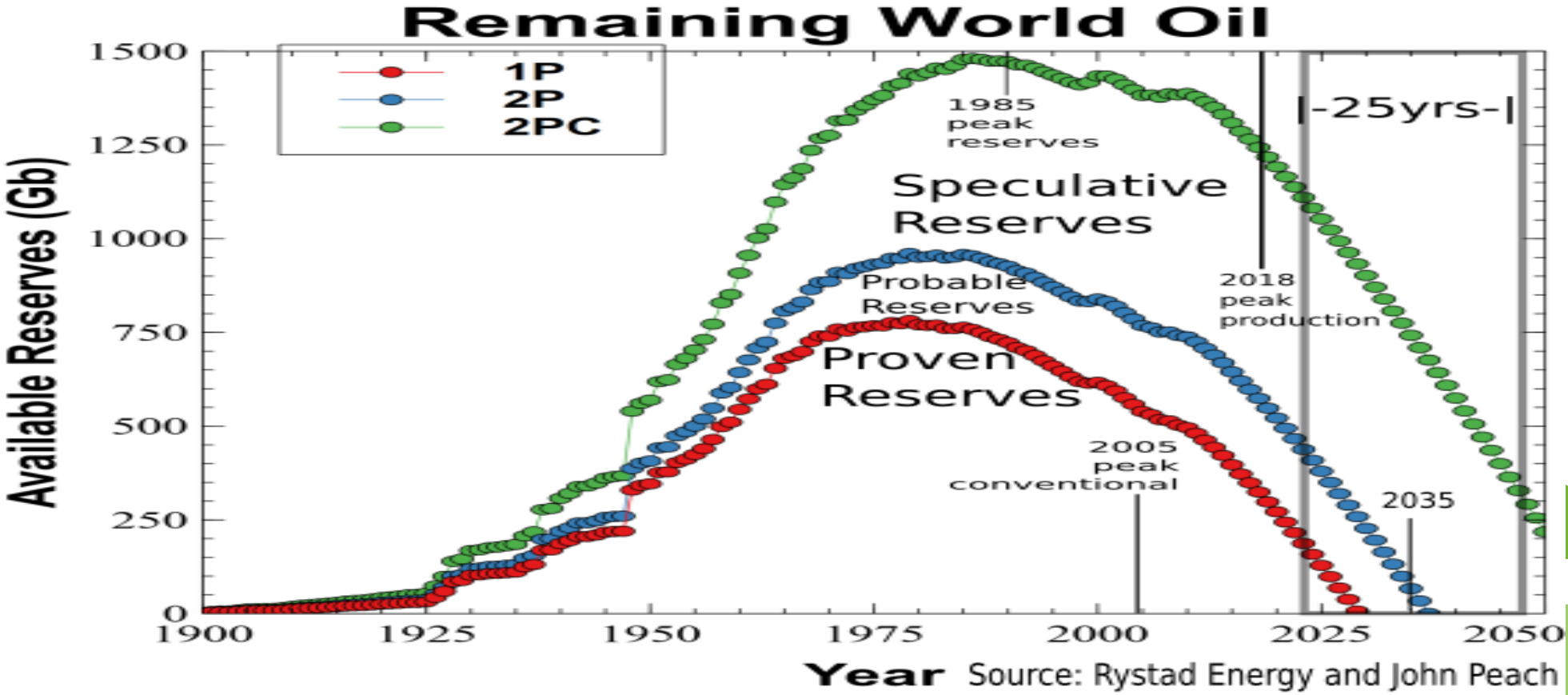
Peak Oil and Rural Transition

- By Andrii Zvorygin of Owen Sound, Grey County



Rystad Energy's 2022 global recoverable oil resources outlook

Billion barrels of oil

	1P	2P	2PC	2PCX	Added	mmbbld*	1P life	2PCX life	BP SR**	BPSR vs. 1P	BPSR vs. 2PC
Non-OPEC	**165**	**256**	**589**	**891**	**-6**	**50.4**	**9.0**	**48**	**518**	**313%**	**88%**
Russia	45	78	120	137	-2	10.2	12.2	37	108	237%	90%
United States	27	36	112	193	8	12.1	6.1	44	69	255%	61%
Canada	32	41	104	118	-1	4.6	19.2	70	168	521%	162%
Brazil	7	11	41	71	-4	3.2	5.9	61	12	174%	29%
China	10	19	31	49	-1	4.0	7.0	33	26	253%	84%
Qatar	6	10	34	37	1	1.3	12.0	77	25	437%	73%
Kazakhstan	8	12	27	32	-1	1.9	12.3	47	30	355%	110%
Mexico	3	6	15	26	-2	1.8	5.0	39	6	182%	41%
Norway	5	7	12	17	-1	1.8	7.6	26	8	163%	67%
Argentina	1	2	6	22	-0	0.6	6.1	106	2	201%	45%
Australia	1	1	3	22	-0	0.3	5.5	181	2	354%	76%
Guyana	1	1	10	12	2	0.2	7.1	131		0%	0%
United Kingdom	1	3	8	10	-1	0.8	5.0	34	3	173%	31%
Azerbaijan	2	3	5	10	-0	0.7	9.4	38	7	287%	130%
Other Non-Opec	12	20	55	127	-2	7.0	4.9	50	52	415%	93%
OPEC	**133**	**292**	**629**	**682**	**-21**	**31.6**	**11.5**	**59**	**1,215**	**915%**	**193%**
Saudi Arabia	56	136	262	275	5	10.8	14.2	70	298	529%	114%
Iraq	19	39	99	105	-1	4.9	10.5	59	145	779%	147%
Iran	14	29	76	84	-13	3.3	11.3	71	158	1165%	207%
UAE	17	31	67	70	1	3.4	13.1	56	98	592%	147%
Kuwait	12	30	51	53	2	2.8	11.7	53	102	860%	198%
Venezuela	2	4	23	27	-10	0.8	7.2	99	304		
Nigeria	3	5	17	18	-2	1.7	5.5	30	37	1093%	215%
Libya	3	6	14	18	-1	1.1	8.0	45	48	1478%	351%
Algeria	4	6	9	13	-0	1.2	8.7	31	12	325%	139%
Angola	2	3	8	10	-0	1.1	5.6	24	8	341%	96%
Congo	1	1	3	4	0	0.3	6.5	36	3	446%	95%
Gabon	0	1	1	2	-0	0.2	6.8	30	2	473%	178%
Equatorial Guinea	0	0	1	1	-0	0.1	4.4	14	1	597%	216%
World Total Oil	**298**	**548**	**1,218**	**1,572**	**-27**	**82.0**	**10.0**	**53**	**1,732**	**581%**	**142%**
Natural Gas Liquids						11.8					
Other liquids						6.0					
World Total Liquids production 2022e						**99.8**					

Source: Rystad Energy UCube, Rystad Energy research and analysis

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* Global oil production 2022, excludes natural gas liquids, biofuel and refinery gains

** Reserve estimate from national authorities 2020, as reported in BP Statistical Review 2022

1P **Proved oil reserves (as of 1.1. 2022), 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

