

## Why Should I Care About Units of Measurement? That's Boring!!!



Because when your MD asks why your model is completely wrong, you'll look stupid and get **bottom-tier bonus** if you sheepishly admit that you screwed up and forgot to multiply everything by 6, or 1,000, or 10,000, or whatever the conversion factor is.

For normal companies, units of measurement are an afterthought because you're always working in dollars, Euros, yen, and so on.

But for natural resource companies they are **critical because companies measure their Production and Reserves in different ways and you have to make sure you're comparing apples to apples.**

**Production** is how much in oil, gas, gold, silver, copper, etc. you're extracting from the ground and selling – measured in Barrels of Oil, Cubic Feet, Ounces, Tons, and so on.

**Reserves** are the total amount of oil, gas, gold, silver, copper, etc. that you have in the ground in the first place. As you **produce** more, your reserves **decrease** and so you have to replace them constantly.

## Units of Measurement

Here are the units that oil, gas, and minerals are normally reported in (see the notes on the next page):

Resource Type	Daily Production	Annual Production & Reserves
Oil, Natural Gas Liquids, Synthetic Oil and Bitumen	Thousands of Barrels (MBbls)	Millions of Barrels (MMBbls) or Billions of Barrels (BBbls)
Natural Gas	Millions of Cubic Feet (MMcf)	Billions of Cubic Feet (Bcf) or Trillions of Cubic Feet (Tcf)
Iron Ore and Coal	Thousand Tonnes (kt)	Million Tonnes (Mt)
Aluminum, Copper, Lead, Zinc, Nickel, and Manganese	Tonnes (t)	Thousand Tonnes (kt)
Uranium	Tonnes (t)	Tonnes (t)
Diamond	Carats	Thousand Carats
Gold and Silver	Ounces (oz)	Thousand Ounces (koz) or Million Ounces (moz)

- 1 Barrel of Oil = 42 Gallons of Oil = 5.8 Million British Thermal Units of Energy (5.8 MMBtu)
- 1,000 Cubic Feet of Gas = 1 Million British Thermal Units of Energy (1.0 MMBtu)
- 1 Tonne = 1 Metric Ton (1,000 kg)
- 1 Carat = 200 milligrams (200 mg)

## These Units Are Crazy – Why Are We Using the Metric System AND the US System?

Sorry, there's no clear answer – companies have traditionally used a mix of both units. Sometimes you'll see ounces rather than grams and sometimes you'll see US tons and pounds (1 ton = 2,000 pounds) in addition to metric tons (tonnes) where 1 tonne is 1,000 kg.

**You need to read the notes carefully – there are always exceptions and strange units.**

The table above gives you a rough idea of what you'll see – but you need to pay attention or you'll end up measuring Diamond Production in Barrels of Oil.



The exact units depend not only on the region, but also on **how much** the company actually produces. If billions are too big, they might use millions; if millions are too big, they might use thousands, and so on.

Even if the country uses the metric system, the company itself may still use US units of measurement – for example, British Petroleum reports energy in Barrels of Oil and Thousands of Cubic Feet despite being UK-based.

## Converting to Equivalent Units

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You do not see mineral units “converted” in a company's filings most of the time. Sometimes you will see a reference to “copper equivalents” or “gold equivalents” – you can calculate those by summing up the dollar amount for all mineral production and then dividing by dollars per ounce, gram, or tonne for the mineral you want to convert into. The exact formula depends on which minerals the company produces.

For energy, it's much easier: since 1 Barrel of Oil = 5.8 MMBtu and 1,000 Cubic Feet of Gas = 1 MMBtu, you round the units and **always** assume that:

- 1 Bbl of Oil = 6 Mcf of Natural Gas
- 1 MBbl of Oil = 6 MMcf of Natural Gas
- 1 MMBbl of Oil = 6 Bcf of Natural Gas
- 1 BBbl of Oil = 6 Tcf of Natural Gas

You convert into **Barrels of Oil Equivalent (BOE)** or **Thousand Cubic Feet Equivalent (Mcf)**.

If a company has over 50% gas production, normally you convert into Mcfe; if it's over 50% oil production, you convert into BOE.

**Example:** A company has 6,000 Bcf of natural gas production and 200 MMBbls of oil production. What is its production in Cubic Feet Equivalent and in Barrels of Oil Equivalent?

