Jean Laherrere 28 July 2017

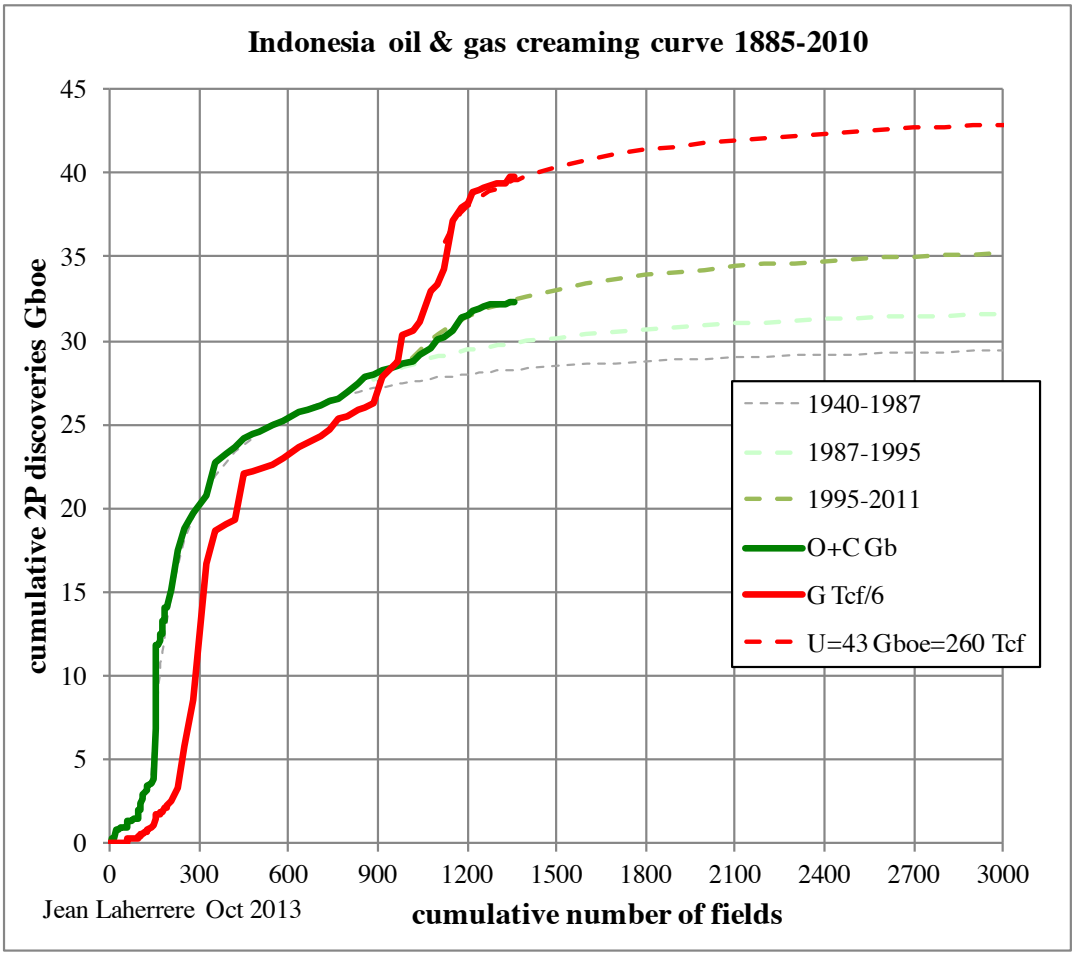
Indonesia: graphs on energy, population, GDP and CO2

Indonesia is a dispersed and large country with a population over 250 M, covering 1.9 million km^2 with many islands: the numbers are found ranging from 13 466 to18 307 (depending the definition of what is an island (uncovered at high tide), data always with 5 significant digits when only the first one is right). A 1996 law states 17 508, the official number for the UN is 14 752 in 2016, it was 13 466 in 2012. 8 844 islands have been named!

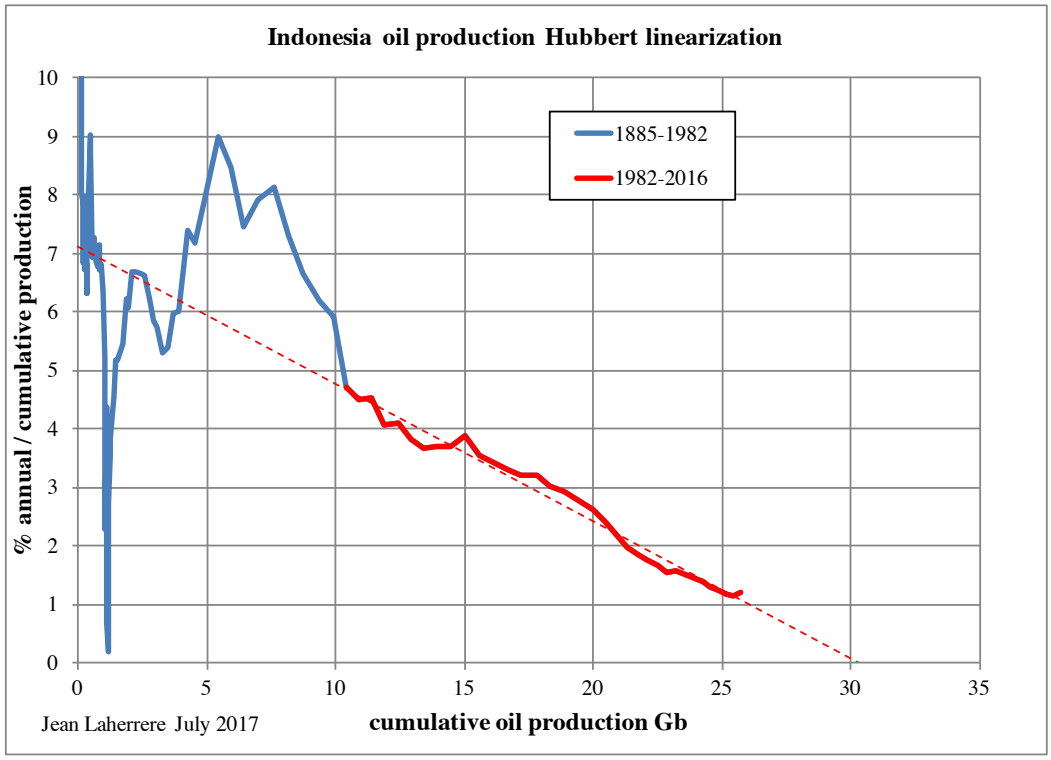
Indonesia has a long story with oil and gas starting in 1885.

-oil discovery & production

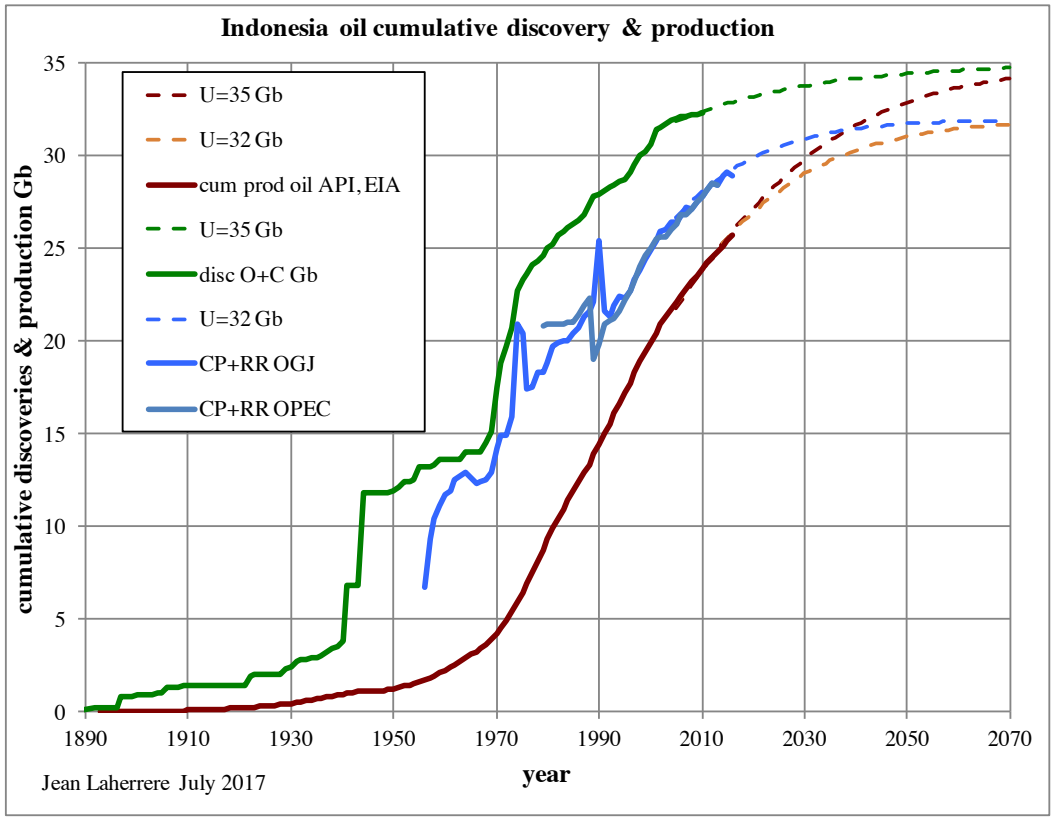
From the IHS 2011 data, the creaming curve (cumulative backdated 2P (proven + probable) reserves versus the cumulative number of fields) is modelled with several cycles to a maximum number of fields (double present number, here 3000 fields) to estimate the ultimate reserves being 35 Gb for crude oil and condensate and 43 Gboe = 260 Tcf for natural gas (NG)



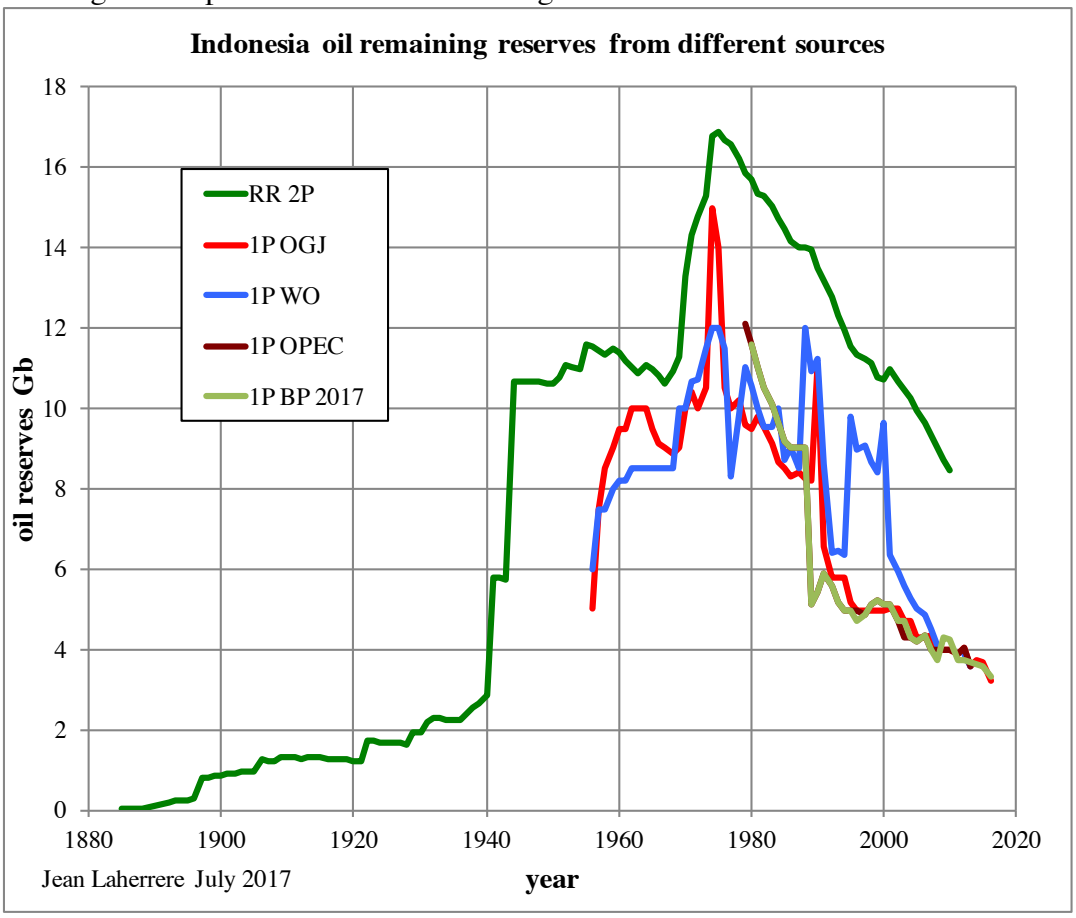
But the Hubbert linear extrapolation of past oil production trend (% annual production over cumulative production for the period 1982-2016) towards zero (end of annual production growth = end of the production) allows to estimate the ultimate reserves being 30 Gb (against 35 Gb for discoveries)



There is a certain uncertainty of the oil and gas ultimates, when comparing cumulative backdated 2P (proved + probable) discoveries and current 1P (proved) remaining reserves plus cumulative production.
The uncertainty for oil ultimate is between 30 and 35 Gb, when the cumulative production up to 2016 is 26 Gb:
Today Indonesia has produced between 74 and 86 % of the crude oil ultimate!
Not much left!

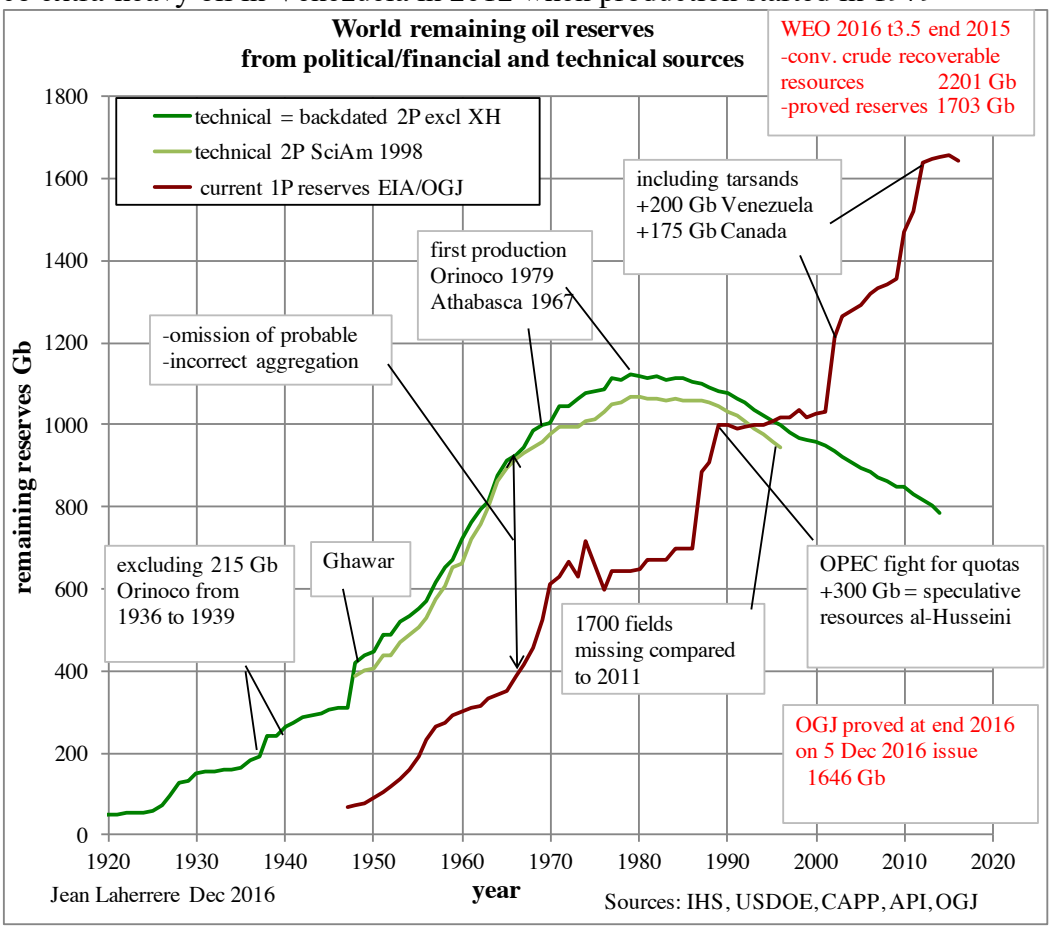


The so called proved (or proven) (1P) reserves are badly defined to allow a certain freedom to the operator: SEC (Securities and Exchange Commission) rules oblige oil operator listed on the US stock market (every International Oil Company) to report only proved reserves being those to exist with a "reasonable certainty". But "reasonable" is not defined and allows every company to report what they want within a large range! In the US any new product is allowed to be on sale by the Food and Drug Agency only if it presents "a reasonable certainty of no harm": again reasonable is not defined, but left to competent experts (Definition of Safety in 21 CFR 170.3(i): " Reasonable certainty in the minds of competent scientists that a substance is not harmful under the intended conditions of use.")
The SPE PRMS rules define proved as corresponding to a probability of over 90% if probabilistic approach is taken.
There are large discrepancies between remaining oil reserves from different sources.