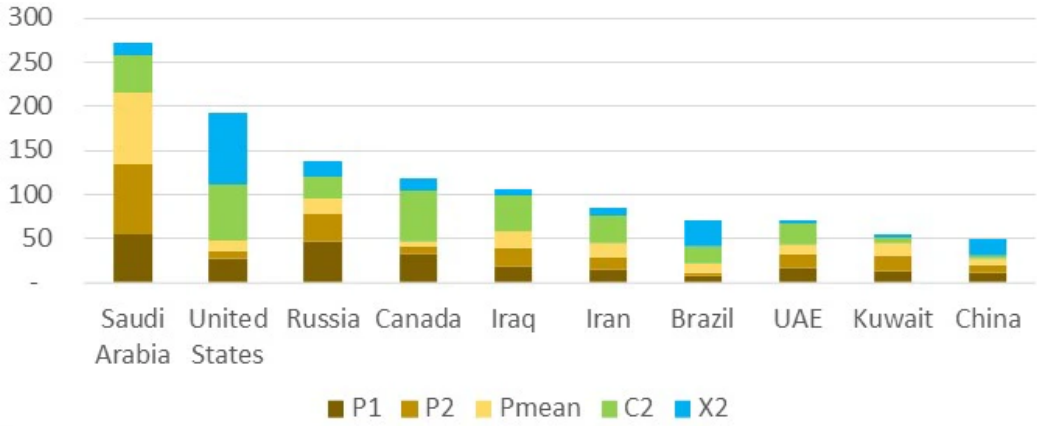
Grey boxes indicates which PRMS category appear closest to official estimates

Red boxes indicates official estimates are higher than any PRMS category

The above classification scheme is aligned with the PRMS standard from the Society of Petroleum Engineers

"Oil" is crude oil + lease condensate. Note BP Statistical Review includes Natural Gas Plant Liquids

Top 10 countries by oil reserves and oil resources (billion barrels)



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

1P = Proven 90% recoverable

2P = Probable 50% recoverable

2PCX = 10-30% recoverable

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.

30 Billion barrels consumed per annum

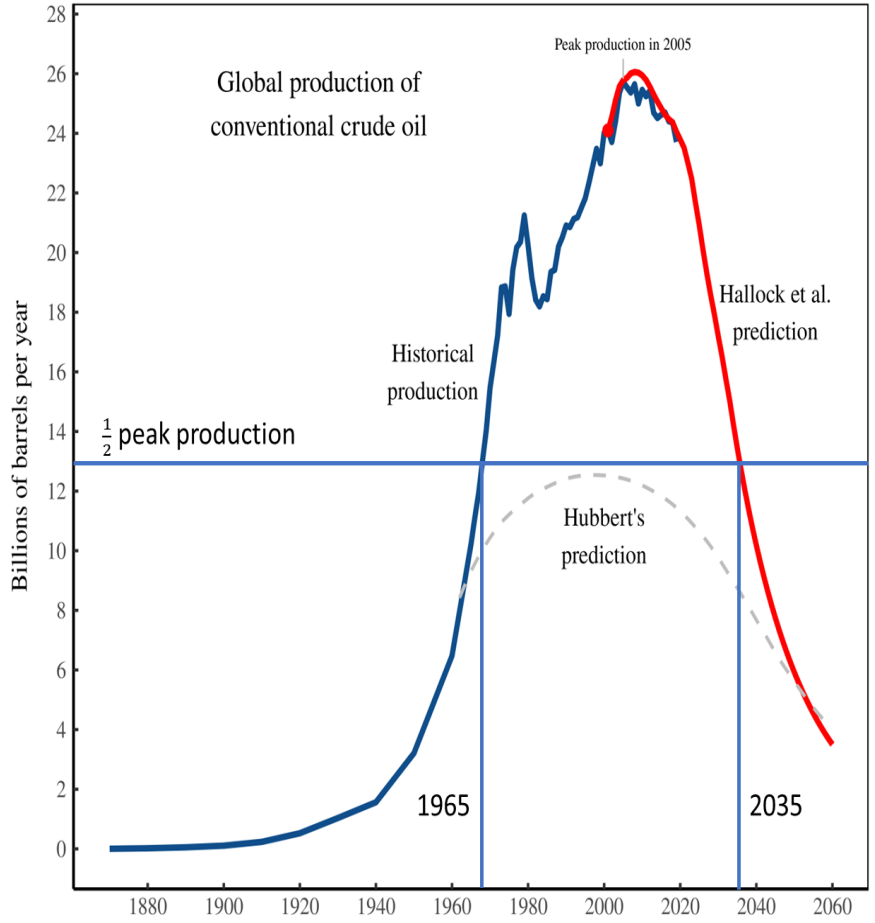
1P = (285*0.9)/30 = 8.55 years remaining

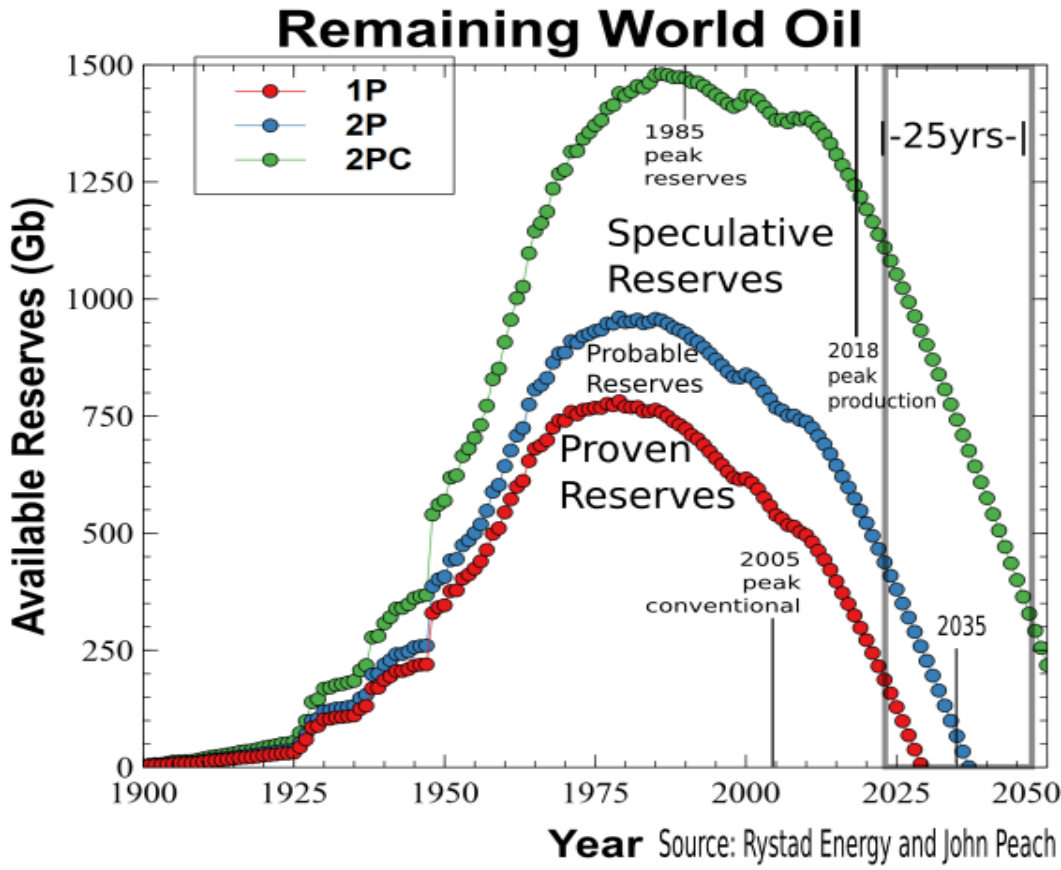
2P = (505*0.5)/30 = 8.41 years remaining