- $6,000 \text{ Bcf} + 200 \text{ MMBbls} * 6 = 7,200 \text{ Bcfe}$
- $6,000 \text{ Bcf} / 6 + 200 \text{ MMBbls} = 1,200 \text{ MMBOE}$

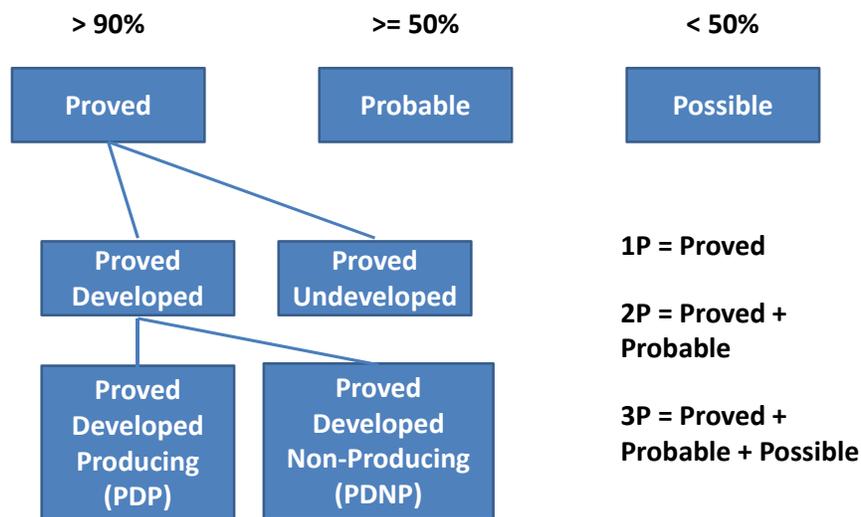
When listing public comps and precedent transactions for natural resource companies you need to list **Production** and **Reserves** in the same units, so you use these conversion factors all the time.

It doesn't make sense to show one company's Reserves in Barrels of Oil and another's Reserves in Thousands of Cubic Feet – everything should be in BOE or Mcfe.

## Reserves

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The **Reserves** tell us how much a company has in the ground, ready to extract. But extraction is never a certainty, so reserves are categorized based on probabilities:



**Proved Reserves** have a greater than 90% chance of being extracted from the ground; **Probable Reserves** are at least 50% likely, and **Possible Reserves** are under 50%.

Natural resource companies have sophisticated technology to measure these probabilities and to estimate the likelihood of extraction – as a banker you never get into this level of detail.

You mostly care about the **Proved Reserves** because that's what you use in models and in valuations.

The **Proved Developed Reserves** are also important because you use them to assess how much a company can produce from the ground with 100% certainty.



Even Reserves are “Proved,” there is still a small chance (< 10%) that they could have nothing. But if the company has actually **developed** those reserves, there are definitely resources there – so Proved Developed Reserves can be more reliable.

Both oil & gas companies and mining companies have reserves – to find them in the filings you can search for “Proved Reserves” or go to the “Oil & Gas Producing Activities” or “Oil & Gas Supplemental Information” sections (similar names for mining companies).

Here’s an example for an oil & gas company (XTO Energy):

Proved Reserves (in millions)	Natural Gas		Natural Gas	
	Gas (Mcf)	Liquids (Bbls)	Oil (Bbls)	Equivalents (Mcf)
December 31, 2006	6,944.2	53.0	214.4	8,548.6
Revisions (a)	(46.3)	10.2	15.5	108.2
Extensions, additions and discoveries	1,797.5	5.8	18.4	1,942.5
Production	(532.1)	(4.9)	(17.2)	(664.8)
Purchases in place	1,278.8	2.7	11.3	1,362.7
Sales in place	(1.0)	—	(1.2)	(8.2)
December 31, 2007	9,441.1	66.8	241.2	11,289.0
Revisions (a)	(665.5)	(9.4)	(20.9)	(847.3)
Extensions, additions and discoveries	2,195.7	4.2	10.4	2,283.3
Production	(697.4)	(5.7)	(20.5)	(854.7)
Purchases in place	1,529.0	19.9	57.6	1,994.1
Sales in place	—	—	(0.3)	(2.0)
December 31, 2008	11,802.9	75.8	267.5	13,862.4
Revisions (a)	(644.4)	18.6	13.2	(453.8)
Extensions, additions and discoveries	2,175.8	6.2	37.9	2,440.8
Production	(855.0)	(7.5)	(24.2)	(1,045.2)
Purchases in place	22.4	0.1	—	23.0
Sales in place	—	—	—	—
December 31, 2009	12,501.7	93.2	294.4	14,827.2

And here’s an example for a mining company (Goldcorp):