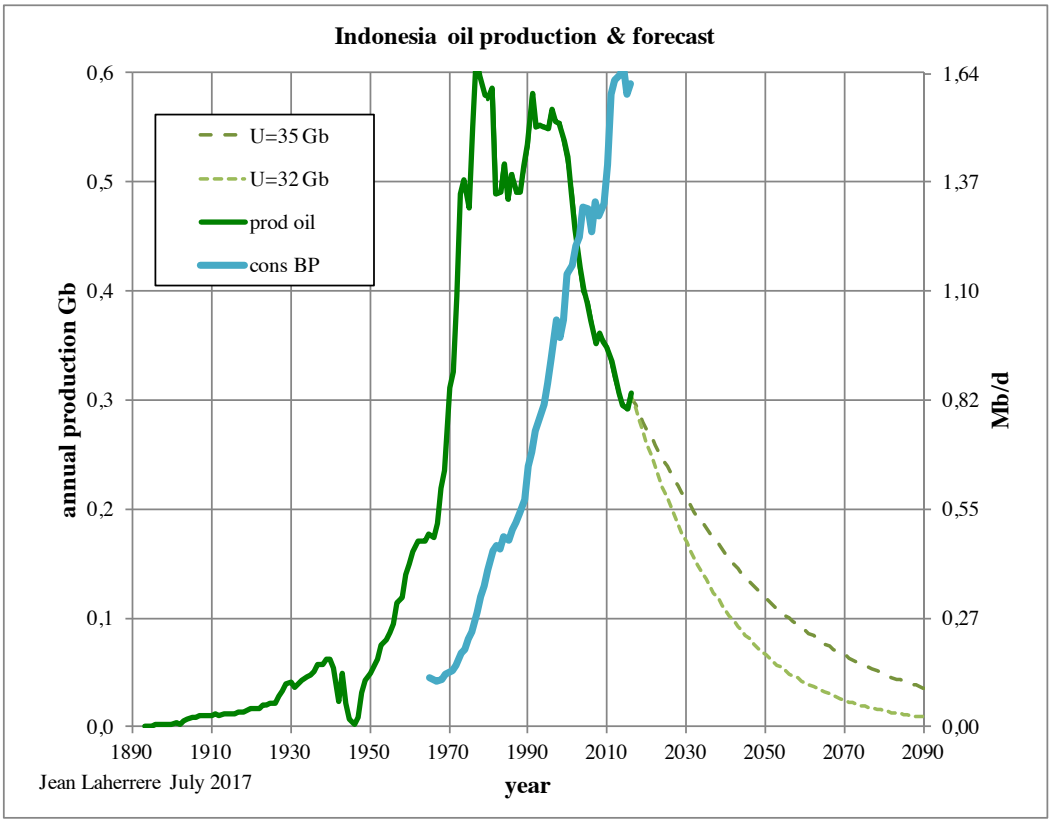
Furthermore it is incorrect to aggregate arithmetically field proved reserves to obtain the proved reserves of the country (or of the world), the addition underestimates the total, leading to artificial reserves growth (= bad practice of reserves reporting)
There are different systems of defining reserves:
There is no consensus on reserves classification, but local practices/
-OPEC unaudited proved reserves = fight for quotas = political = 300 Gb speculative resources stated in 2007 by former VP Aramco al-Husseini
-SEC audited proved reserves, forbidding to report probable reserves = financial to please the bankers
-SPE/WPC/AAPG PRMS: 1P =P90, 2P = P50, 3P = P10, arithmetic addition is only correct for 2P
-Russian ABC1 grossly exaggerated (Khalimov 1959 & 1993) = 3P
-Norwegian classification = mean value,

For the world the historical technical remaining 2P reserves (green curve) behave completely differently from the 1P current reserves (brown curve): for end 2016 1P reserves are twice larger than 2P reserves: it should not be, something wrong 2P or 1P?
1P oil reserves have changed definition by including in 2002 175 Gb of Athabasca tarsands in Canada , but the production of Athabasca started in 1967! Same when adding 200 Gb for Orinoco extra-heavy oil in Venezuela in 2012 when production started in 1979

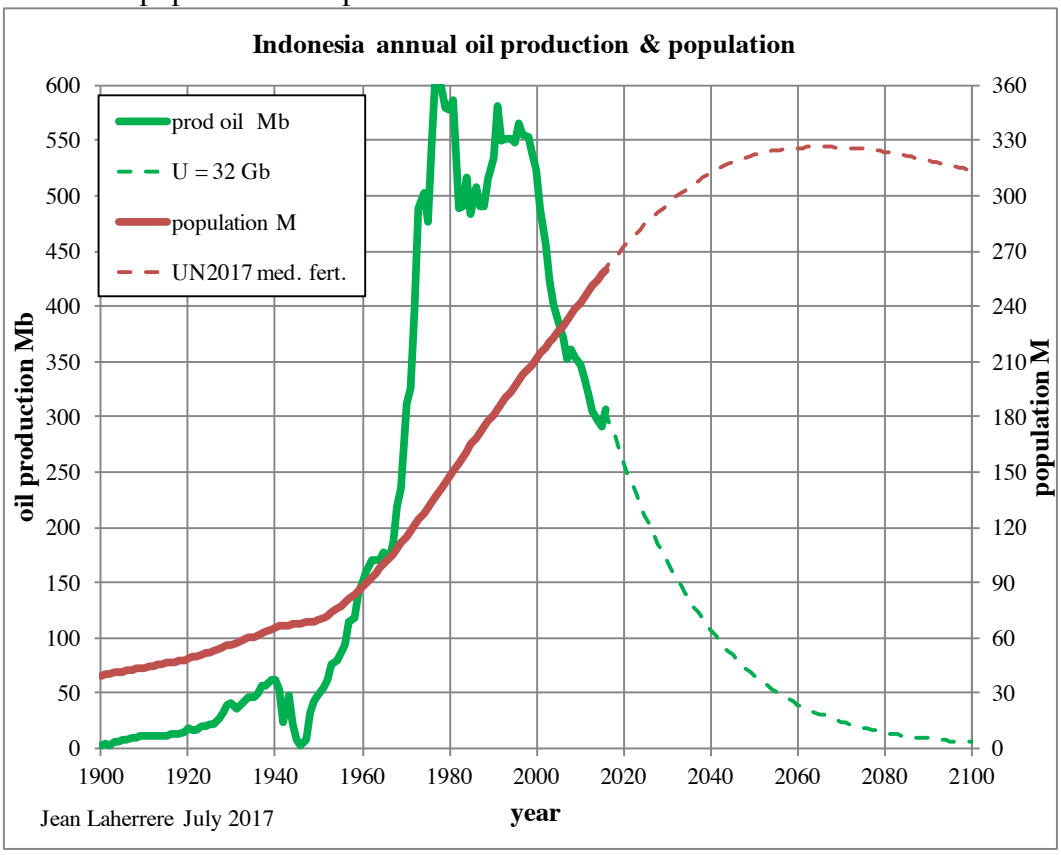


Energy data is uncertain in the world because the lack of consensus between countries on definition of products and on rules of reporting.
Poor or no data is favored by most actors either in politics or in industry.
Competition is the rule and everybody lies if it is advantageous to him!
In the world of football there rules, umpires and red cards, but not in real life!

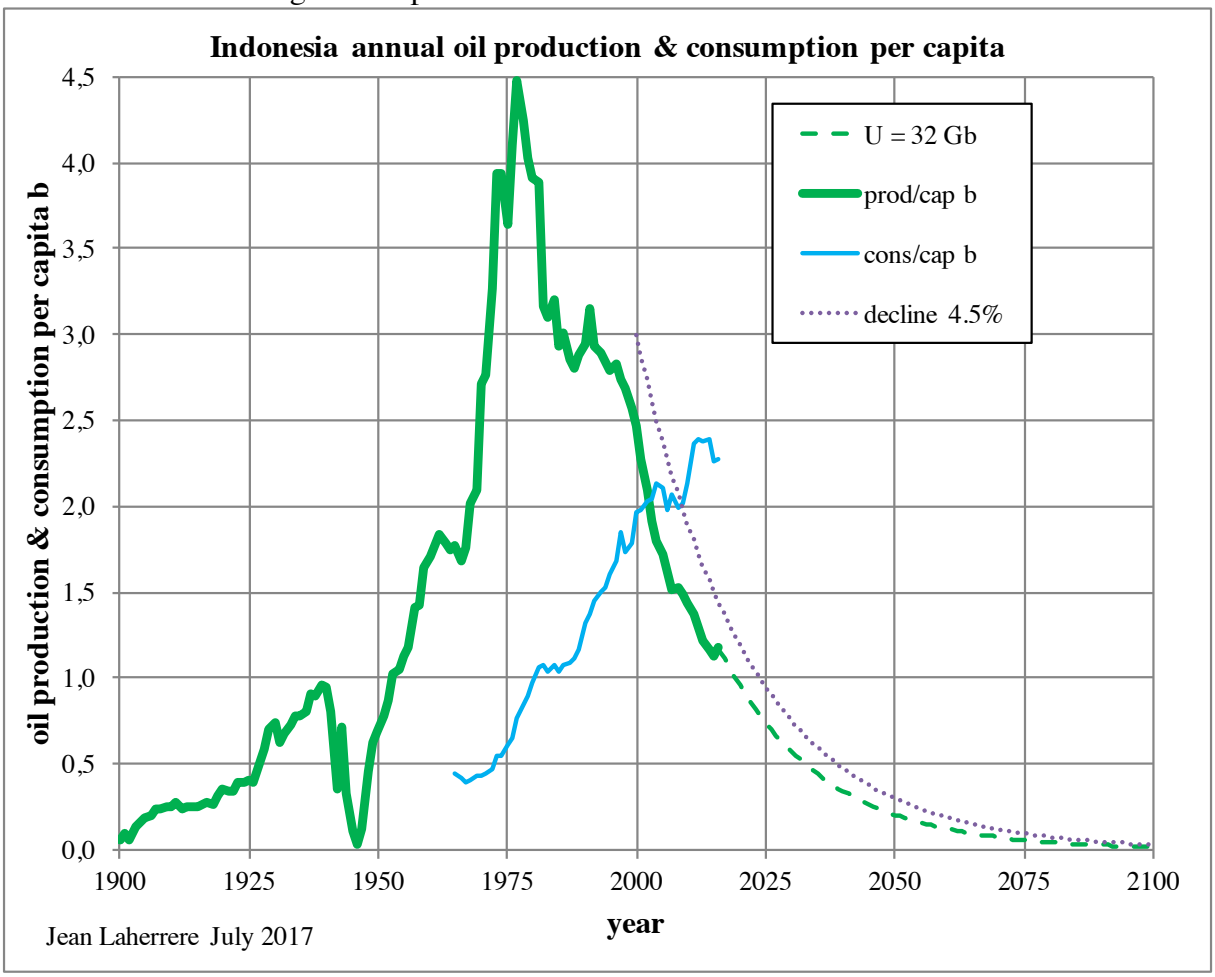
Indonesia crude oil production peaked in 1978-1981 and 1992-1998 and its decline since will continue until the end around 2100 despite few small steps.
Indonesia oil consumption overpassed oil production in 2003.



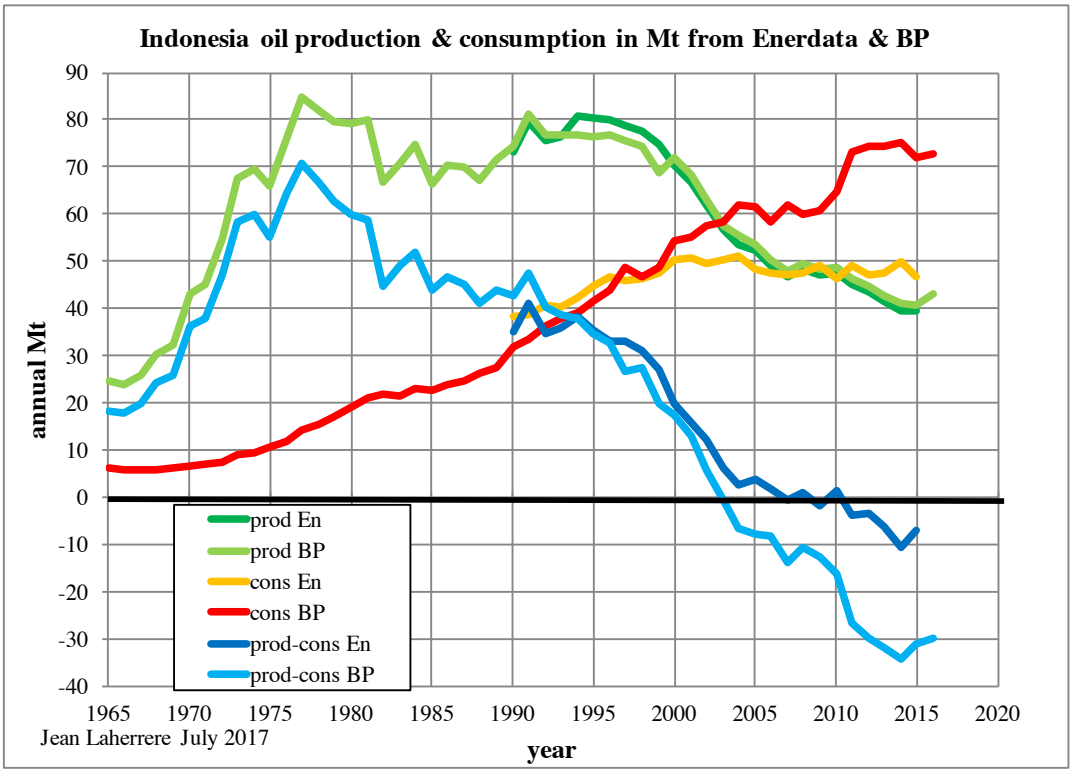
Indonesia crude oil production and forecast for U= 32 Gb is compared to population for 1900-2100. Indonesia population will peak in 2060 at 550 M for the scenario of medium fertility

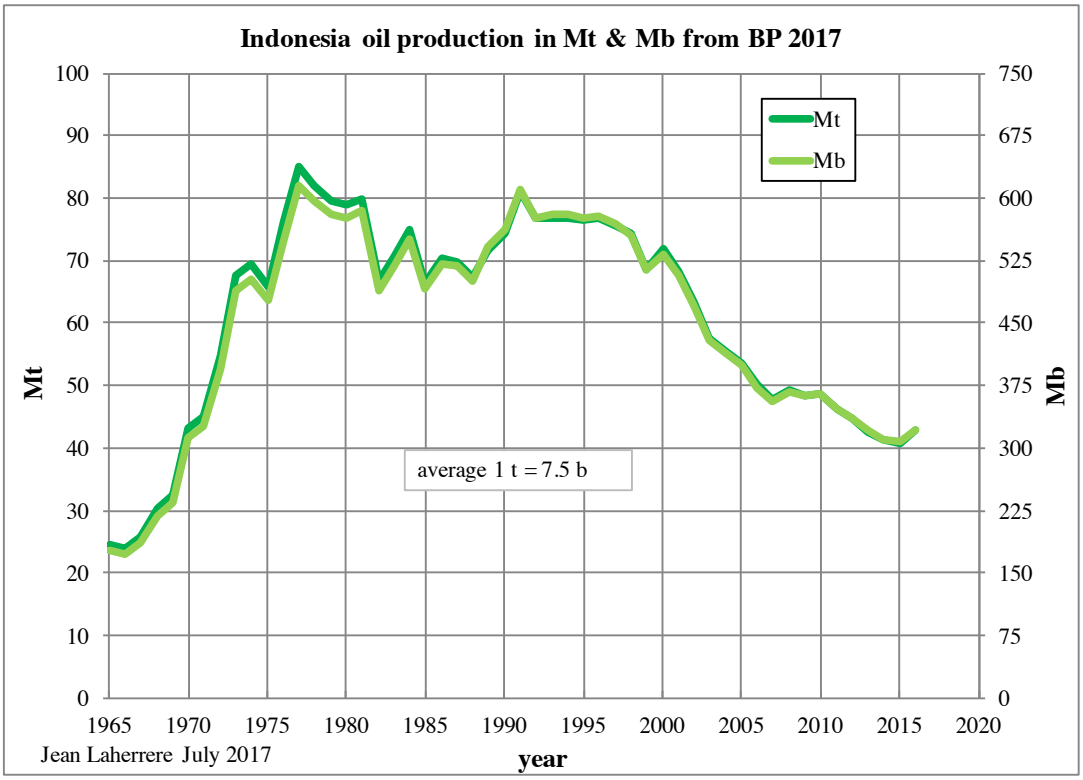


Indonesia oil production per capita has peaked in 1977 at 4.5 b and is today at 1.1 b compared to a consumption about the double!
Oil production per capita will decline in the future about 4.5% per year, like it did since 1995.
Since 2003 Indonesia is obliged to import crude oil.

