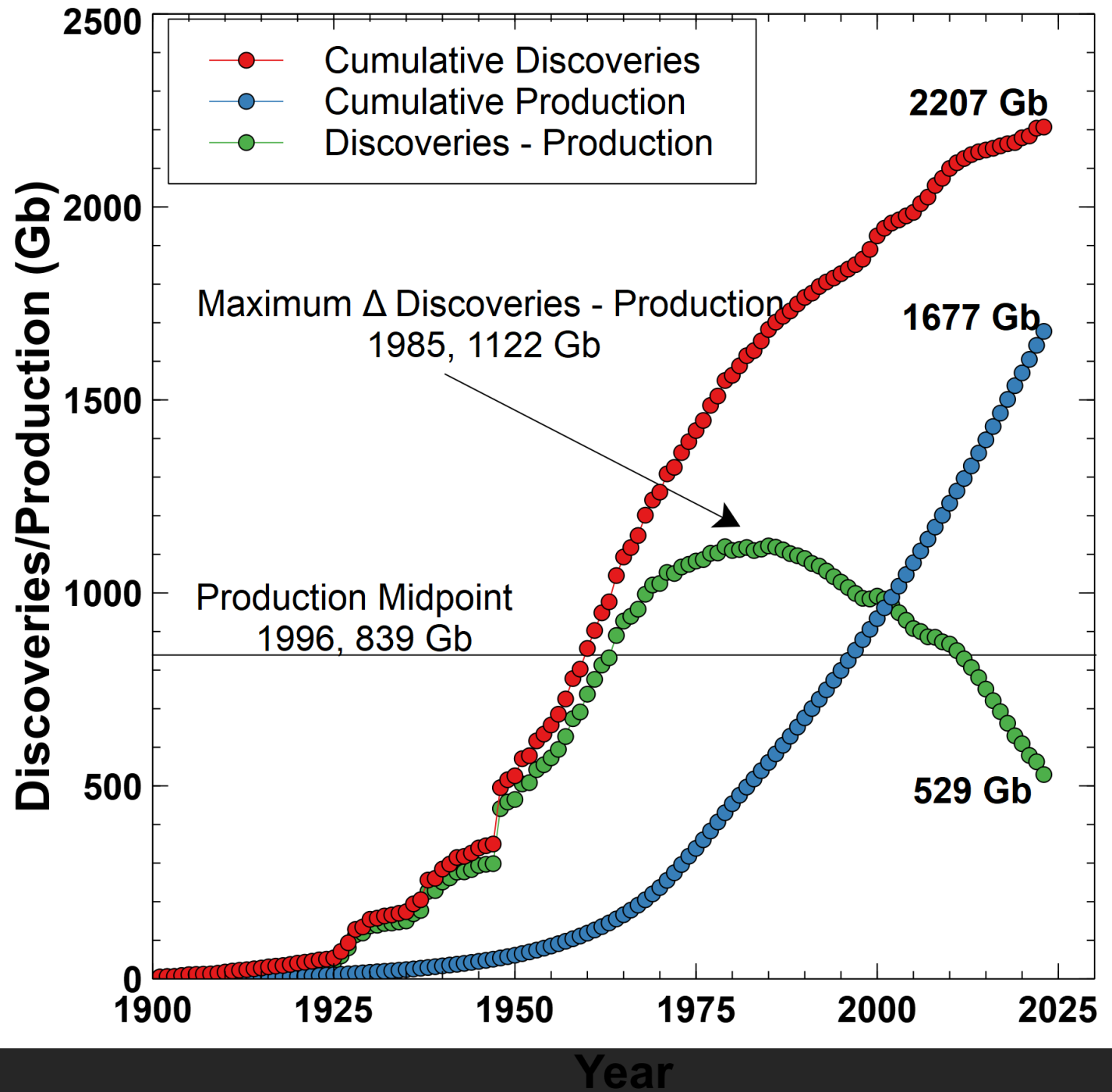
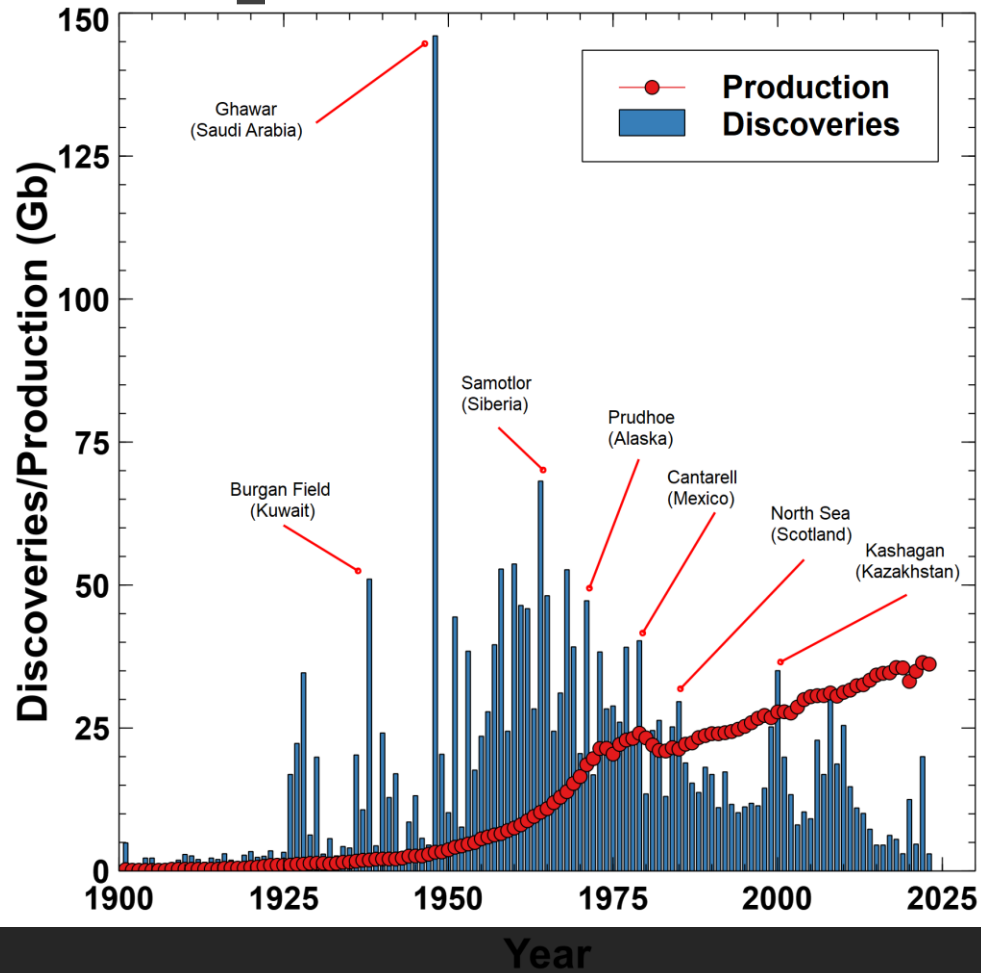