2PCS = 5-16 years remaining

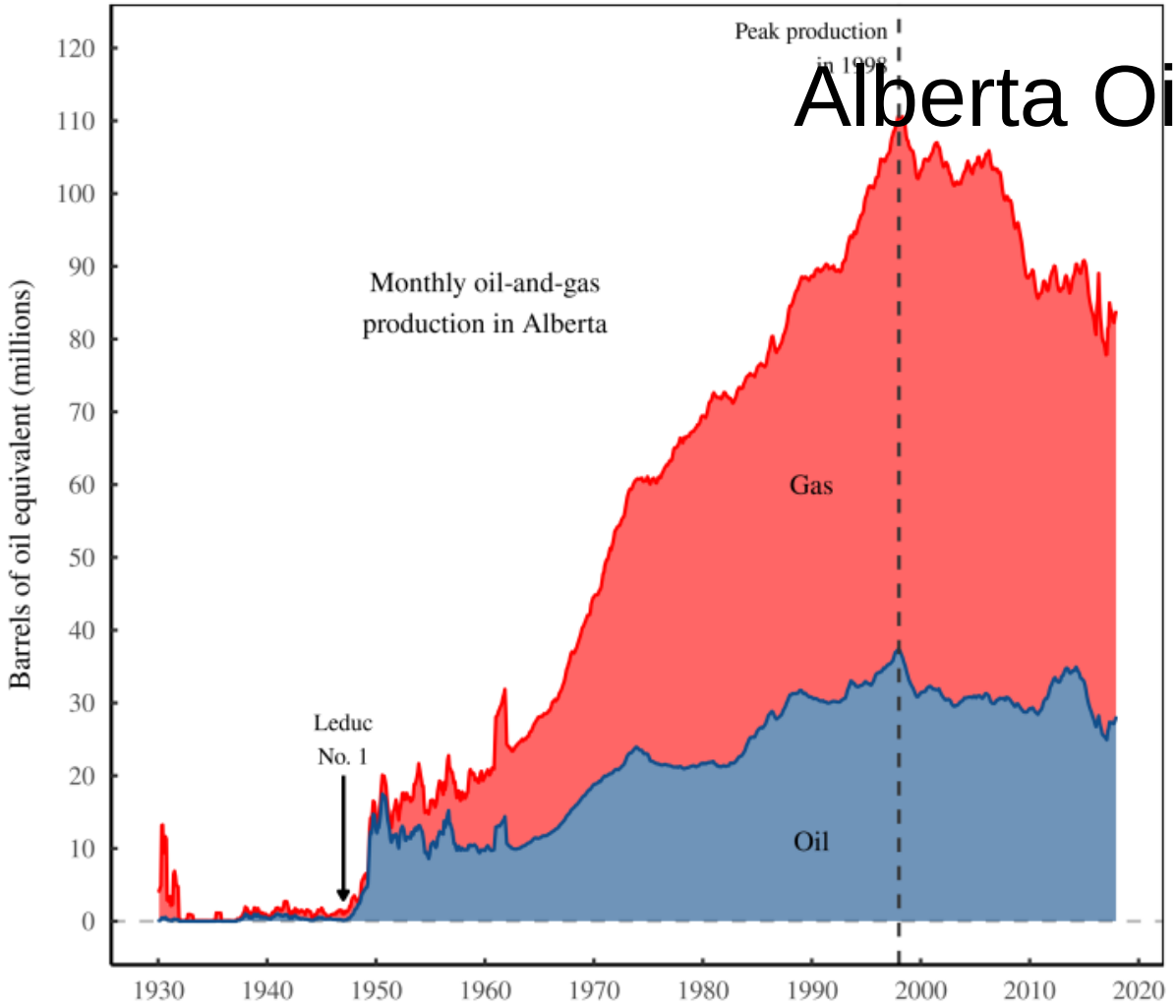
Decline from 2022:
1P 13Gb, 2P: 43Gb

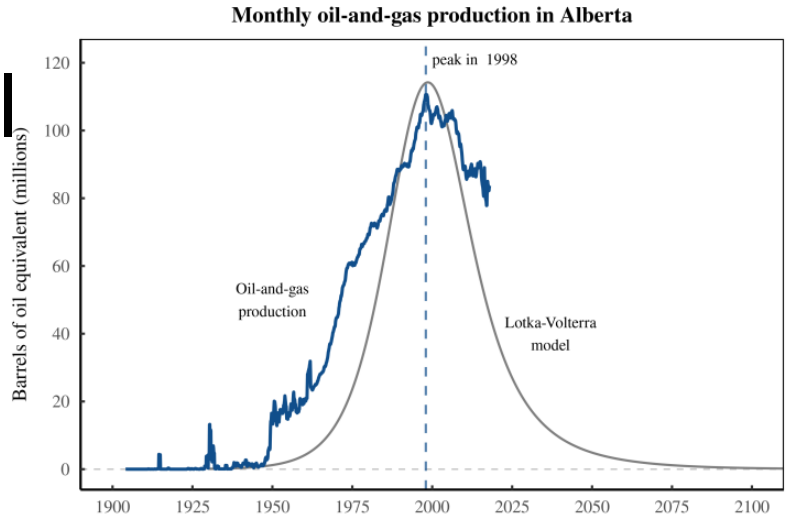
Source: Rystad Energy's Upstream Solution, June 2023
A Rystad Energy graphic

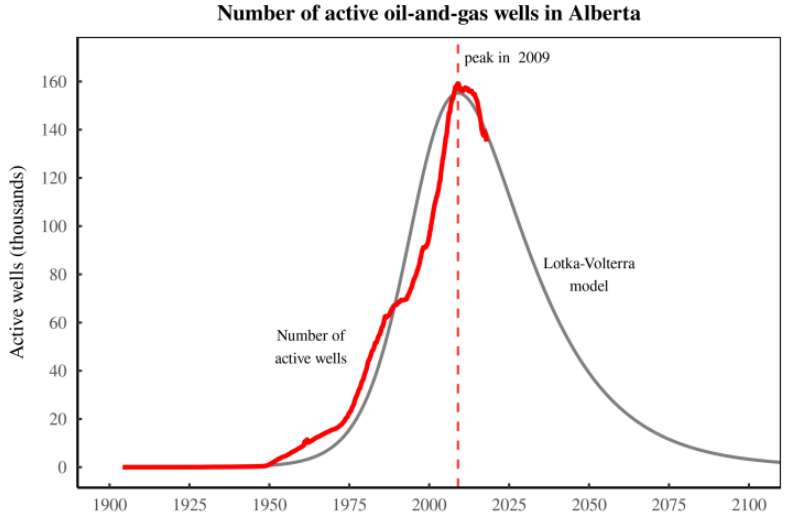

Peak production in 2005
Global production of
conventional crude oil
Hallock et al.
prediction
Historical
production
½ peak production
Hubbert's
prediction
1965
2035
Billions of barrels per year
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
1880
1900
1920
1940
1960
1980
2000
2020
2040
2060


Remaining World Oil
1P
2P
2PC
1985
peak
reserves
|-25yrs-|
Speculative
Reserves
Probable
Reserves
2018
peak
production
Proven
Reserves
2005
peak
conventional
2035
Available Reserves (Gb)
0
250
500
750
1000
1250
1500
1900
1925
1950
1975
2000
2025
2050
Year
Source: Rystad Energy and John Peach