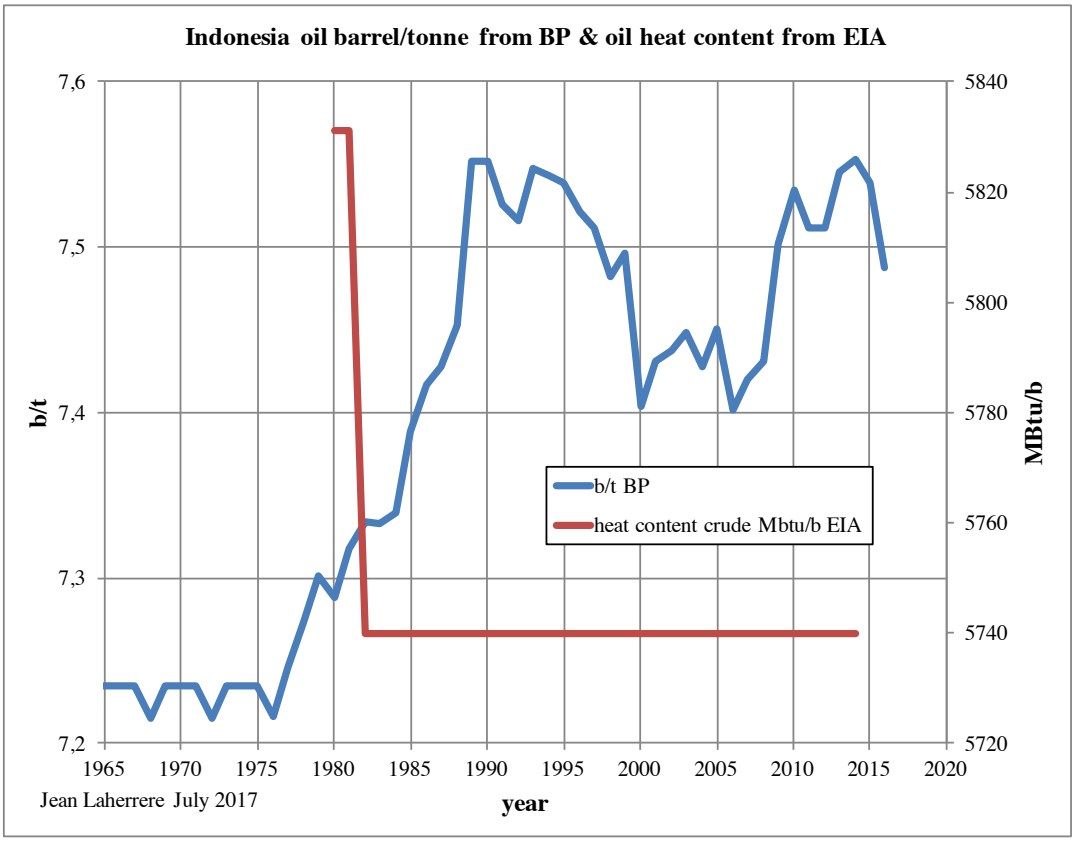


Previous graphs report production in volume (barrel), but data in energy are needed to compare with other energies. Weight is more related to energy (heat content) than volume.
BP since 1965 and Enerdata since 1990 report oil production and oil consumption in weight = Mt (million tonne) instead of volume = Mb for EIA.
The data by BP and Enerdata is about equal for production but differs widely since 2002 for consumption (oil for BP, oil products for Enerdata).
Indonesia consumes more oil in tonne than it produces since 2003 for BP and since 2010 for Enerdata



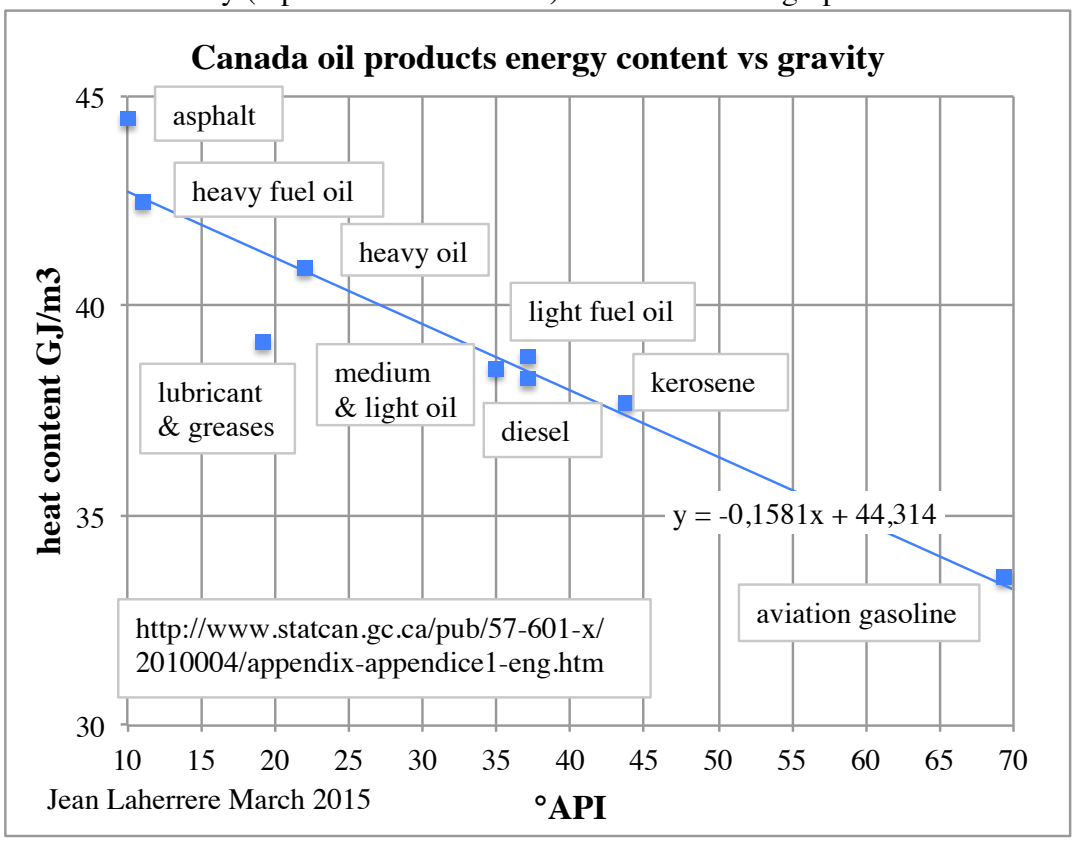


The problem is often the lack of precise definition for oil = crude oil or crude oil + natural gas liquids (NGL), BP excludes biofuels in contrary with IEA & EIA.
The problem to convert oil production from volume (Mb) to weight (Mt) is that the data on density and heat content does not correlate as they should.
BP reports crude oil production both in Mt and in Mb/d and EIA reports oil heat content .
There is no correlation and the evolution of these measures looks queer



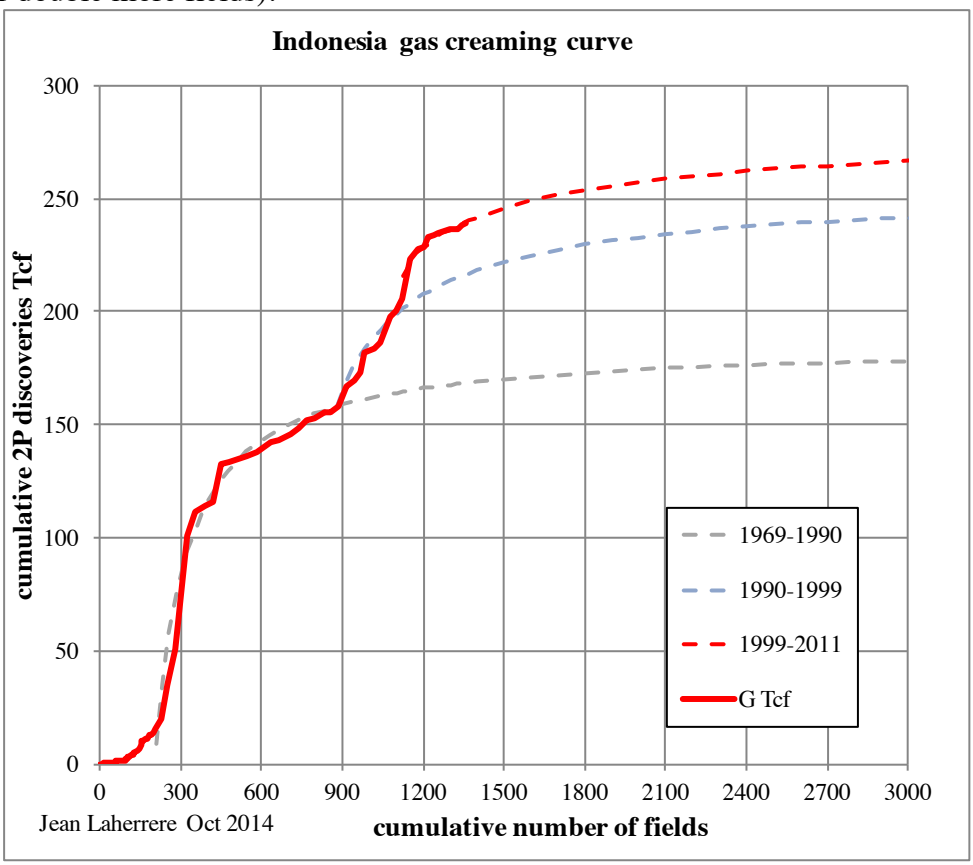
The conclusion is that the conversion from volume to weight is unreliable

The ratio b/t depends of the density of crude oil and there is a linear relationship between heat content and density (reported in US in °API) as shown in this graph from Canada

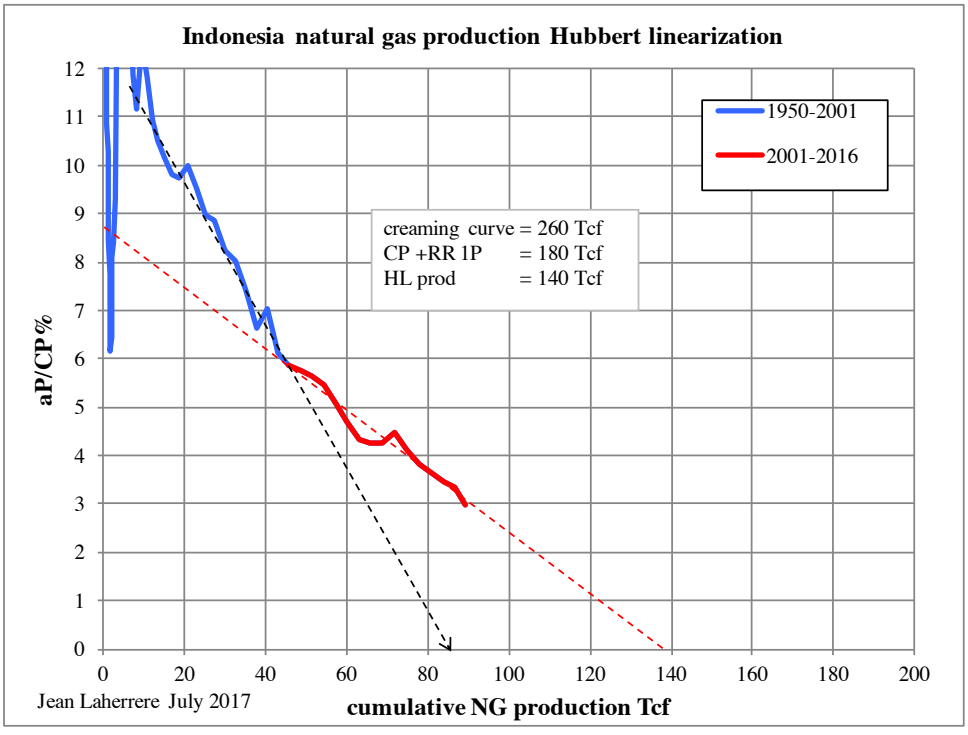


-natural gas (NG) production

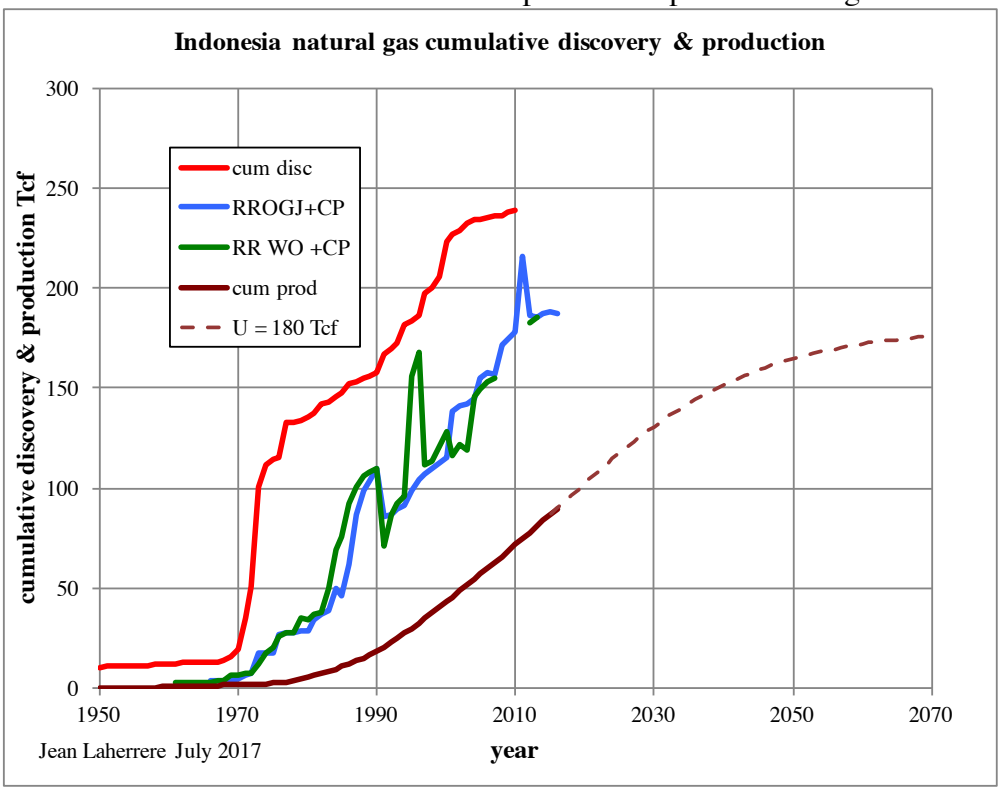
The creaming curve of NG cumulative 2P discoveries is extrapolated to an ultimate of 260 Tcf (for double more fields).