GOLDCORP RESERVES										
(as of December 31, 2009)										
	Ownership	PROVEN			PROBABLE			PROVEN & PROBABLE		
		Tonnage	Grade	Contained	Tonnage	Grade	Contained	Tonnage	Grade	Contained
		mt	g Au/t	moz	mt	g Au/t	moz	mt	g Au/t	moz
Alumbrera	37.5%	116.25	0.40	1.50	3.75	0.29	0.03	120.00	0.40	1.53
Dee	40.0%	—	—	—	14.31	1.86	0.86	14.31	1.86	0.86
El Sauzal	100.0%	3.04	1.58	0.15	2.77	1.97	0.18	5.81	1.77	0.33
Los Filos	100.0%	50.16	0.99	1.60	172.12	0.74	4.08	222.28	0.79	5.67
Marigold	66.7%	28.12	0.62	0.56	62.59	0.52	1.05	90.72	0.55	1.61
Marlin	100.0%	3.46	5.78	0.64	9.99	4.44	1.43	13.45	4.78	2.07
Musselwhite	100.0%	6.07	6.44	1.26	4.35	6.09	0.85	10.42	6.29	2.11
Peñasquito Heap Leach	100.0%	72.50	0.17	0.40	—	—	—	72.50	0.17	0.40
Peñasquito Mill	100.0%	580.58	0.62	11.49	564.19	0.33	5.93	1,144.76	0.47	17.42
Porcupine	100.0%	30.75	1.42	1.41	26.88	1.60	1.38	57.63	1.50	2.79
Pueblo Viejo	40.0%	5.14	3.33	0.55	95.64	2.91	8.95	100.78	2.93	9.50
Red Lake	100.0%	1.34	26.94	1.16	7.10	9.87	2.25	8.44	12.58	3.42
San Dimas	100.0%	2.01	5.68	0.37	3.58	4.30	0.49	5.59	4.80	0.86
Wharf	100.0%	7.89	0.69	0.17	0.88	0.71	0.02	8.78	0.69	0.19
<b>Totals</b>				<b>21.25</b>			<b>27.50</b>			<b>48.75</b>

It’s in different units and is laid out differently because mining companies only recover a fraction of the minerals (hence the grams of Silver per ton column), but the idea is the same.



Goldcorp produces several other minerals (not shown above), but unlike XTO they do not convert everything into an equivalent unit such as “gold equivalents.”

**Proved Reserves** can be used as a valuation multiple – Enterprise Value / Proved Reserves – and are also used to select public comps and precedent transactions.

They also constrain **Production** – if a company has 10 Bcf of Proved Reserves, you can’t assume that they suddenly jump from 1 Bcf of annual production to 5 Bcf, or their reserves would be depleted in 2 years.

## Production

**Production** tells us how much in resources we’re extracting from the ground. It might be on a daily, quarterly, or annual basis; oil & gas companies look at it on a daily basis and valuation multiples are based on **Daily Production** whereas mining companies focus on longer time periods.

You find these numbers in the same section of a company’s filings that has information on the reserves. Example for XTO:

	Year Ended December 31		
	2009	2008	2007
<b>Total production:</b>			
Gas (Mcf)	855,008,071	697,392,186	532,097,846
Natural gas liquids (Bbls)	7,504,580	5,718,295	4,943,781
Oil (Bbls)	24,198,273	20,505,178	17,172,191
Mcfce	1,045,225,189	854,733,024	664,793,678
<b>Average daily production:</b>			
Gas (Mcf)	2,342,488	1,905,443	1,457,802
Natural gas liquids (Bbls)	20,560	15,624	13,545
Oil (Bbls)	66,297	56,025	47,047
Mcfce	2,863,631	2,335,336	1,821,353
<b>Average realized sales prices:</b>			
Gas (per Mcf)	\$ 7.13	\$ 7.81	\$ 7.50
Natural gas liquids (per Bbl)	\$ 30.03	\$ 48.76	\$ 45.37
Oil (per Bbl)	\$ 107.65	\$ 87.59	\$ 70.08
<b>Average realized sales prices before hedging:</b>			
Gas (per Mcf)	\$ 3.67	\$ 8.04	\$ 6.26
Natural gas liquids (per Bbl)	\$ 30.03	\$ 52.05	\$ 45.37
Oil (per Bbl)	\$ 57.10	\$ 93.17	\$ 68.68
<b>Average NYMEX prices:</b>			
Gas (per MMBtu)	\$ 3.99	\$ 9.03	\$ 6.86
Oil (per Bbl)	\$ 61.82	\$ 99.75	\$ 72.39
Production expense (per Mcfe)	\$ 0.96	\$ 1.10	\$ 0.93
Taxes, transportation and other expense (per Mcfe)	\$ 0.65	\$ 0.82	\$ 0.67

Notice how they are getting **less** than the NYMEX market prices, and are also using **hedging** to further alter their average realized sale prices.