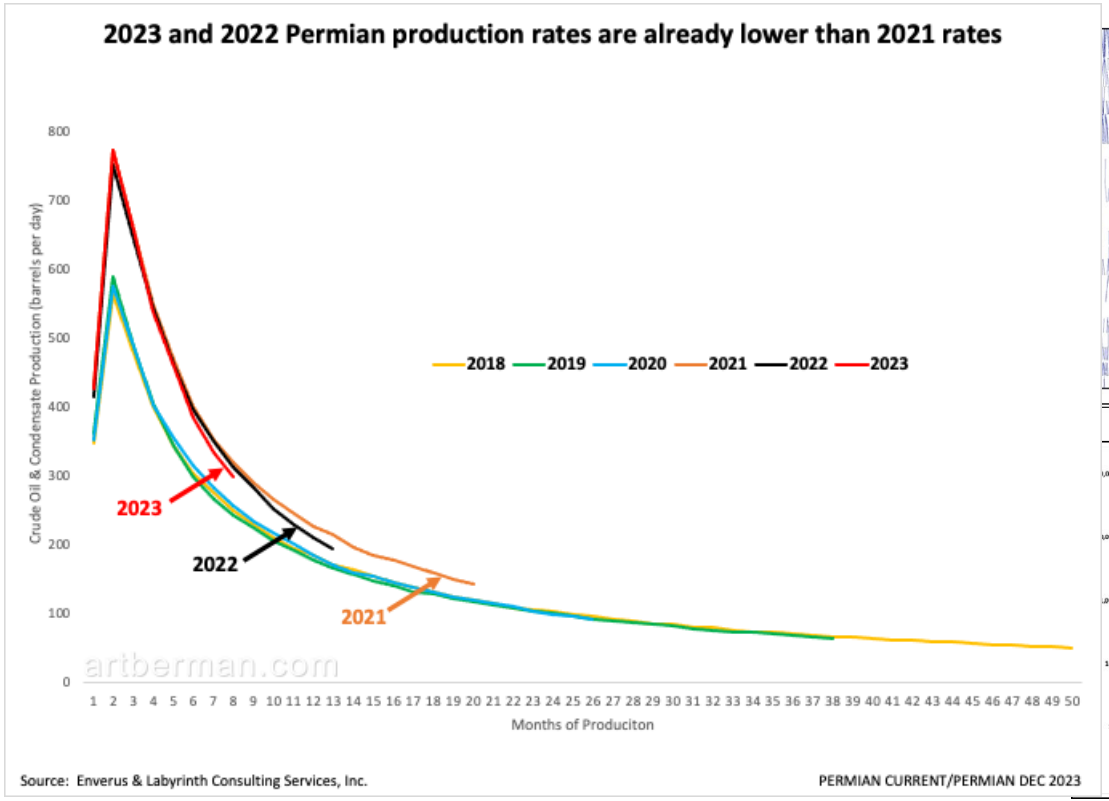
Alberta Oil

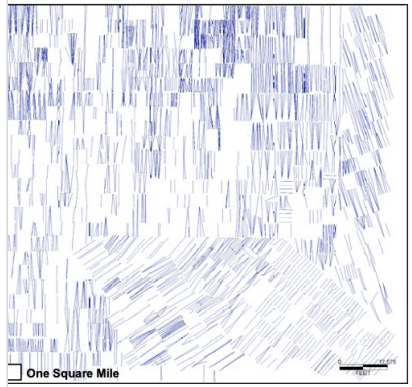

Peak production in 1998
Monthly oil-and-gas production in Alberta
Gas
Oil
Leduc No. 1
Barrels of oil equivalent (millions)
0
10
20
30
40
50
60
70
80
90
100
110
120
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020

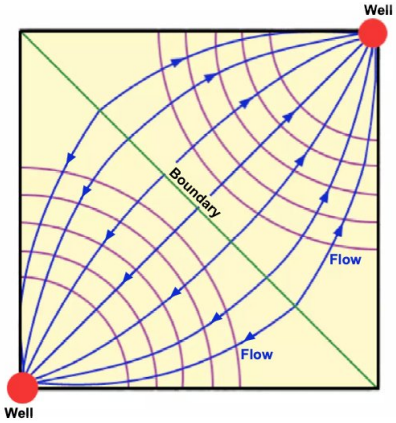

Monthly oil-and-gas production in Alberta
peak in 1998
Oil-and-gas production
Lotka-Volterra model
Barrels of oil equivalent (millions)
0
20
40
60
80
100
120
1900
1925
1950
1975
2000
2025
2050
2075
2100

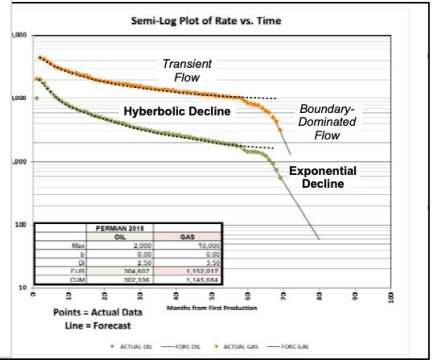

Number of active oil-and-gas wells in Alberta
peak in 2009
Lotka-Volterra model
Number of active wells
Active wells (thousands)
0
20
40
60
80
100
120
140
160
1900
1925
1950
1975
2000
2025
2050
2075
2100

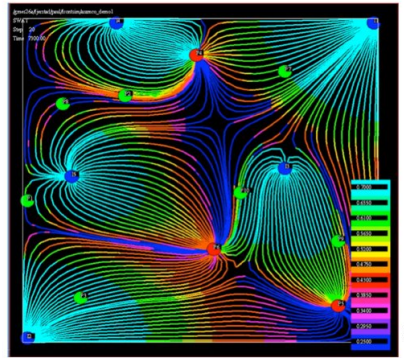
U.S. Shale Oil


2023 and 2022 Permian production rates are already lower than 2021 rates
Crude Oil & Condensate Production (barrels per day)
800
700
600
500
400
300
200
100
0
2018
2019
2020
2021
2022
2023
2023
2022
2021
artberman.com
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Months of Produciton
Source: Enverus & Labyrinth Consulting Services, Inc.
PERMIAN CURRENT/PERMIAN DEC 2023