Energy Update

JOHN PEACH

Discovery and Production Update



Energy Rates

Energy returned = Energy rate \times Time

$$\text{EROI} = \frac{\text{Energy returned}}{\text{Energy input}} = \frac{\textit{Rate} \times \textit{Time}}{\textit{Input}}$$

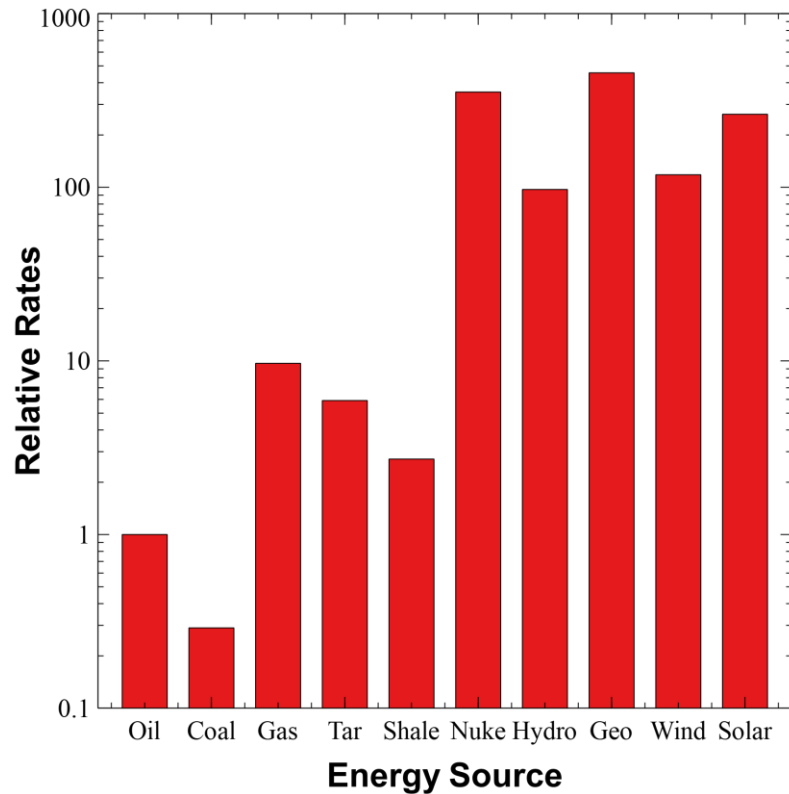
$$\text{Energy rate} = \frac{\text{EROI}}{\text{Time}}$$

