶

Mining and petroleum: contribution to GDP of New Zealand 2001–2009



¹⁵ <http://www.mbie.govt.nz/info-services/sectors-industries/natural-resources/oil-and-gas/petroleum-expert-reports/pdf-document-library/Economic%20contribution%20and%20potential%20of%20NZs%20oil%20and%20gas%20industry.pdf>

¹⁶ <http://www.radionz.co.nz/news/business/313650/mining-drags-on-growing-economy>

List of Mining Companies in Australia ¹⁷

- Adani Mining
- Bechtel (Csg-Lng Project Management)
- Bhp Billiton
- Cuesta Coal
- Fortescue Metals Group
- Gloucester Coal (Middlemount)
- Gvk
- Hancock Prospecting
- International Coal
- Rio Tinto
- Tinkler Group Pty Ltd
- Newmount
- Ozminerals
- Xstrata
- Yancoal
- New Talisman Gold Mines Limited

List of mining companies in New Zealand ¹⁸

- Fieldwork Group
- Black Lion Limited
- Birchfield Minerals Ltd
- Newmont Waihi Gold
- Koiterangi Lime Co
- Heaphy Mining
- New Zealand Steel Mining Ltd
- Doug Hood Mining Ltd
- Ron King Mining & Industry Services
- Aotea Minerals LTD - A W Tattersfield
- Heritage Gold NZ Ltd
- Mining Permit Solutions
- Stracon Mining Limited
- Geotech Limited
- Westmere Drilling Ltd
- Centago Mining Ltd
- First Break SG Metals Ltd
- Black Lion Limited
- SGS Mining
- New Talisman Gold Mines Limited

¹⁷ <http://iminco.net/mining-companies-australia/>

¹⁸ <https://yellow.co.nz/new-zealand/mining-companies?what=mining+companies+&where=New+Zealand>

Trends of mining industry

- **Ensuring innovation: preparing for change:** Below are the game changing technologies ¹⁹
 - **Networks:** This is the interconnectivity brought about Industrial Internet of Things (IIoT), and feeds into the Big Data movement. As machinery sensors become more prevalent miners now have greater oversight of how their equipment truly operates, giving them more flexibility in their usage and maintenance.
 - **Machine learning:** As automation becomes more widespread, the potential for machines to perform increasing complex tasks grow, lifting safety and productivity on site. According to Deloitte, an end game for this is the continued growth of centralized remote operating hubs, such as Rio Tinto's Mine of the Future remote operations hub or its Processing Centre of Excellence, as well as similar remote control hubs run by Roy Hill, Fortescue, and BHP from Perth.
 - **Wearable's:** Similar to machine sensors, but for the miners themselves. Systems like FitBit, incorporated into miners' clothes and PPE can measure and monitor their performance and health. These are already being rolled out in terms of fatigue management systems that monitor haul truck drivers' tiredness; heat measurement vests that monitor if workers are at risk of heat stress; and RFID systems that track workers locations on site and can be used to alert others if they face an emergency situation.
- **Understanding the drivers of shareholder value:** Miners seek a balance between financial discipline and growths²⁰
 - By balancing financial discipline and growth, taking a more forward-looking view on capital allocation and optimizing their asset portfolios, companies gain the ability to maximize shareholder value, generate superior growth and increase returns on invested capital.
- **Creating healthy and inclusive workforces:** Wellness and diversity are rising on miners' agendas
 - Following the commodity price weakness of recent years, productivity improvement has been elevated to a mining industry mantra. To ensure sustainable productivity improvements, companies must also foster healthy workforces and inclusive workplaces.
- **Operating in an ecosystem:** Collaboration and unorthodox partnerships will drive the industry forward
 - Several mining innovation ecosystems, like the Canadian Mining Innovation Council (CMIC), have also sprung up to encourage greater industry collaboration.
 - Some mining companies are even leveraging the power of technology to encourage idea sharing through crowdsourcing.
 - In May 2016, BHP Billiton teamed with Uearthed to host a 54-hour hackathon. Participants were provided with actual data from BHP Billiton's Western Australia iron ore operation and given challenges designed to uncover more efficient, effective and safer ways to work.
- **Adopting an integrated approach to reporting:** Demands for greater disclosure and transparency increase
 - In a trend that has emerged from the shadow of resource nationalism, governments in a growing number of jurisdictions are demanding greater levels of transparency from their domestic extractive industries. Beyond tying up resources, this has put companies under greater scrutiny as governments seek to establish that each company is paying the right amount of tax.

¹⁹ <https://www.australianmining.com.au/features/top-ten-trends-mining-2016/>

²⁰ <https://www2.deloitte.com/au/en/pages/energy-and-resources/articles/tracking-the-trends-2017.html>