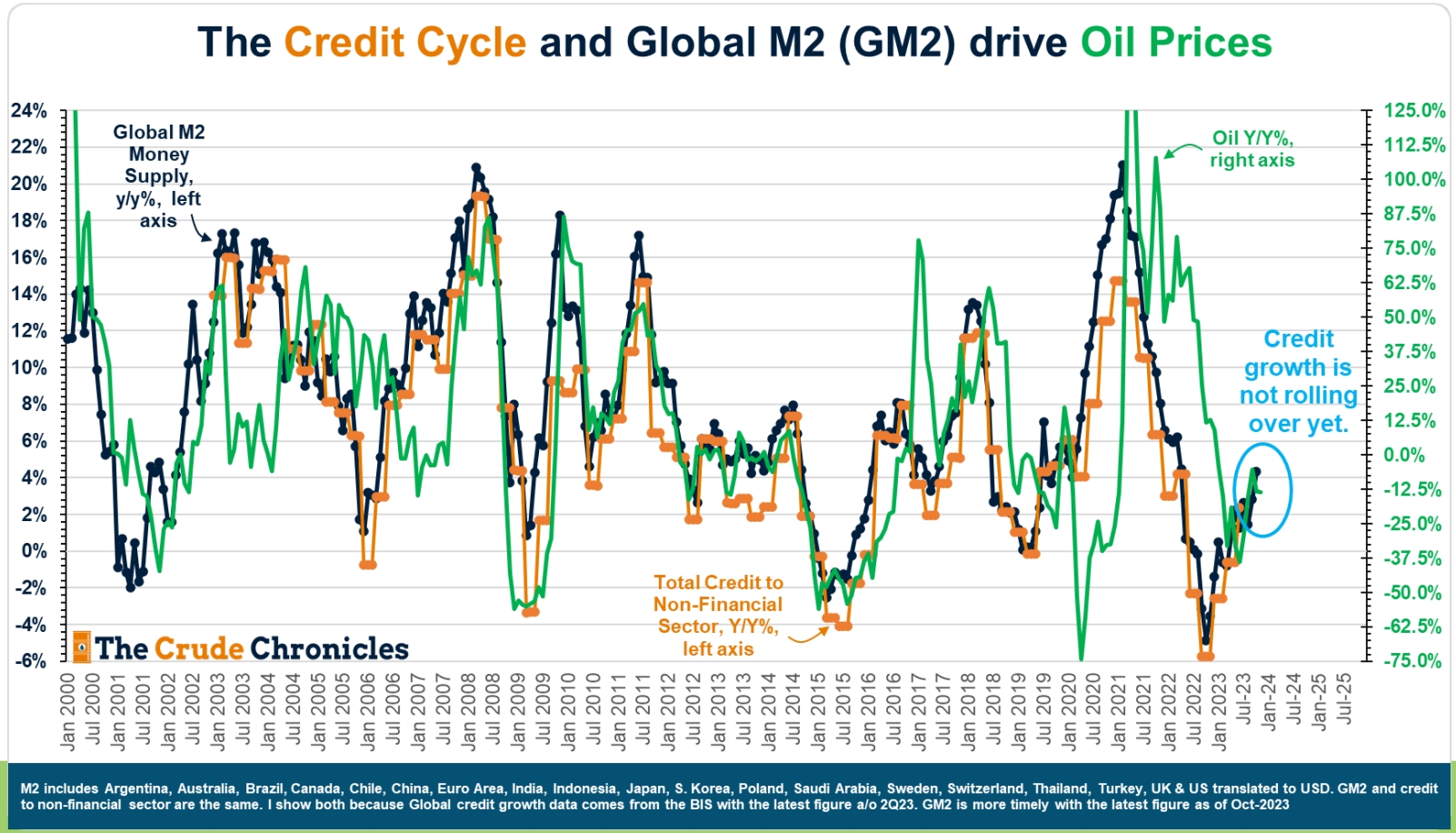

One Square Mile


Well
Boundary
Flow
Flow
Well

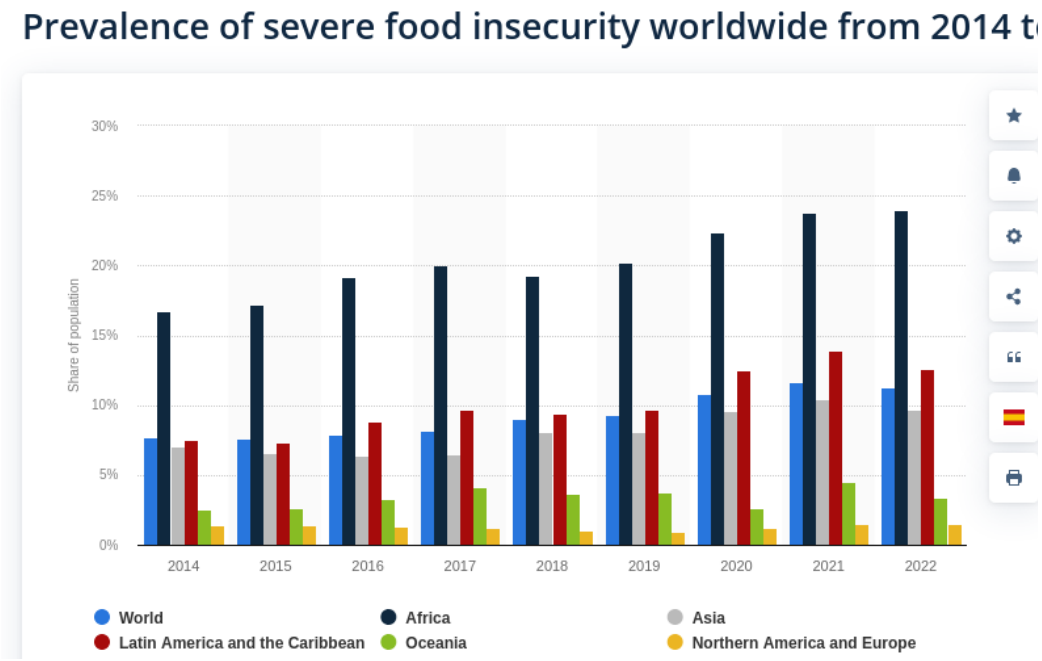

Semi-Log Plot of Rate vs. Time
Transient Flow
Hyberbolic Decline
Boundary-Dominated Flow
Exponential Decline
PERMIAN 2018
OIL
GAS
Points = Actual Data
Line = Forecast
Months from First Production