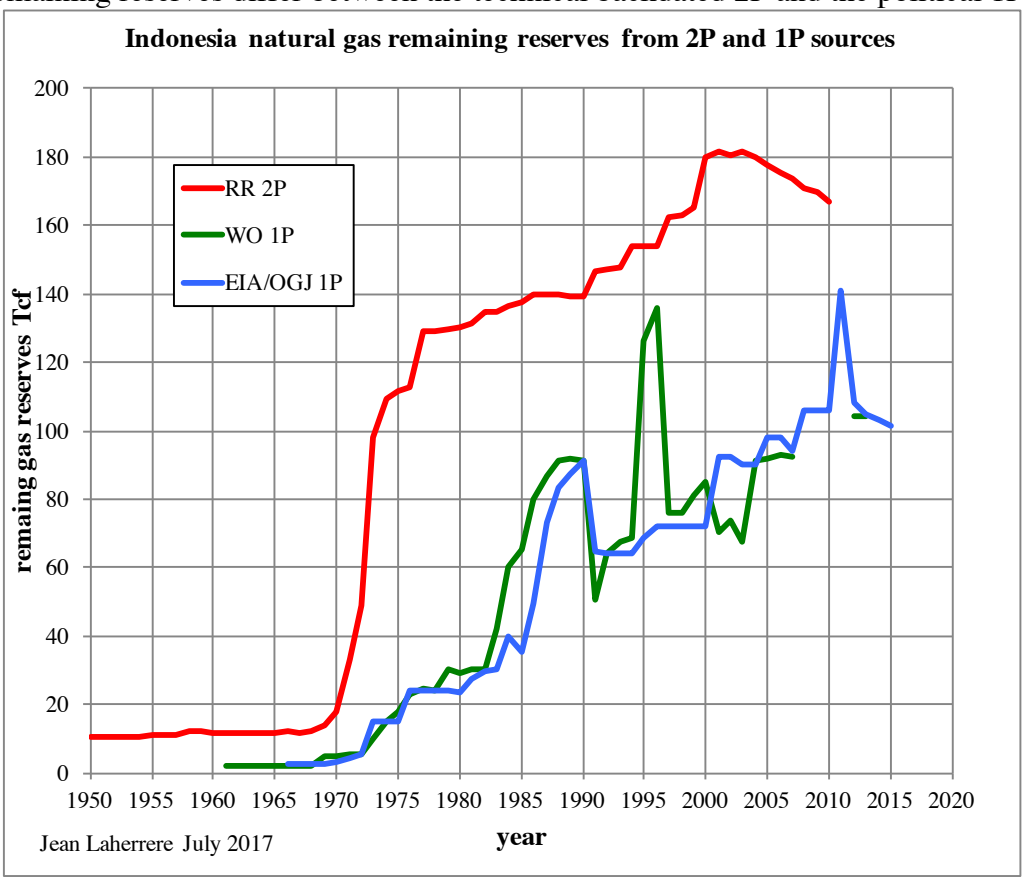
But the Hubbert linearization (linear extrapolation of the percentage of annual production over cumulative production for certain period) of past production for the period 2001-2016 trends towards an ultimate of 140 Tcf



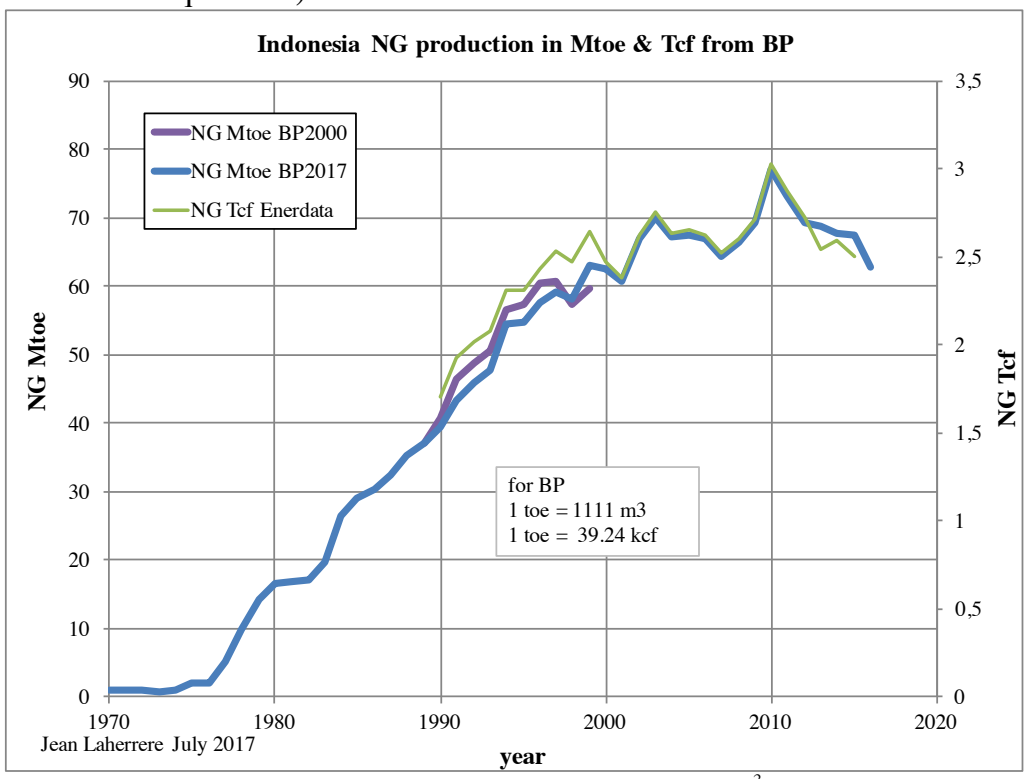
In front of such discrepancy, an ultimate of 180 Tcf is considered. This value is not far from the cumulative production plus proved reserves in 2015
Cumulative NG production is extrapolated with an ultimate of 180 Tcf compared to the cumulative 2P discoveries and the cumulative production plus remaining 1P reserves



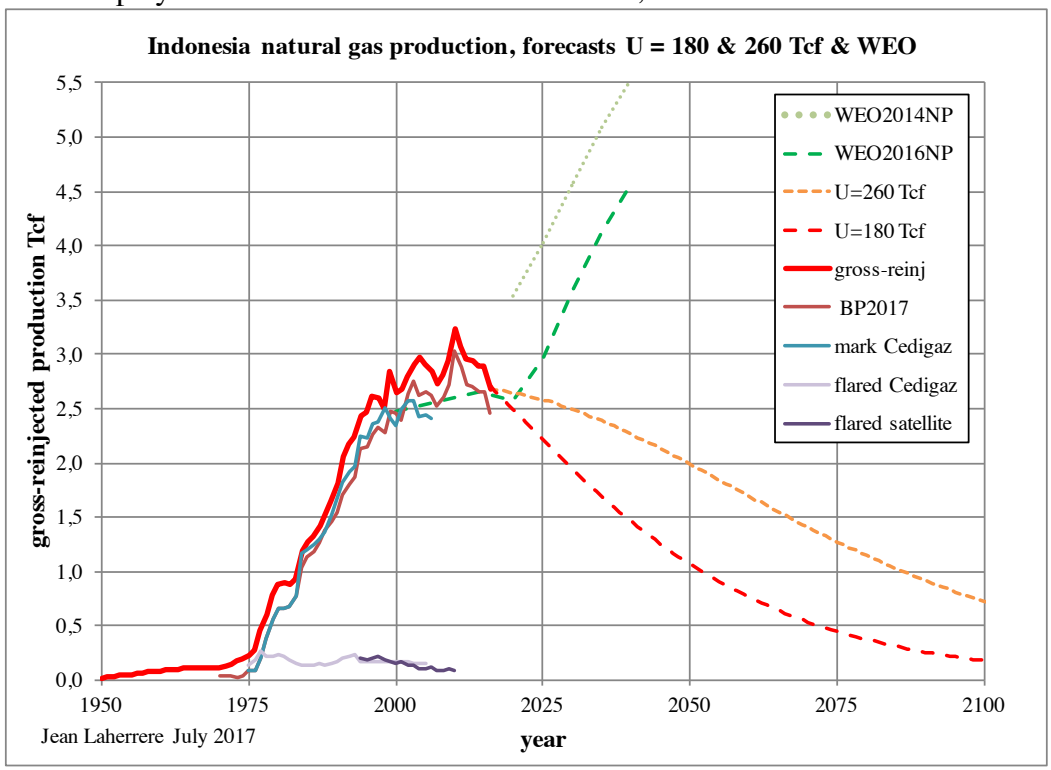
NG remaining reserves differ between the technical backdated 2P and the political 1P



Most agencies report the marketed dry production, omitting the losses by flaring, venting or liquids extraction and compare with NG reserves, which is wrong because of these losses.
In contrary gross less reinjected production should be compared with reserves.
BP is then only agency reporting both NG production in volume (G.m^3 or Gcf/d) and energy (Mtoe = tonne oil equivalent)



BP converts NG volume in energy with 1 toe = 39 kcf = 1111 m^3
The gross less reinjected production is plotted in Tcf (as marketed production, flared from Cedigaz & gas flared from satellite (NOAA) and the forecast for U= 180 & 260 Tcf
U=180 Tcf displays a decline more in line with the rise, as it is seen in the oil decline.



IEA forecast WEO 2014NP was very high, WEO2016NP is smaller, but still very high compared to my forecasts: it appears that IEA does not bother about ultimates: the sky (or the earth) is without limit!

-coal production

There is a huge difference between coal reserves (what is economical) and coal resources (what is in the ground). Indonesia resources are about 5 times larger than reserves on the data reported by the German Institute BGR.

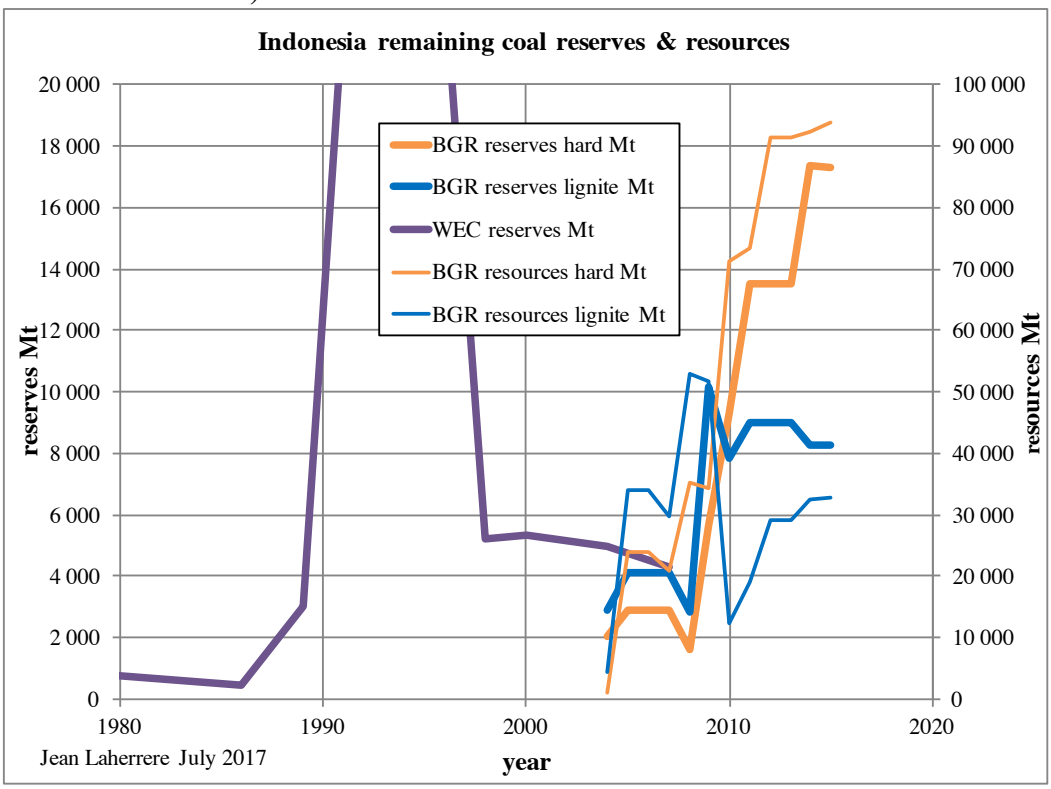
Thin layers, deep layers (>1500 m) and offshore are not considered economical (in fact needing more energy to extract than they contain).

WEC (World Energy Council) coal reserves estimates increased from 451 Mt in 1986 to 32063 Mt in 1992 & 1995 to fall to 5220 Mt in 1998

Coal heat content by weight varies widely: anthracite twice lignite.

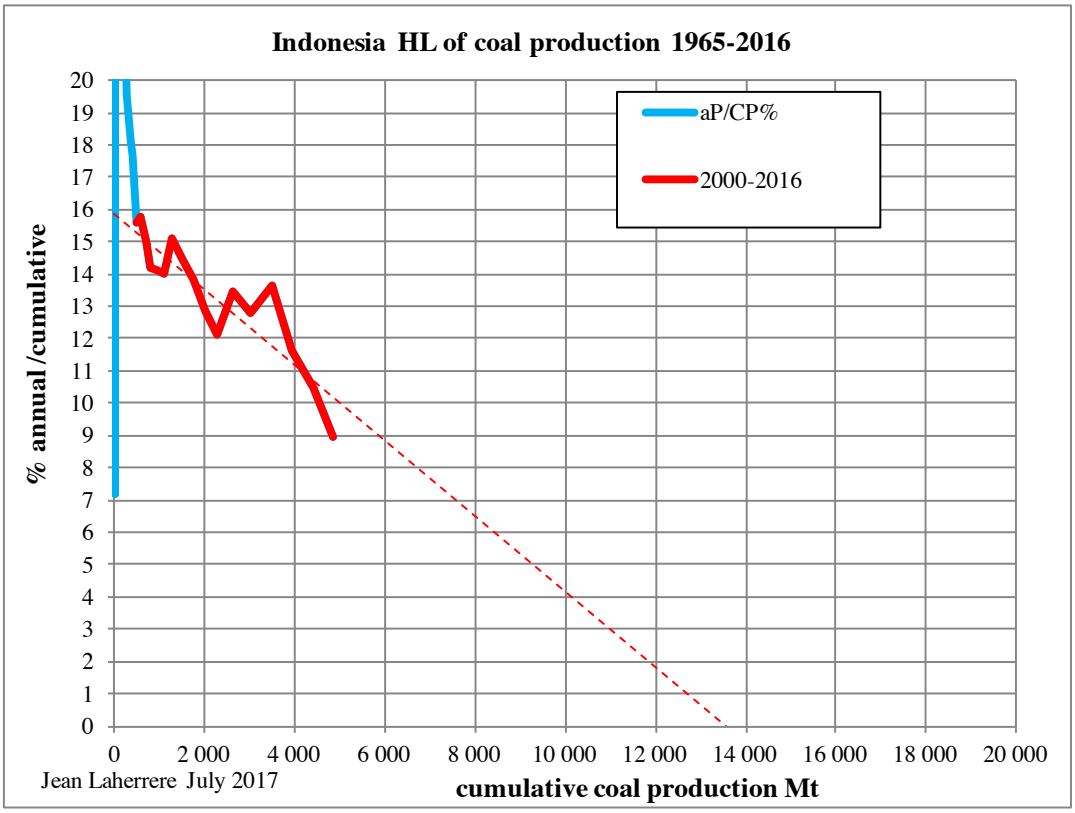
Data reported in tonne differs from data reported in Joule or in toe = tonne oil equivalent (defined as 1 toe = 42 GJ gigajoule)

BGR reports reserves separately for hard coal to lignite (called before brown coal) in Mt (only in 2008 & 2009 in Joules).