Here’s an example of **Production** for Goldcorp:

		Revenues	Gold produced (ounces)	Gold sold (ounces)	Average realized gold price (per ounce)	Earnings (loss) from operations	Total cash costs (per ounce) <sup>(1)(3)</sup>
Red Lake	2009	\$ 624.8	622,700	635,300	\$ 982	\$ 329.2	\$ 288
	2008	\$ 535.8	629,200	618,300	\$ 865	\$ 231.5	\$ 302
Porcupine	2009	310.2	318,300	318,600	973	88.7	447
	2008	255.6	291,000	294,000	869	(34.2)	588
Musselwhite	2009	225.5	232,600	231,200	975	52.1	585
	2008	184.6	210,500	214,000	862	21.2	611
Terrane	2009	-	-	-	-	(5.0)	-
	2008	-	-	-	-	(6.5)	-
San Dimas <sup>(4)</sup>	2009	128.6	113,000	113,000	982	61.0	287
	2008	92.6	86,700	88,800	870	30.0	405
Los Filos	2009	236.2	239,300	238,900	975	72.9	469
	2008	189.2	213,600	215,100	871	58.3	407
El Sauzal	2009	198.7	203,800	206,500	958	66.1	201
	2008	239.3	274,200	274,100	868	96.1	149
Peñasquito <sup>(2)</sup>	2009	-	90,300	-	-	-	-
	2008	-	20,000	-	-	-	-
Marlin <sup>(4)</sup>	2009	331.8	274,900	274,600	982	136.9	192
	2008	258.1	241,400	241,300	870	100.0	191
Alumbraera <sup>(4)</sup>	2009	495.5	158,200	157,800	988	158.9	(722)
	2008	490.7	189,200	192,200	870	135.3	(449)
Marigold	2009	99.0	97,900	99,500	994	22.0	596
	2008	81.4	96,200	93,300	872	12.1	608
Wharf	2009	70.9	67,700	69,300	974	12.2	686
	2008	57.2	60,700	62,200	873	19.7	481
El Limón <sup>(4)</sup>	2009	-	-	-	-	(24.0)	-
	2008	-	-	-	-	-	-
Other <sup>(5)</sup>	2009	2.4	2,600	2,600	911	(155.0)	-
	2008	35.1	11,600	11,400	893	(157.5)	-
<b>Total</b>	<b>2009</b>	<b>\$ 2,723.6</b>	<b>2,421,300</b>	<b>2,347,300</b>	<b>\$ 978</b>	<b>\$ 816.0</b>	<b>\$ 295</b>

## Production to Revenue & Expenses

**Revenue** = Production of Commodity \* Realized Commodity Price

You project **Production** based on historical numbers and company guidance – if they have been growing at 10% per year and expect to grow at 8% next year, you might use 8% and then make it decline by 1% per year.

If the company produces multiple types of resources, you make different assumptions for each one and add them all together.

- For **mining** companies you assume that a number of tons / tonnes are mined, but that you can only recover a certain % of what you're looking for, or that each ton / tonne contains only a certain amount. So you need to make a few more assumptions to get the final numbers.

On the realized price side, there are a few complications:



- You have to include **scenarios** – for example, an upside scenario for gas might be \$10.00 / Mcf, a base scenario might be \$7.00 / Mcf and a downside scenario might be \$4.00 / Mcf. You **always** need to look at a range of values.
- You need to include a **price differential** between market prices and what the company gets; this varies a lot for minerals but for oil and gas it's usually around 90% (e.g. they realize 90% of market prices) and for natural gas liquids (NGLs) it's closer to 50%.
- The company may use **hedging** – so if market prices suddenly drop, their realized prices may be a certain percentage higher, and if market prices shoot up, their prices may be a certain percentage lower.

Most **expenses** for natural resource companies are linked to Production and are projected on a per unit basis. XTO makes this obvious:

We analyze on a per Mcfe produced basis, the following expenses, most of which trend with changes in production:

	2009	2008	Increase (Decrease)
Production	\$0.96	\$1.10	(13)%
Taxes, transportation and other	0.65	0.82	(21)%
Depreciation, depletion and amortization	2.95	2.37	24%
Accretion of discount in asset retirement obligation	0.04	0.04	—
General and administrative, excluding stock compensation	0.21	0.25	(16)%
Interest	0.50	0.56	(11)%
	\$5.31	\$5.14	3%

Common per unit expenses:

- Production (how much it costs to produce individual resource units, similar to COGS)
- Sales Taxes
- Transportation
- Depreciation, Depletion & Amortization (DD&A)
- Accretion of Asset Retirement Obligation

Expenses that could be per unit or could be based on growth rates or company guidance:

- General & Administrative (G&A)



Oil & Gas Modeling  
Quick Reference – Production, Reserves & Units of Measurement

<http://breakingintowallstreet.com>

- Exploration
- Capital Expenditures (both Acquisitions and Development & Exploration)

Expenses that should **not** trend with Production:

- Stock-Based Compensation
- Derivative Fair Value Gain / (Loss)
- Impairment / Restructuring / Other Non-Recurring Charges
- Interest Expense

Companies sometimes show Interest Expense on a per unit basis; Production and Interest Expense are *loosely* linked (to produce more, they need to raise more debt), but in models you create debt schedules and calculate the interest expense based on that, just as you would for other companies.