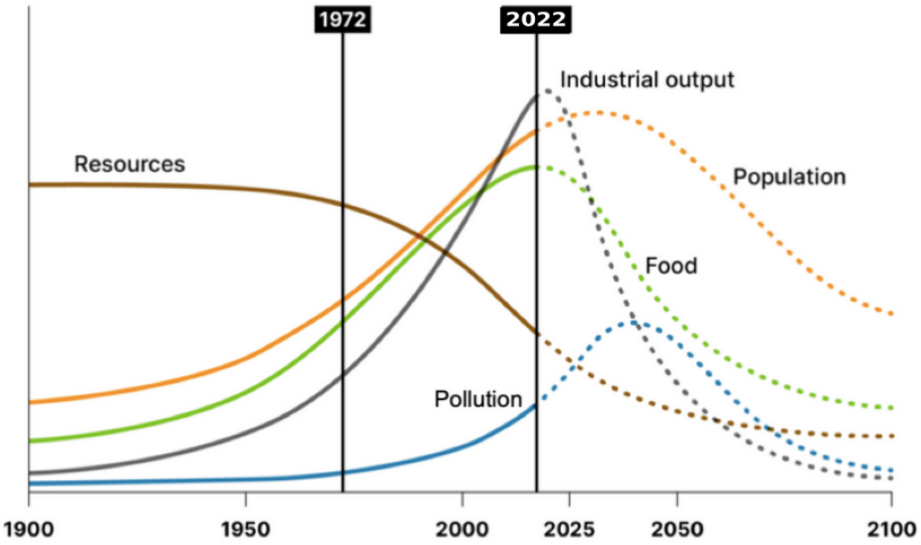


Oil Price depends on Money Supply



Limits to Growth

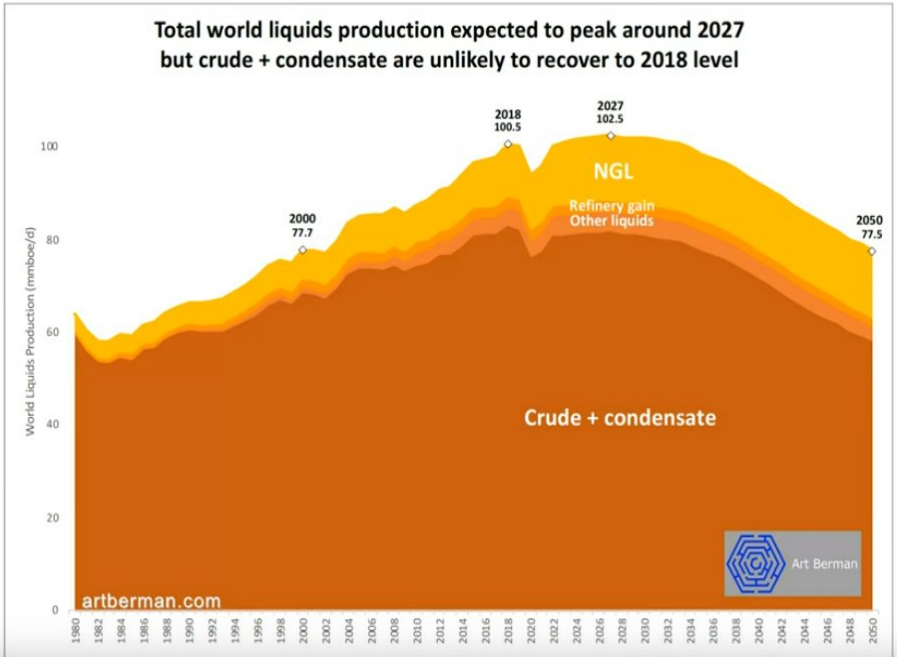


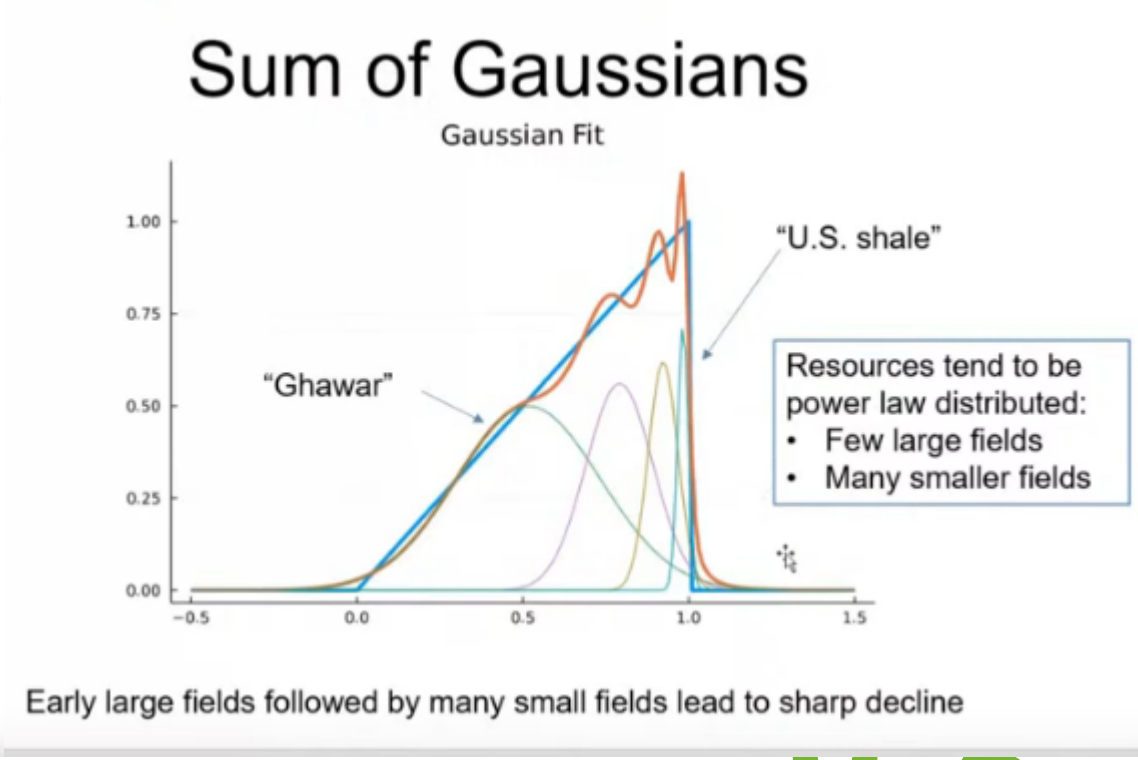


This figure shows the BAU 1 scenario which had tended to follow the data relatively well. Source: Meadows et al (1972), Earth4all

NGL and Decline Slope

Oils ain't oils....





Green Transition Not-Enough-Minerals

Table A9. Total metal quantity required to manufacture one generation of technology units, with a 28 day power buffer for wind and solar to phase out fossil fuels compared to 2019 global production

Metal	Element	Total including 28 day buffer stationary power storage (million tonnes)	Global Metal Production 2019 (million tonnes)	Years to produce metal at 2019 rates of production (assuming the 28 day buffer) (years)
Aluminium	Al	353.5	63.14	5.6
Copper	Cu	6 161.1	24.20	254.6
Zinc	Zn	48.2	13.52	3.6
Magnesium Metal	Mg	0.5	1.12	0.4
Manganese	Mn	306.0	20.59	14.9
Chromium	Cr	9.2	37.50	0.2
Nickel	Ni	1 251.2	2.35	532.4
Lithium	Li	1 274.2	0.095	13 388.3
Cobalt	Co	292.9	0.126	2 324.6
Graphite ◆	C	11 466.2	2.73	4 201.2
Molybdenum	Mo	1.5	0.277	5.4
Silicon (Metallurgical)	Si	67.35	3.43	19.7
Silver	Ag	0.198	0.03	7.5
Platinum	Pt	0.0027	0.000190	14.1
Vanadium	V	923.96	0.096	9 622.4
Zirconium	Zr	2.61	1.34	2.0
Germanium	Ge	4.16	0.000130	32 024.3
Rare Earth Element				
Neodymium	Nd	1.14	0.024	47.8
Lanthanum	La	5.97	0.036	166.8
Praseodymium	Pr	0.265	0.0075	35.4
Dysprosium	Dy	0.212	0.0010	212.1
Terbium	Tb	0.023	0.00028	81.4
Hafnium	Hf	0.000293	0.000066	4.4
Yttrium	Y	0.000293	0.014	0.0

Where are we? Scarcity Industrialism

- Scarcity Industrialism characterized by energy conservation.
- Slow deteriororation of services as society grinds to a halt.
- EU is ahead of the curve, over 55,000 companies closed in 2023 in France alone.
- Most heavy industry has shut off, and medium industry is shutting down as well.
- In Canada people can’t afford housing and are living in the tents.