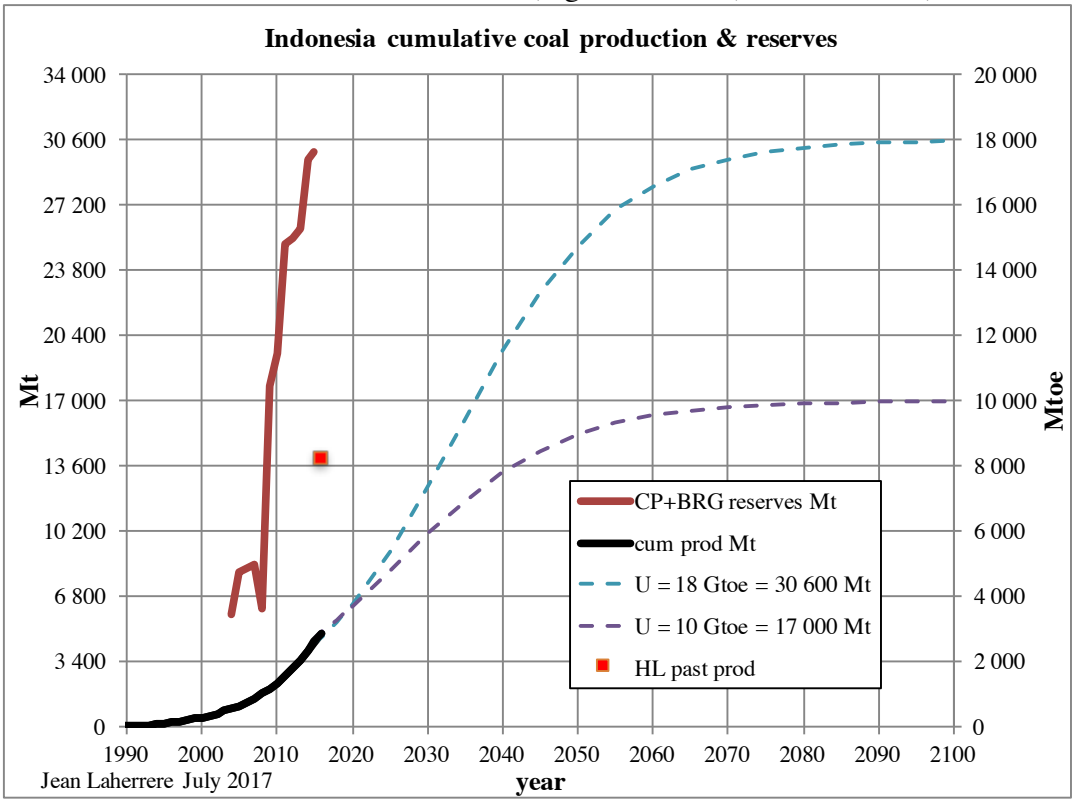


BP reports coal production in Mt and in Mtoe with 1 t = 1.7 toe

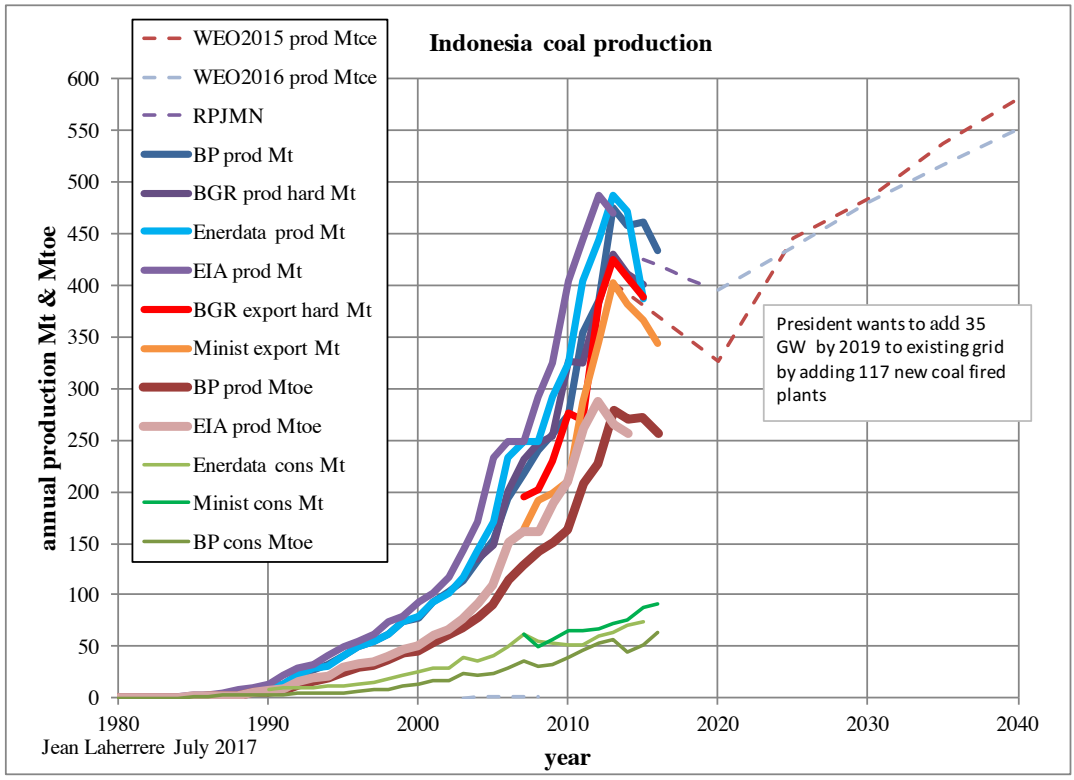
The past production in Mt is extrapolated using the Hubbert linearization trending towards 14 Gt = 8.2 Mtoe



But coal reserves estimates by the BGR were multiplied by 5 from 1988 to 2015.
It is hard to choose between ultimates 10 Gtoe (higher than HL) and 18 Gtoe (= BGR2016)

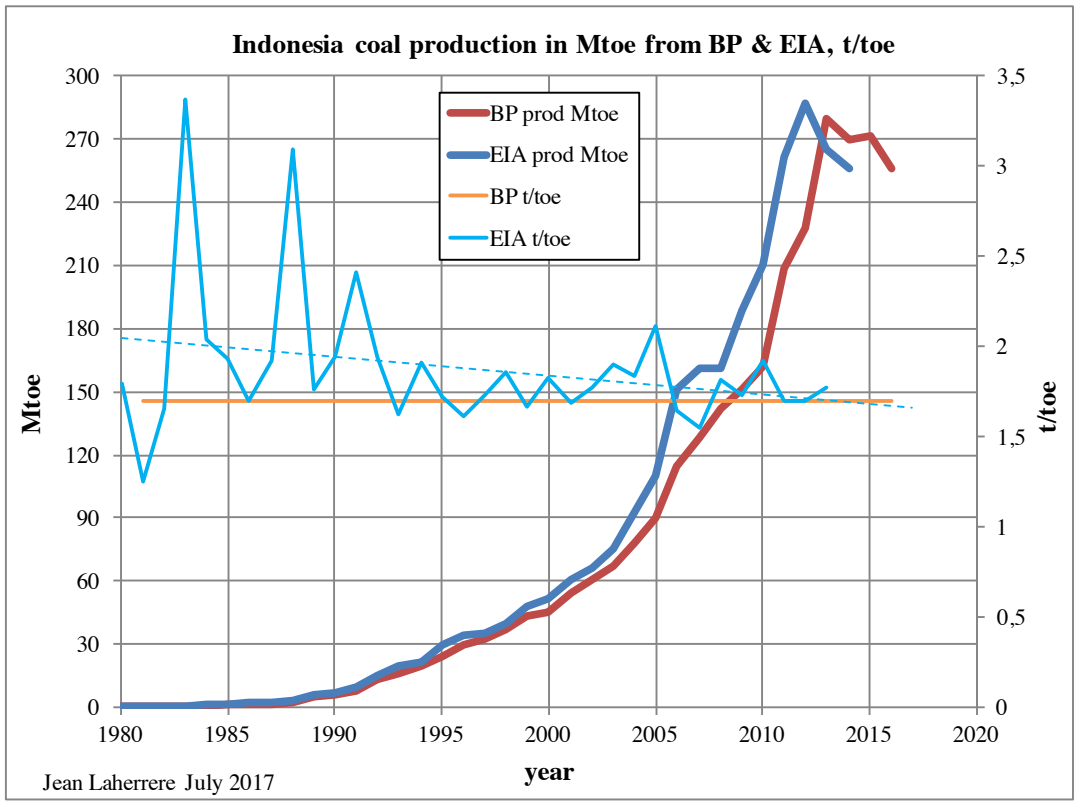


Coal production from different sources (BP, BGR, EIA, Enerdata, Ministry) and different units displays significant discrepancies, likely because the lack of reliable data provided by the government!



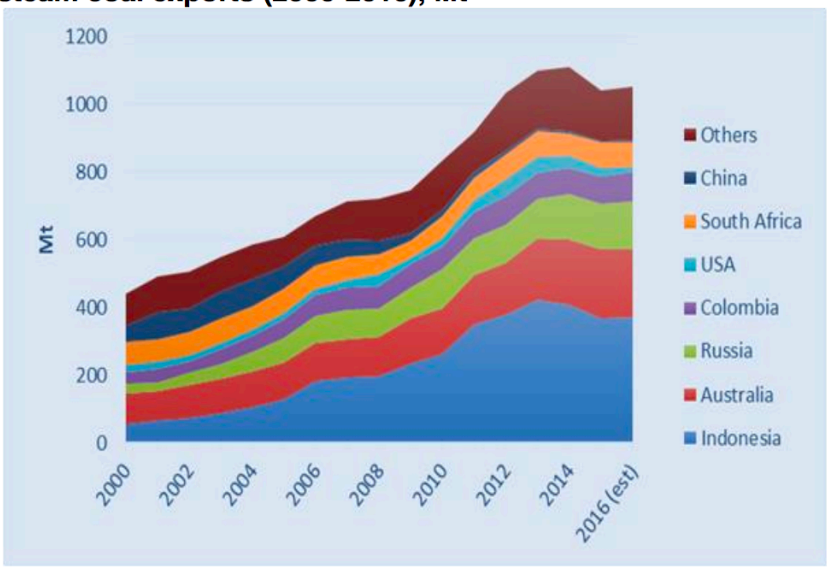
Forecasts by IEA/WEO2015 and RPJMN show a low around 2020 and rise beyond

Because the large range of the heat content of coal, it is important to get the production in energy units, being Mtoe. There are two sources available on the web, being BP and EIA. BP and EIA Mtoe coal production displays a peak in 2012 for EIA and 3013 for BP.
The ratio t/toe is constant for BP at 1.7, when for EIA, it varies widely in the 1980s and less in the 2000s. The truth must be a small variation because new mines should have different heat content.



But it is obvious that Indonesia produces much more than its consumption and is the largest exporter for steam coal as shown by this graph by the Oxford Institute https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/03/Indonesias-Electricity-Demand-and-the-Coal-Sector-Export-or-meet-domestic-demand-CL-5.pdf

Figure 8: Global steam coal exports (2000-2016), Mt



Source: 2000-2015: IEA, 2016 estimated.

Forecasting coal production should be in Mtoe to compare with other fossil fuels.
The below 2016 forecast is done in Mt and foresees a peak around 2025 about 500 Mt, neglecting the past peak of 2013. "Forecasting on Indonesian Coal Production and Future Extraction Cost: A Tool for Formulating Policy on Coal Marketing" 2016 Fadhila Achmadi Rosyid , Tsuyoshi Adachi http://file.scirp.org/pdf/NR_2016120614122390.pdf
They report at end 2013 cumulative production = 3.44 Gt, reserves = 31.4 Gt

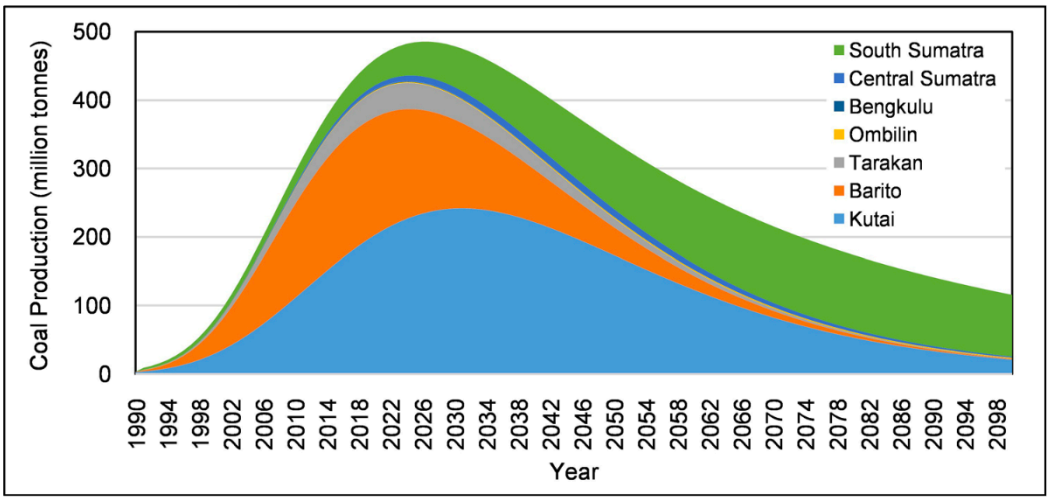
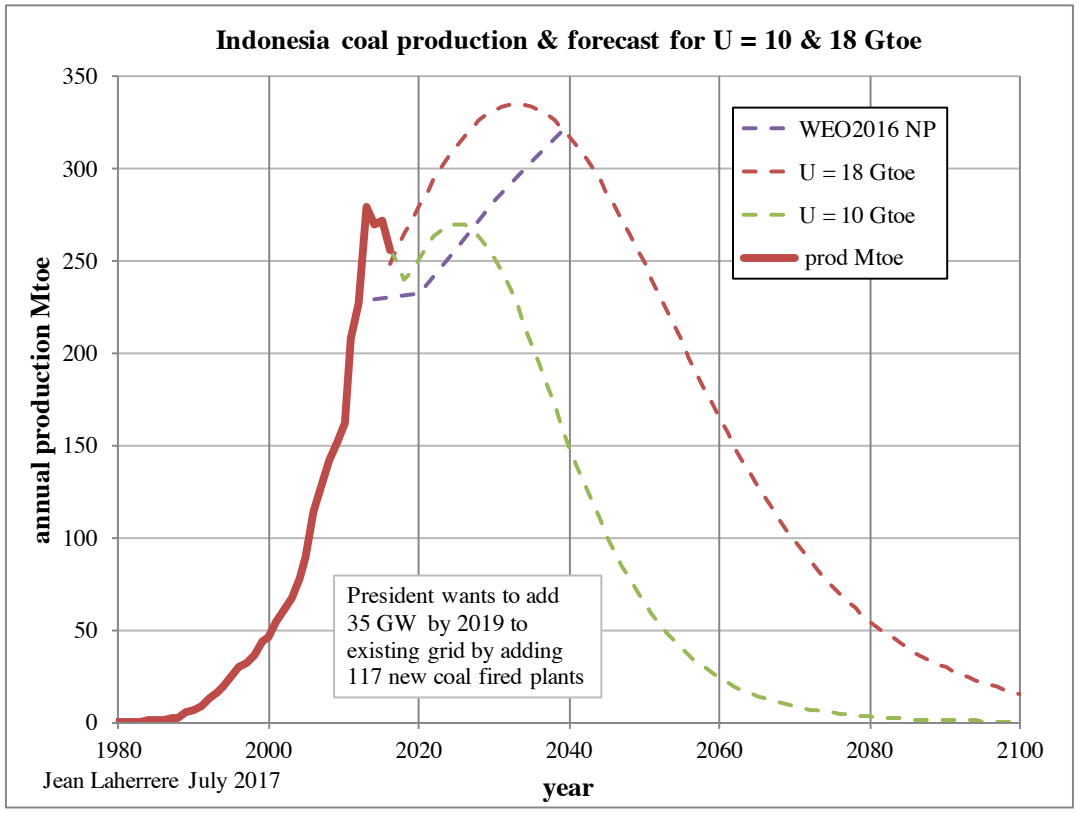


Figure 3. Forecasting of Indonesian coal production to 2100.