Example:

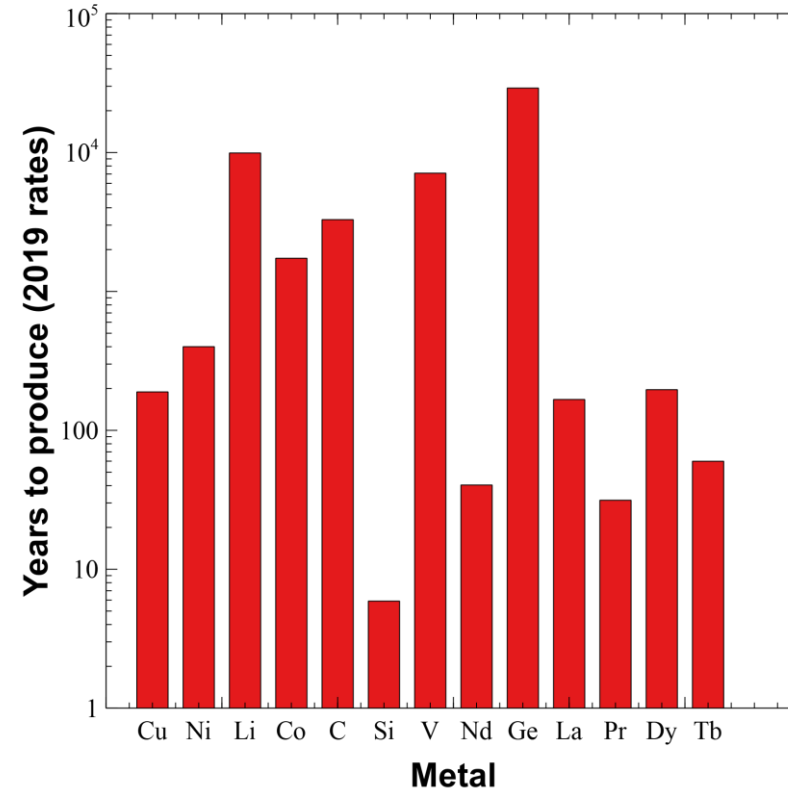
- EROI = 20
- Lifetime = 20 years
- Energy rate = 1 unit/year