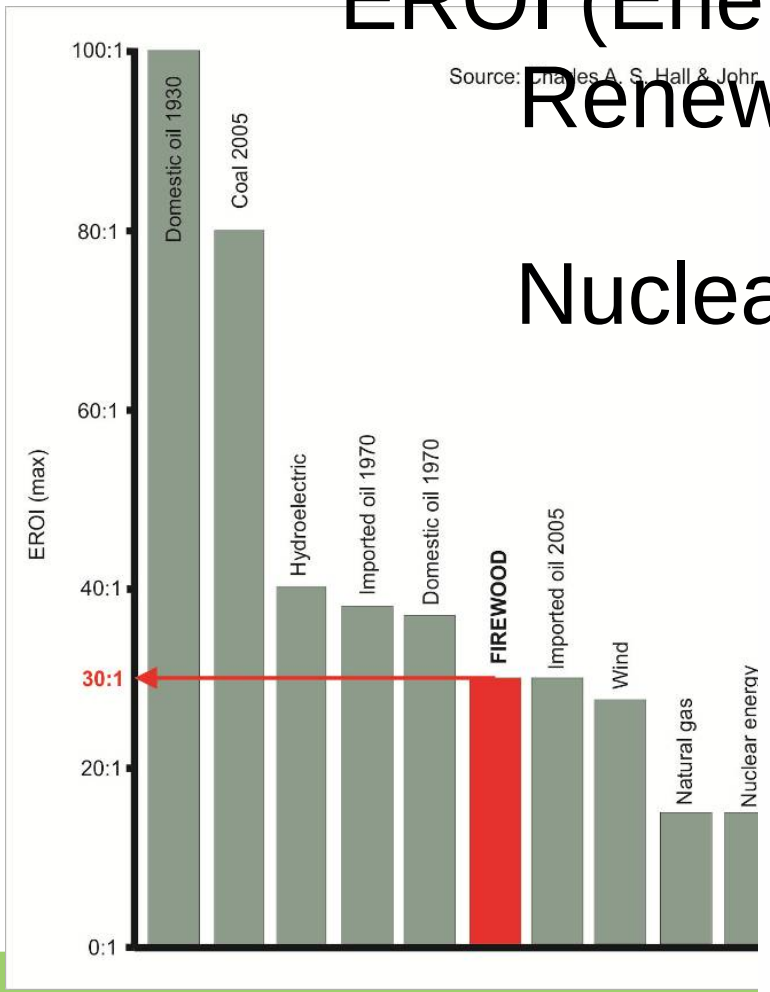
EROI Basics, Service decline

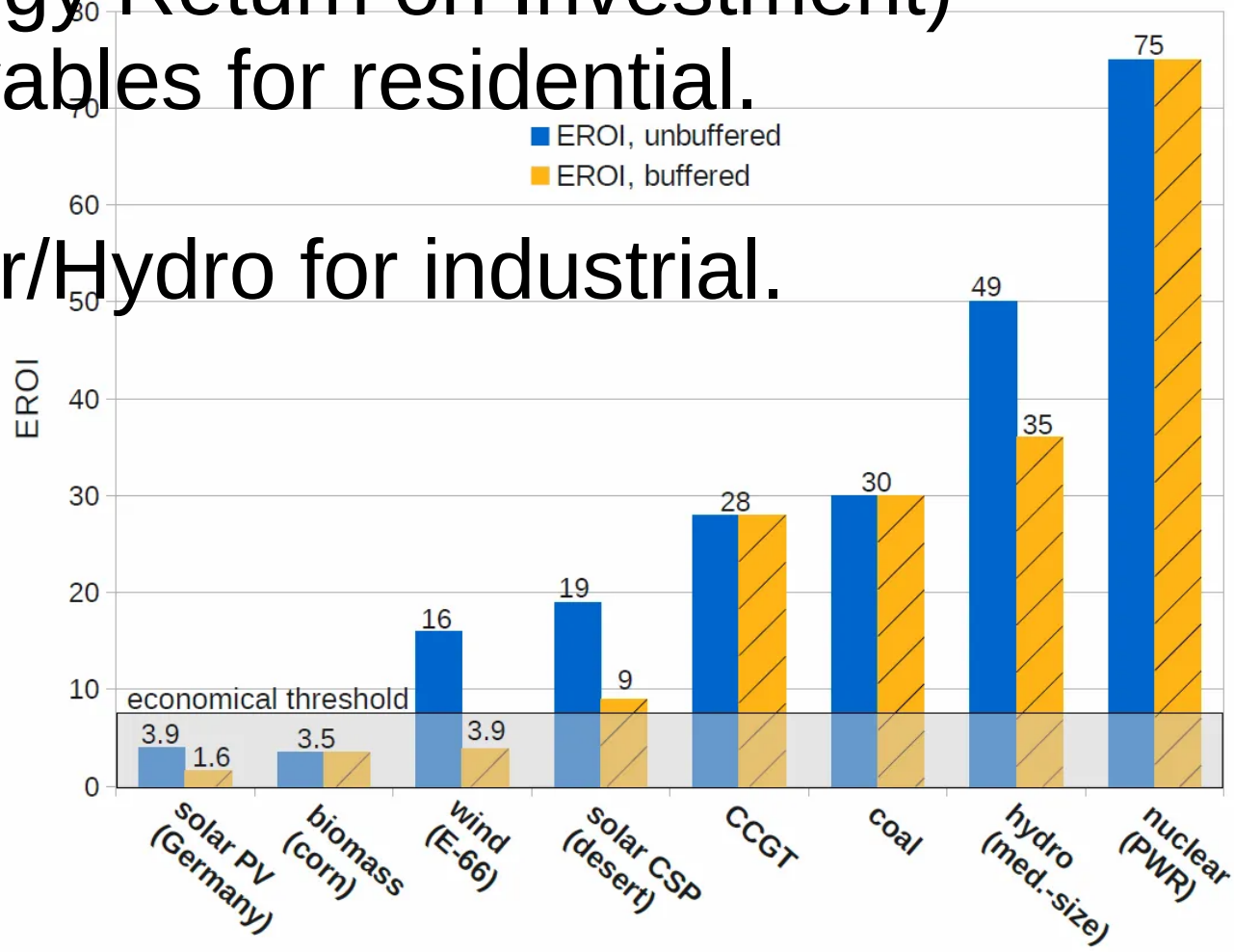
- EROI 14, enough to pay for arts (90s)
- EROI 12, enough to pay for healthcare (2010s)
- EROI 9, enough to pay for a school system (2020s?)
- EROI 7, enough to pay truck drivers, farmers (2030s?)
- EROI 5, enough to truck commodities other than fuel (2040s?)
- EROI 3, enough to truck the fuel
- EROI 1, enough to dig a hole to look at fuel

EROI (Energy Return on Investment)

Renewables for residential.

Nuclear/Hydro for industrial.





Where are we headed? Salvage Economy

- In Salvage economy most energy is embeded energy. So wrecking crews taking apart sky scrapers and landfills are some of the more profitable ventures.
- Unless there is land distribution crime will continue to increase as people are unable to meet their needs in urban areas.
- It is good idea to promote local scrapyards, recycling, and accumulation of high energy metals for the future salvage economy

- Mass Dreams of Future: 4 lifestyles: Urban, Rustic, Indigenous, Sylvan

Urban Lifestyle: Salvage post collapse

Urban Timeline dystopic underground military bases (till 54 yo)

Rustic Lifestyle: Amish/Mennonite

Amish Rustic timeline of horse and buggy annual till (till 56 yo)

Indigenous Survialist Lifestyle

Indigenous Survivalist lifestyle, hunting gathering (till 70 yo)

New Age Sylvan: Food Forest Communities

New Age Sylvan food forests, organized community (89+ yo)

What Can Work?

- People homesteading, growing their own food and firewood with manual labour.
- A church of 60 people could support equine or bovine transport.
- A village of 360 could support a biogas vehicle, kiln or forge.
- A neighbourhood of 5,000 having farmers markets and store.
- A city of 55,000 having thorium reactor for industrial production.
- County of 700,000 having radio, internet and rail for connectivity.

Family of 6 Homestead

- Carrying capacity in South Ontario is 1-2 hectare per capita.
- Family homestead of 6 would need 6-12 hectares.