Because the large uncertainty on coal ultimate, Indonesia coal production is modelled with two ultimates of 10 and 18 Gtoe



The range is huge for the forecast of coal production in 2040: 150 Mtoe or over 300 Mtoe (250-500 Mt). IEA/WEO2016NP forecasts 320 Mtoe
The President Widodo wants to add 35 GW by 2019 to existing grid with 117 new coal fired plants
The article Indonesia-Investments dated 18 July 2017 "Coal mining in Indonesia: can authorities limit coal output" https://www.indonesia-investments.com/news/todays-headlines/coal-mining-in-indonesia-can-authorities-limit-coal-output/item7994

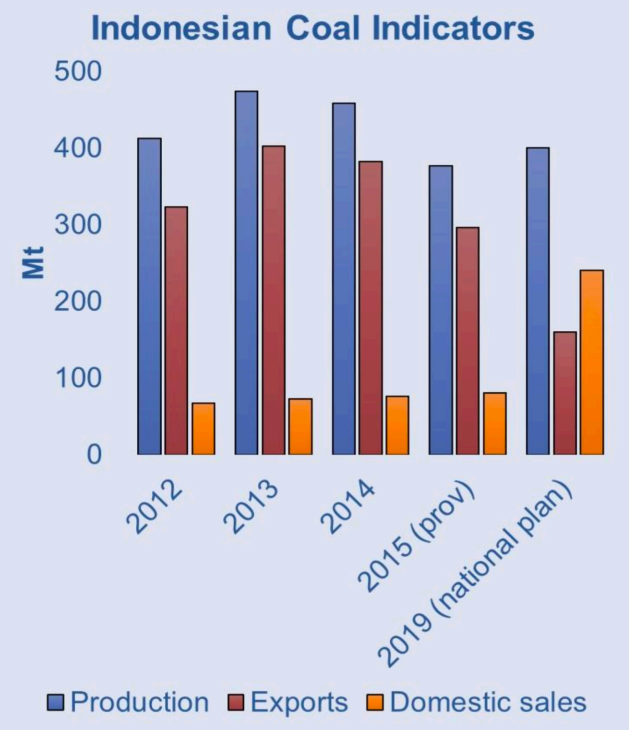
Indonesian Production, Export, Consumption & Price of Coal:

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Production (in mln tons)	217	240	254	275	353	412	474	458	461	434
Export (in mln tons)	163	191	198	210	287	345	402	382	366	343
Domestic (in mln tons)	61	49	56	65	66	67	72	76	87	91
Price (HBA) (in USD/ton)	n.a	n.a	70.7	91.7	118.4	95.5	82.9	72.6	60.1	61.8

Sources: Indonesian Coal Mining Association (APBI) & Ministry of Energy and Mineral Resources

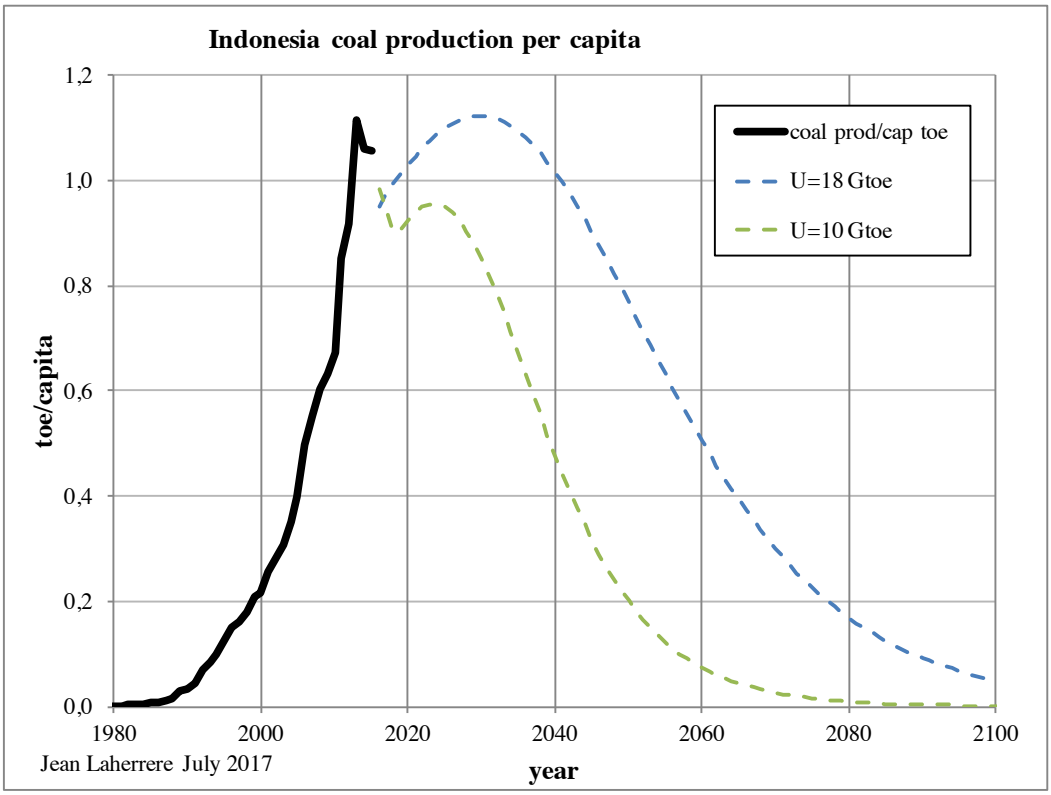
In the National Medium-Term Development Plan (*Rencana Pembangunan Jangka Menengah Nasional*, or RPJMN) the Indonesian government sets a 413 million metric tons of coal production target for 2017. However, based on estimates of stakeholders in the coal sector, the actual figure may nearly touch 478 million tons. And this figure does not even include illegal coal shipments. Lastly, it all depends on the coal price.

The next EIA graph displays the coal indicators for 2019 with increase of production and consumption and decrease of export.
https://www.eia.gov/conference/2016/pdf/presentations/gandolphe.pdf



Source: Ministry of Energy & Mineral Resources, 2015

Indonesia coal production per capita has peaked in 2013 and will peak again between 2025 and 2030.



-**poverty and inequality**

Poverty in % of the population is an interesting parameter to study, but there are different definition of such % and it is difficult to find reliable homogeneous historical series

For Indonesia.investments site, poverty has declined in Indonesia since 2008 but levelling.

https://www.indonesia-investments.com/news/todays-headlines/poverty-in-indonesia-absolute-poverty-up-relative-poverty-down/item7995

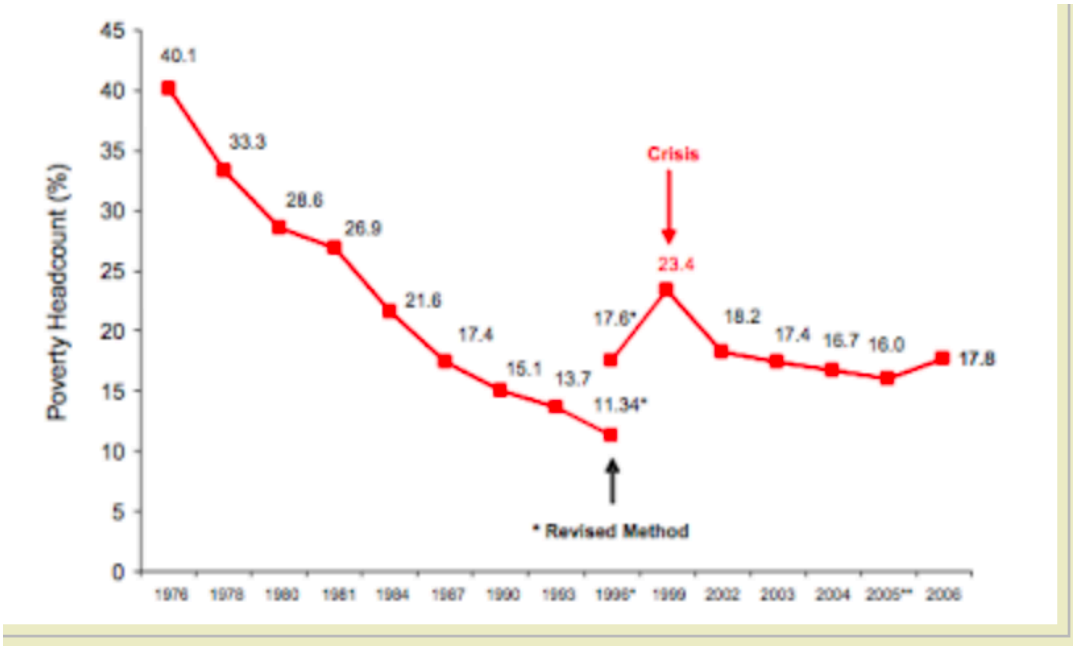
Indonesian Poverty & Inequality Statistics:

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Relative Poverty (% of population)	15.4	14.2	13.3	12.5	11.7	11.5	11.0	11.2	10.7	10.6[1]
Absolute Poverty (in millions)	35.0	32.5	31.0	30.0	28.7	28.6	27.7	28.5	27.8	27.8[1]
Gini Coefficient/ Gini Ratio	0.35	0.37	0.38	0.41	0.41	0.41	0.41	0.41	0.40	

[1] In March 2017

Source: Statistics Indonesia (BPS)

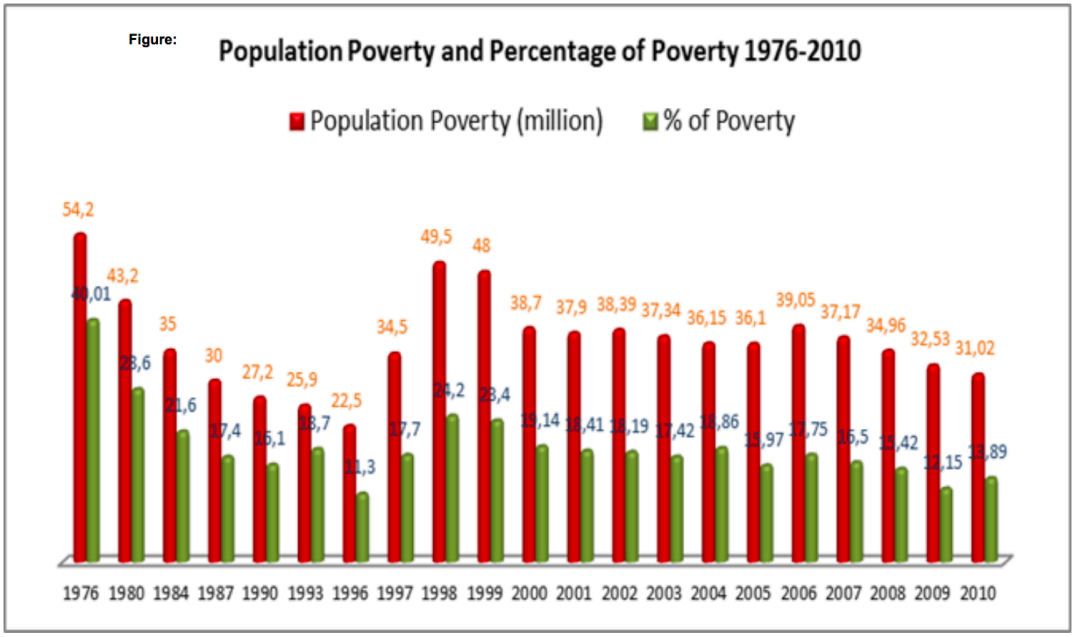
But searching on Internet, it appears that the method was revised in 1996 and that the previous data was different http://whizkidz27.blogspot.fr/2008/10/poverty-and-inequality-in-indonesia.html



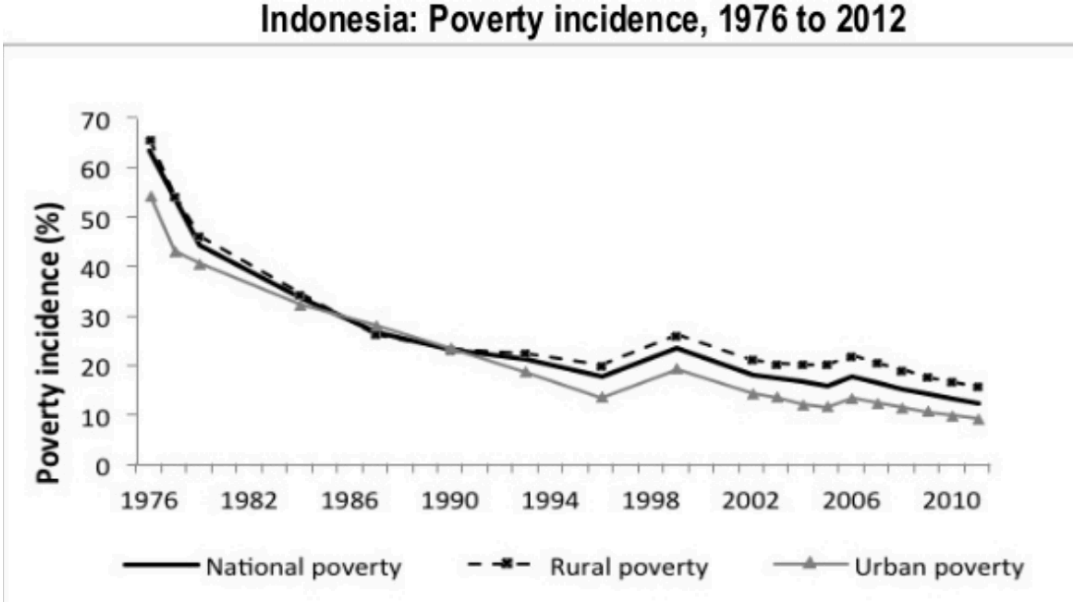
S.Subanidja displays poverty % on the period 1976-2010 without telling that the method has changed in 1997!

It is always good to search for different papers and not to stop when finding one, because very often sources differ. The truth is hard to find and most of the time only a wild range of uncertainty!