Energy and material rates

Relative Energy Rates

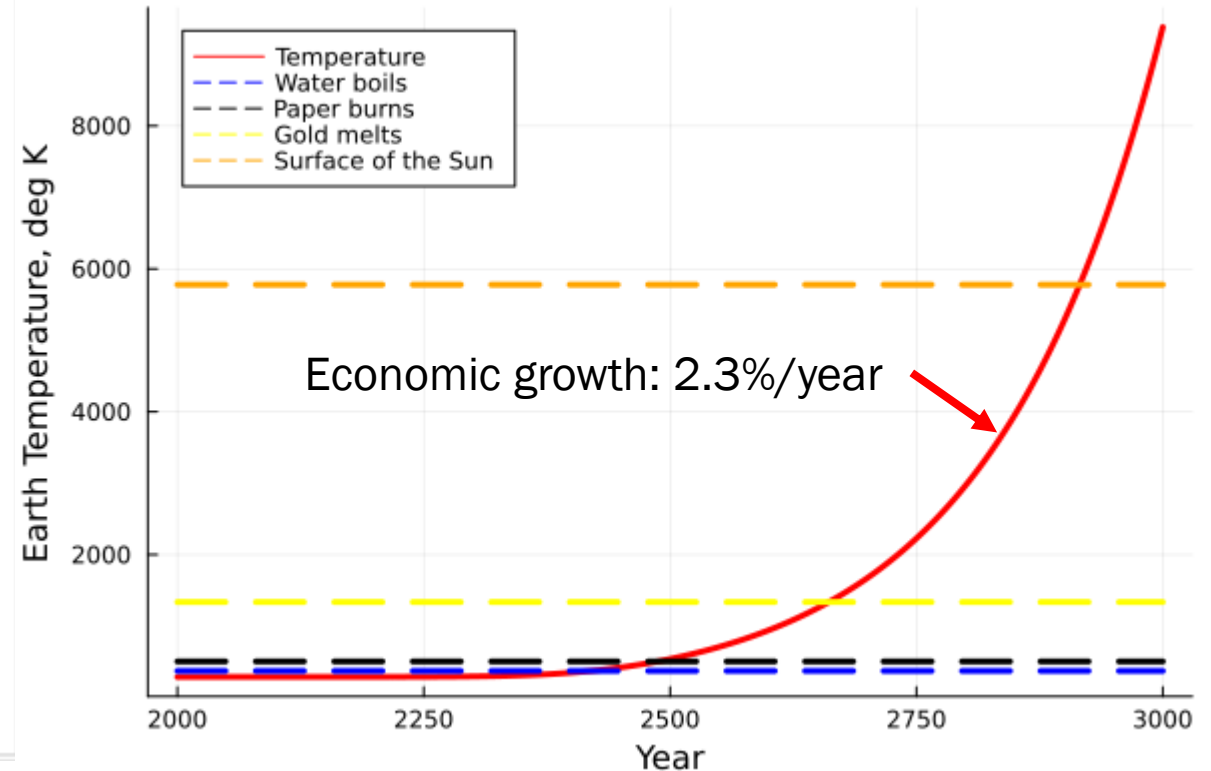
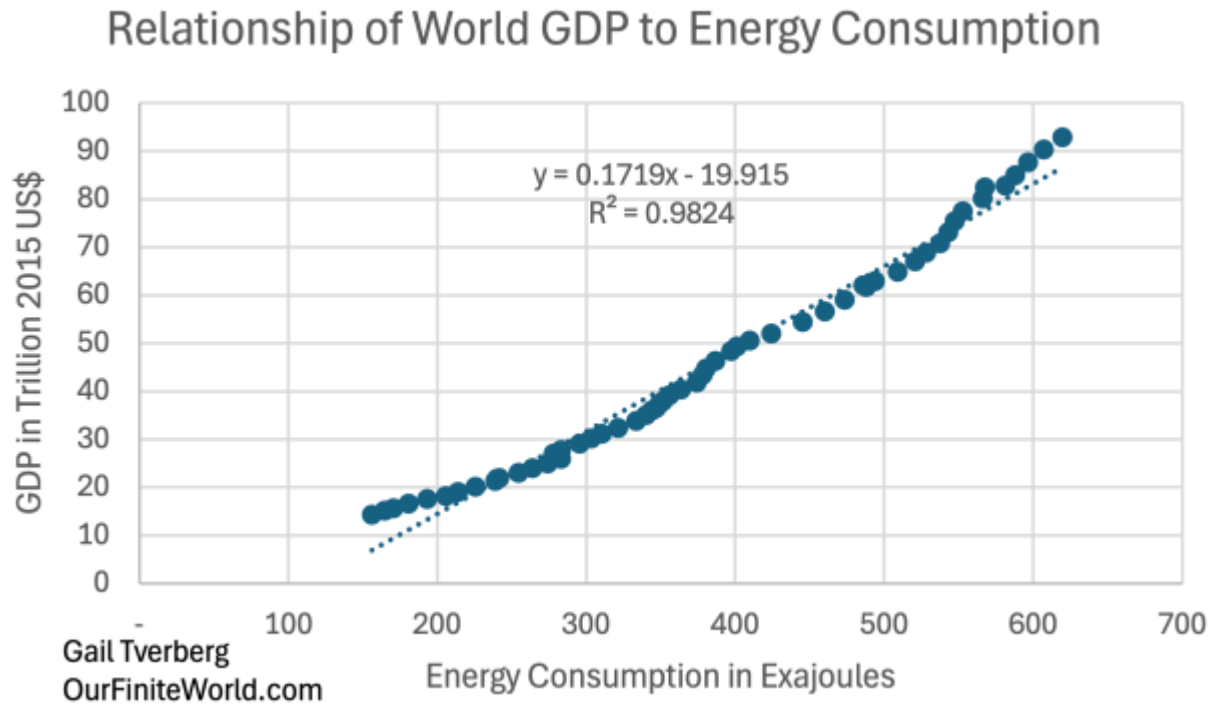