Active 75kg human
food ~4-5Gj/year

Core wood:
Willow SRC 0.5gHa
1 cord = ~15Gj

backup
food 0.25
~5-7Gj

core food
0.25gHa
~5-7Gj

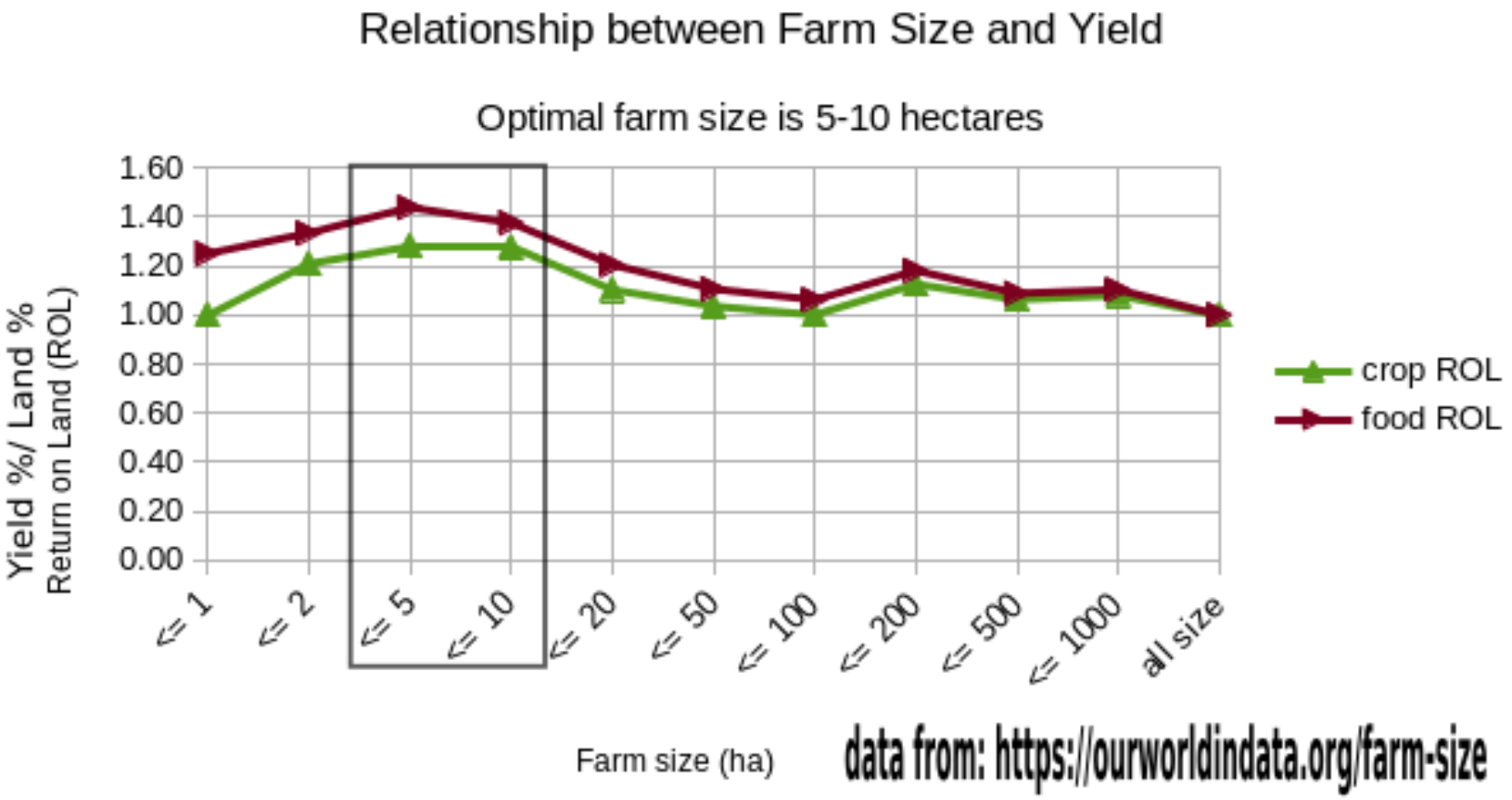
Active 75kg human
food ~4-5Gj/year

0.5gHa Wood Coppice ~15Gj

0.25gHa Food Forest 5-7Gj

core food
0.25gHa
~5-7Gj

Optimal Farm Size: 5-10 hectares (12-25 acre)



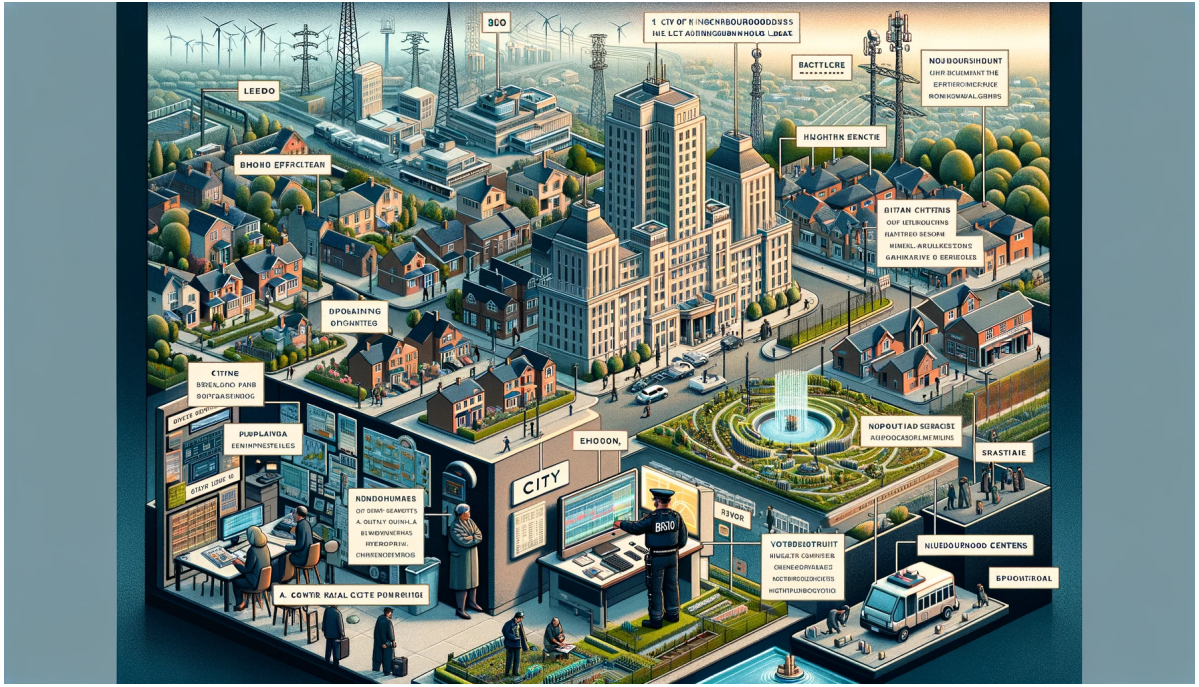
data from: https://ourworldindata.org/farm-size

Community Church of 60 with animal transport

Village of 360 with BioGas production facility

Neighbourhood of 5040 with markets and stores

City of 55,000 with thorium industrial manufacturing



County of 720,720 with rail/road and communication networks

Recommended Policies Federal

- Opening up crown land for homesteading of sustainable size lots 10-20 hectares. Allowing for waterway accessible lots.

Recommended Policies Provincial

- Through WOWC and AMO can lobby for a Land Protection Act to set cap on per capita land ownership 10-20 hectares for South Ontario. Surplus sold to citizens on market or adding family onto title.

Recommended Policies County

- Allowing/encouraging sustainable living practices, including rainwater collection, compost toilets, local building materials.
- Set maximum single family lot size to be in the 10-20 hectare range.
- 30-50m offset and hedge from road to avoid roving bandits.
- Support a county radio, fiber optic, and consider rail.
- Encourage sustainable rural homesteads and orchards

Recommended Policies Municipal

- Set minimum lot size to be 1 hectare for single person occupancy.
- Affordable housing at sustainable density, of at least a hectare per capita.
- Allow temporary housing permits to enable residents to live on their land while they are building more permanent structures.
- Community Development Plans: Encourage the formation of community associations such as churches and villages in homestead areas to foster collaboration, resource sharing, etc.

Grey County Collaboration

- How am I helping with the transition?
- I email County Councillors on Friday mornings.
- I attend county meetings, and am available for consultation.
- Further involvement? At councillors discretion.
- I run an IT business, and a proof of concept tree seedling business, selling at venues like Keady Farmers Market.
- I attend Glad Tidings Mennonite Fellowship in Tara.

Rural Transition Discussion