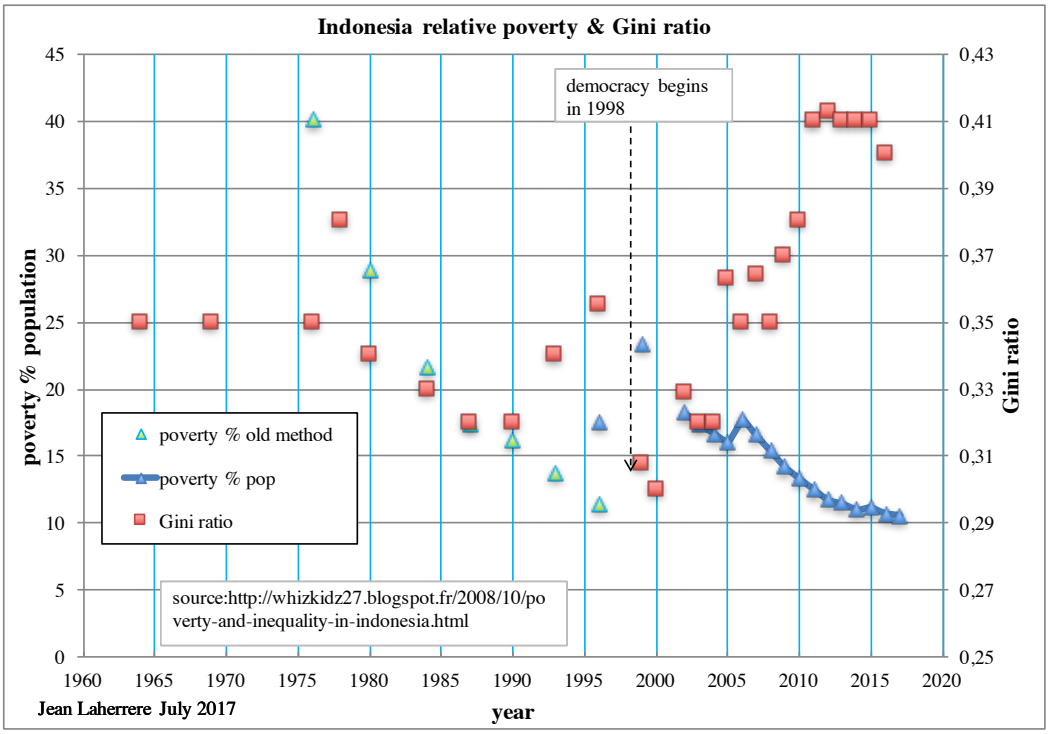
Figure:



The site by P.Warr 2015 reports also different data where poverty starts at 65% in 1976 against 40% for the two previous ones: https://www.slideshare.net/gcard/agricultural-research-raises-productivity-and-reduces-rural-poverty-emperical-evidence-from-indonesia-and-thailand



The plot of poverty %, as the Gini ratio, gathers most data and displays drastic changes.
The interpretation of such graph is difficult because the heterogeneous data.
Democracy begins in 1998 when Gini was the lowest = more equality!
Gini ratio measures the inequality of income, with 0 being perfect equality and 1 being perfect inequality

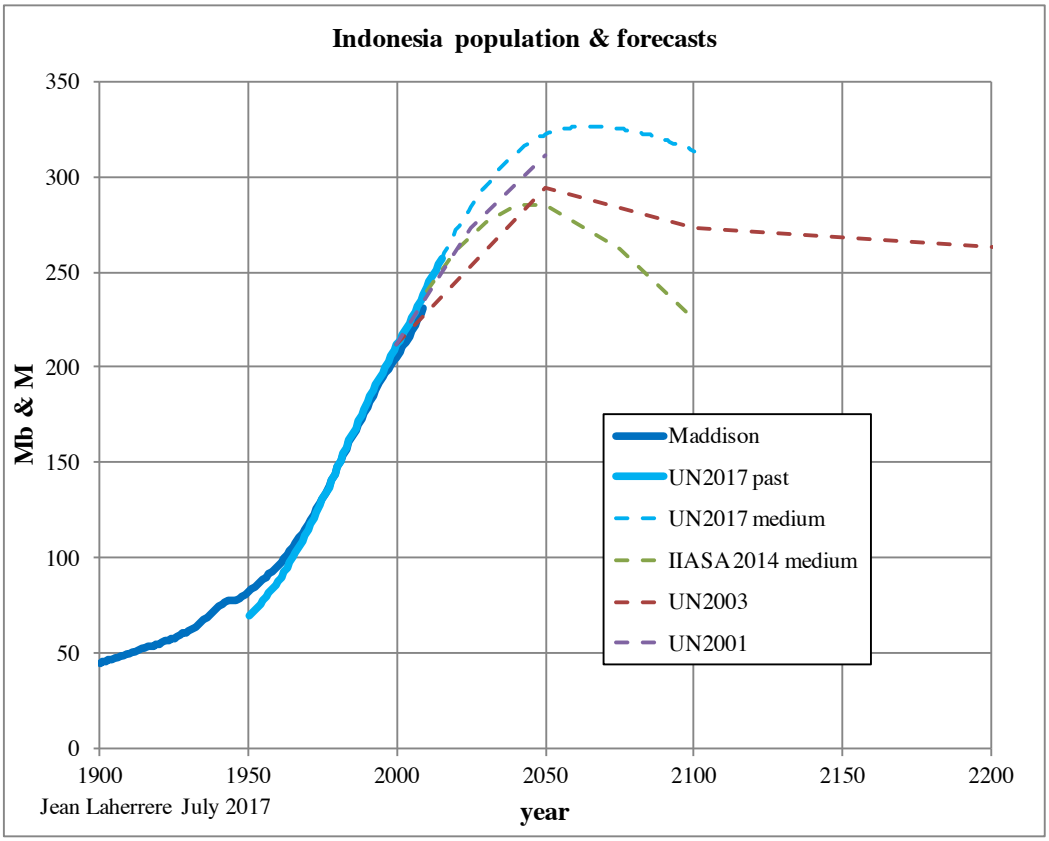


Inequality has increased from 1999 to 2011, in contrary with poverty!
Today little change on both parameters!

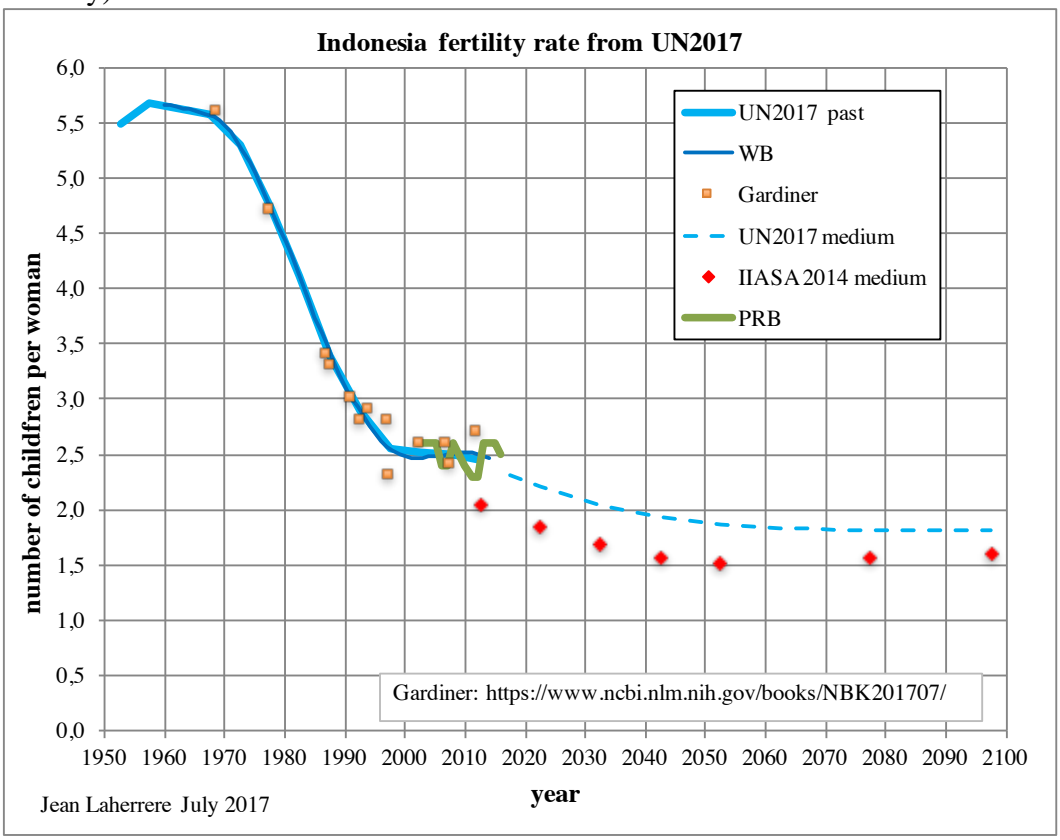
Indonesia has done well on poverty, but should continue to reduce poverty and mostly inequality.

-**population & fertility rate**

Indonesia population is plotted with UN 2017 & Maddison past and forecast for medium fertility, as the forecast for UN 2001, UN 2003 (going to 2300) and IAASA 2014
The discrepancy for 2100 between UN and IIASA is about 100 M, showing a large uncertainty.
Maddison reports 83 M in 1950 against 70 M for UN
UN2017 displays a peak around 2065 at 326 M, compared to 260 M in 2016.

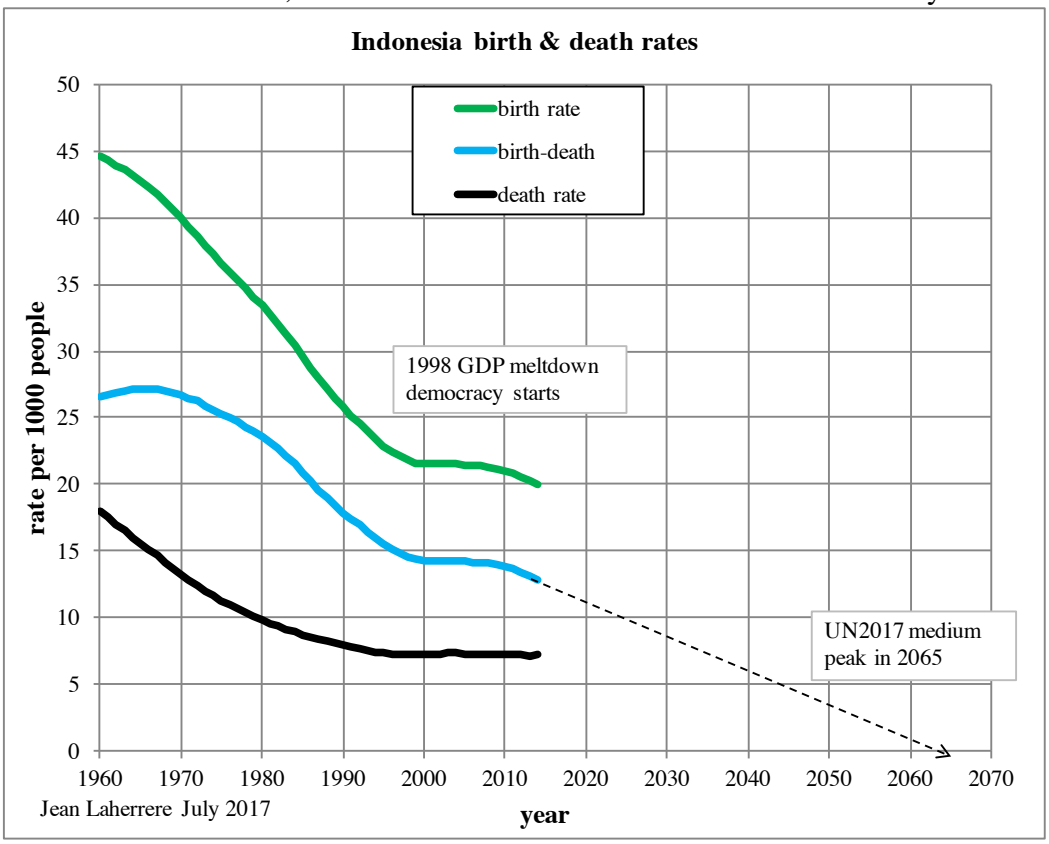


UN population forecasts are based on fertility rate scenario.
Indonesia fertility rate dropped in 1970 from 5.5 children per woman to 2.5 around 2000 (start of democracy).



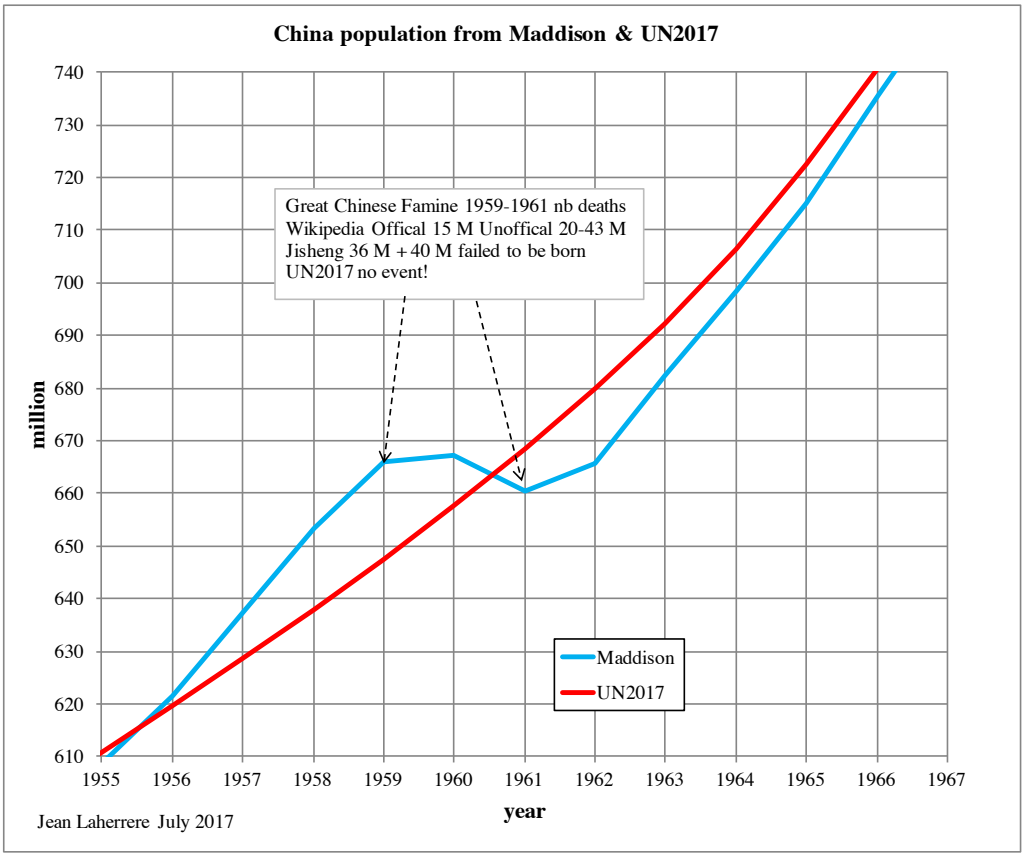
Since 2000 fertility rate oscillates around 2.5 as shown by the data from Gardiner and PRB (US Population Reference Bureau). The UN2017 decline in the medium scenario going from 2.5 to 2 in 2035 is not in line in the last data from PRB!
IIASA 2014 medium forecast looks also much too low.
It appears that UN2017 medium fertility scenario seems too low and that the population forecast in 2050 could be too low.

If fertility rate is hard to measure, being the number of children that a woman can bear during her life, the birth rate is easier being the number of births for a year for 1000 people.
Indonesia birth rate (green curve from World Bank 1960-2014), after an important decline since 1960, is flat for the period 1999-2010 with a small decline beyond
Death rate (dark curve)is flat since 1990
The difference birth less death (blue curve) after a flat step 2000-2010 is slowly declining towards a zero around 2065, which is the UN2017 forecast for medium fertility

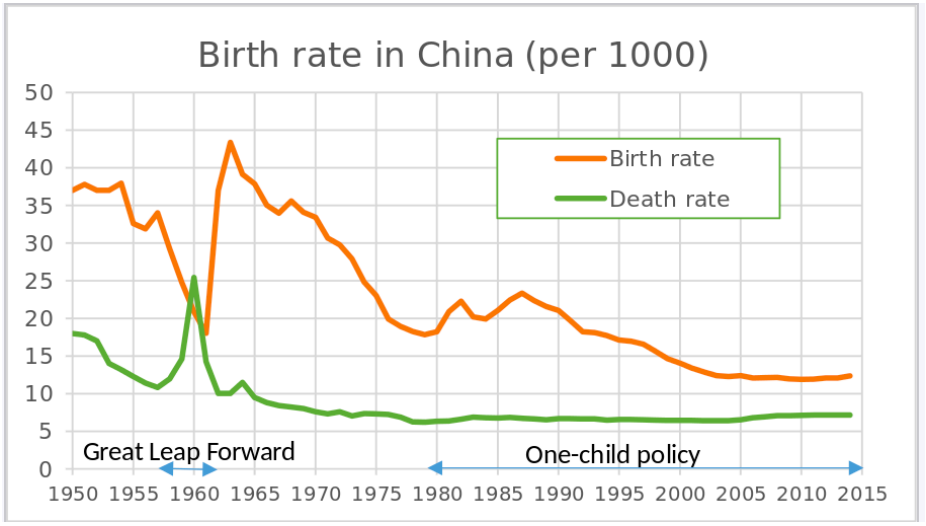


Indonesia displays a sustainable population behavior.