Metal Mining Rates



Global Warming = Energy \times Greenhouse Gases

“Green energy” still produces heat



4% of global warming due to economic activity

Energy Rates

Energy source	EROI		Life		EROI Rates		EROI rate	Normalized EROI rate	Rel time
	min	max	min	max	min	max			
Oil	19.6	21.2	0.83	0.25	78.40	84.80	81.600	1.0000	1.00
Coal	39.5	53	0.83	0.17	237.01	318.01	277.511	3.4009	0.29
Gas	4.9	9.1	0.02	0.83	5.90	10.96	8.434	0.1034	9.68
Tar sands	3	3.9	0.83	0.25	12.00	15.60	13.800	0.1691	5.91
Shale oil	6.4	8.6	0.83	0.25	25.60	34.40	30.000	0.3676	2.72
Nuclear	10.5	17.2	40.00	60.00	0.18	0.29	0.231	0.0028	353.50
Hydro	64.7	103.4	50.00	100.00	0.65	1.03	0.841	0.0103	97.09
Geothermal	8.6	9.3	20.00	50.00	0.17	0.19	0.179	0.0022	455.87
Wind	19.4	22.1	20.00	30.00	0.65	0.74	0.692	0.0085	117.98
Solar	8.8	9.8	20.00	30.00	0.29	0.33	0.310	0.0038	263.23
EROI data:	EROI of different fuels and the implications for society - ScienceDirect								

Recoverable oil by country and resource classification

Billion barrels of oil

	1P	2P	2PC	2PCX	Mbbl/d*	1P life	2PCX life	Upstream emissions kgCO2/bbl
Non-OPEC	183	306	646	928	52.4	9.6	48.5	22
United States	41	55	122	192	12.9	8.8	40.6	13
Russia	43	65	126	143	10.6	11.2	37.2	23
Canada	35	49	114	127	4.7	20.5	73.8	53
China	12	29	58	75	4.1	7.9	50.0	17
Brazil	7	23	41	65	3.4	5.9	52.2	16
Qatar	5	12	33	36	1.3	11.2	74.3	18
Kazakhstan	10	16	27	33	1.9	15.1	47.4	17
Mexico	3	7	16	23	2.0	4.4	32.4	25
Australia	1	1	3	22	0.3	4.9	209.4	35
Argentina	2	3	7	19	0.7	7.8	76.0	31
Norway	4	8	11	16	1.9	5.9	23.0	9
Guyana	1	5	10	14	0.4	4.9	96.4	29
United Kingdom	1	3	7	9	0.7	4.7	32.3	27
Other non Opec	16	32	71	153	7	6	57	25
OPEC	102	199	638	696	30.5	9.2	62.6	23
Saudi Arabia	33	62	257	271	10.4	8.6	71.2	9
Iraq	17	37	100	107	4.5	10.4	65.3	26
Iran	15	28	80	88	3.3	12.7	73.4	37
UAE	14	25	69	72	3.2	11.5	61.2	10
Kuwait	6	14	48	51	2.4	6.7	57.2	12
Venezuela	2	5	23	27	0.8	6.7	94.2	98
Libya	4	8	15	20	1.3	8.6	42.9	70
Nigeria	3	6	17	19	1.5	6.1	36.0	38
Algeria	4	6	8	13	1.1	8.6	31.9	50
Angola	3	4	8	13	1.1	6.7	32.4	21
Congo	1	1	3	5	0.3	6.5	51.3	48
Gabon	0	1	1	3	0.2	5.9	41.4	51
Equatorial Guine	0	0	1	1	0.1	4.5	16.5	35
World Total Oil	285	505	1,283	1,624	82.9	9.4	53.7	

Natural Gas Liquids 12.0
 Other liquids 6.3
World Total Liquids production 2023e 101.2

Source: UCube by Rystad Energy

Source: Rystad Energy's Upstream Solution, June 2023
 A Rystad Energy graphic

RystadEnergy

* Global oil production 2023, excludes natural gas liquids, biofuel and refinery gains

- 1P** Proved oil reserves (as of 1.1. 2023), conservative estimate in existing fields
- 2P** Proved+Probable oil reserves, most likely estimate in existing fields
- 2PC** Proved+Probable oil reserves plus mean contingent recoverable oil resources in yet undecided projects/discoveries, including noncommercial volumes
- 2PCX** Most likely estimate for existing fields, plus contingent resources in discoveries, plus risked prospective resources in yet undiscovered fields

The above classification scheme is aligned with the PRMS standard from the Society of Petroleum Engineers
 "Oil" is crude oil + lease condensate.