Indonesia population growth (M) is plotted with GDP $2010 growth rate (%).
The 1965 tragedy (against the communists reported by Wikipedia with a range of 0.3 to 3 M deaths) is not shown on UN population data.
The UN are politically correct: the Great Chinese Famine is not shown on UN data, when shown on Maddison China data
China population from UN2017 and Maddison 1955-1967 is very clear on UN stand to erase bad events as this “Great Leap forward”!

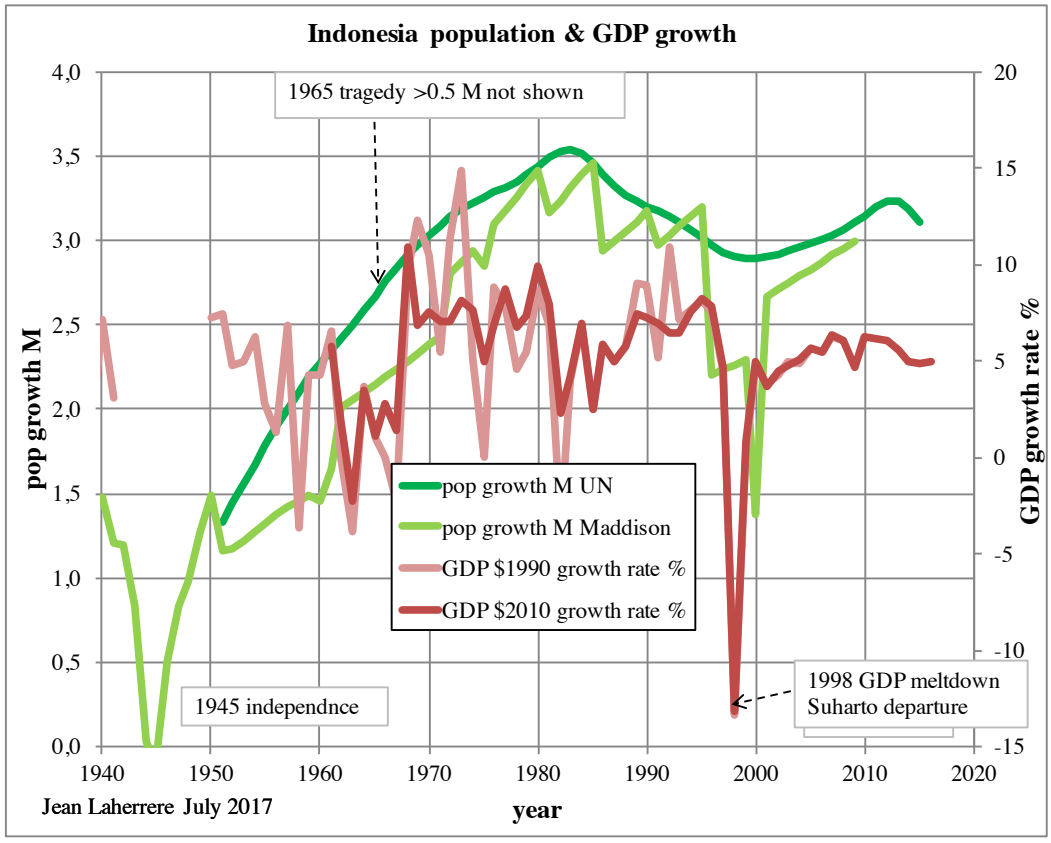


Wikipedia shows it well on birth and death rate

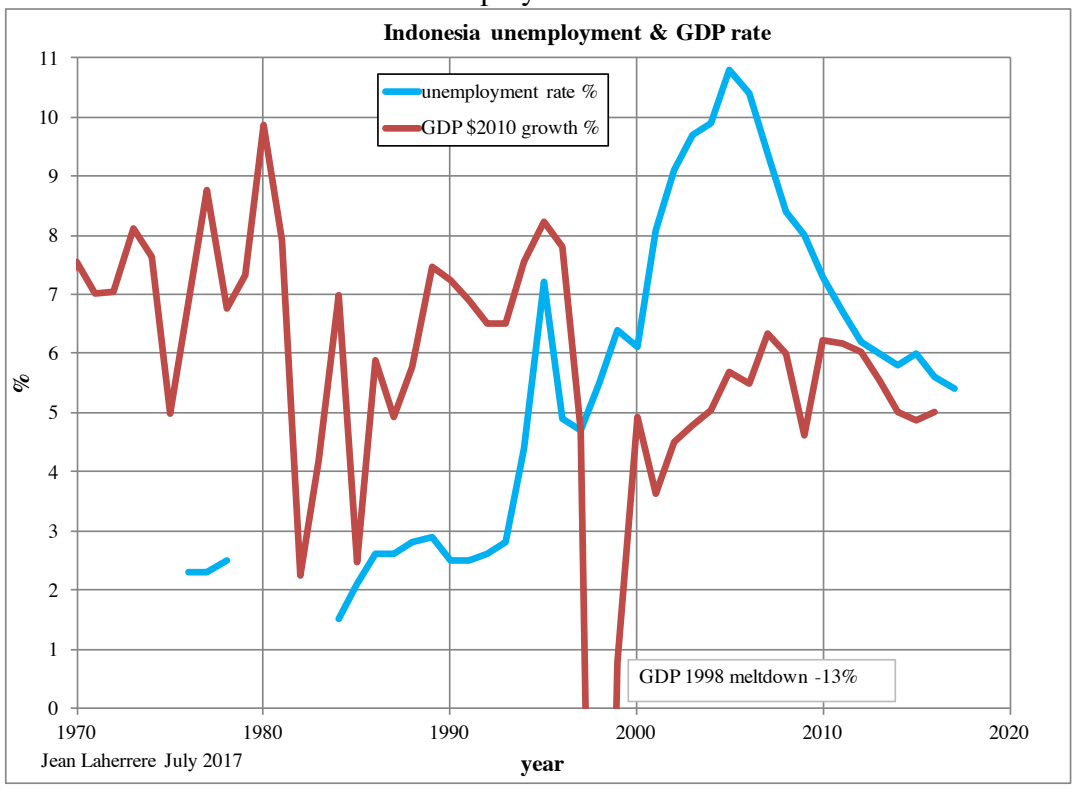


But Indonesia 1965 Tragedy is neither on Maddison data, when the loss (Dutchmen departure) with Indonesia independence is shown in 1945.

But the 1998 GDP meltdown (-13%) corresponding to the departure of Suharto and following the Asia 1997 economic crisis correlates with an increase of population growth following the decline after the peak of 1982 and a low in 1999 (stop of fertility rate decline as shown in the birth rate of the graph above).
Maddison population growth is lower than UN population growth because for 1950 Maddison value is 83 M against 70 M for UN.
Maddison GDP $1990 growth rate agrees very often with WB GDP $210 growth rate.



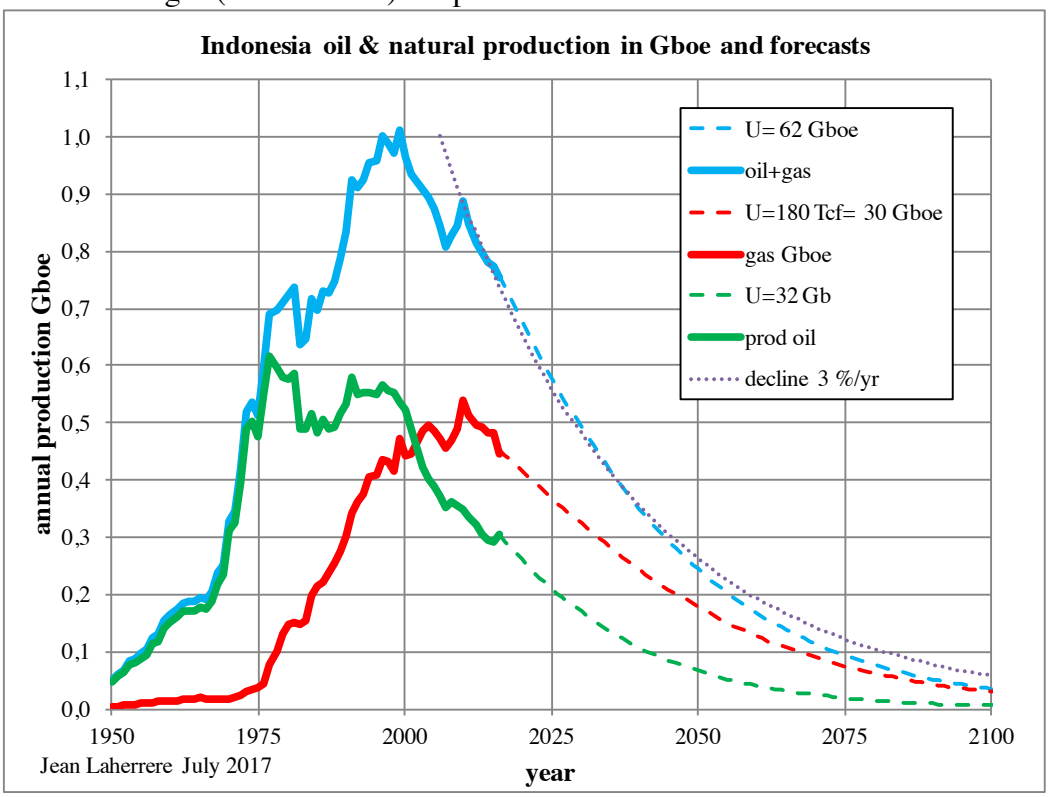
Indonesia unemployment has declined since 2005 at 11% down to 5.4 % in 2017 (1st Q)
The big question is if this strong decline in unemployment will continue?
The GDP 1998 meltdown follows an unemployment low of 1997



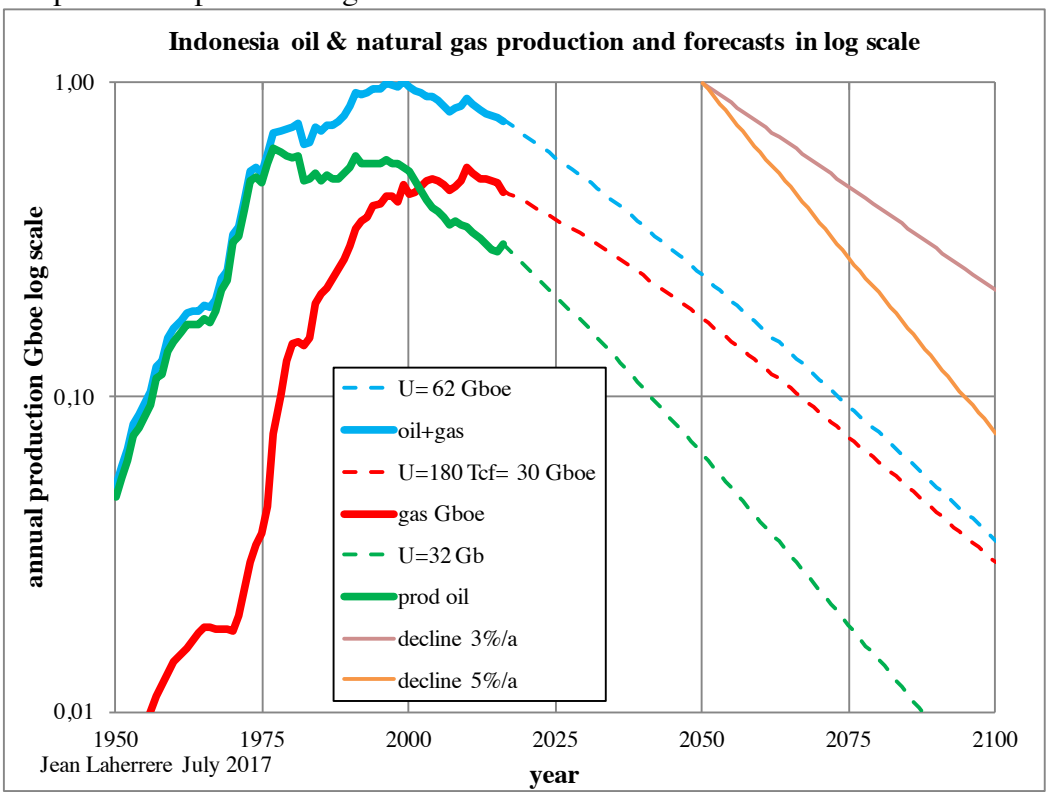
-fossil fuels (FF) and other fuels

-oil and gas production in volume

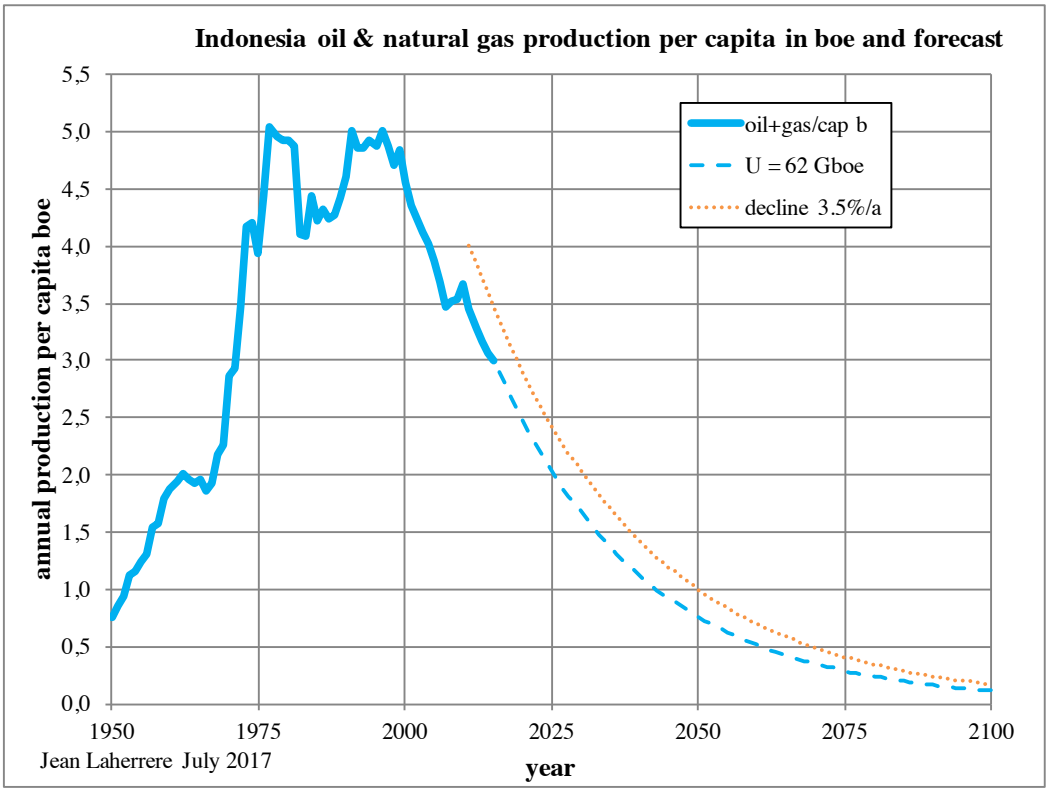
Oil and natural gas being liquid and gaseous could be measured in volume (b, m3 or cf)
The plot in Gboe shows a bumpy plateau from 1975 to 2000 for oil and a peak in 2011 for gas. Their future production is obviously decline, despite few steps or bumps.
Combined oil and gas (1boe = 6 kcf) the peak is in 1999 and the decline since 2010 is 3%/yr



Combined oil and gas (1boe = 6 kcf) production has peaked in 1999 and the decline is better to be compared on a plot with log scale



The oil +natural gas production per capita has peaked during the period 1977-1996 and the decline is sharp (about 3.5 % per year), but less than the rise before 1976.

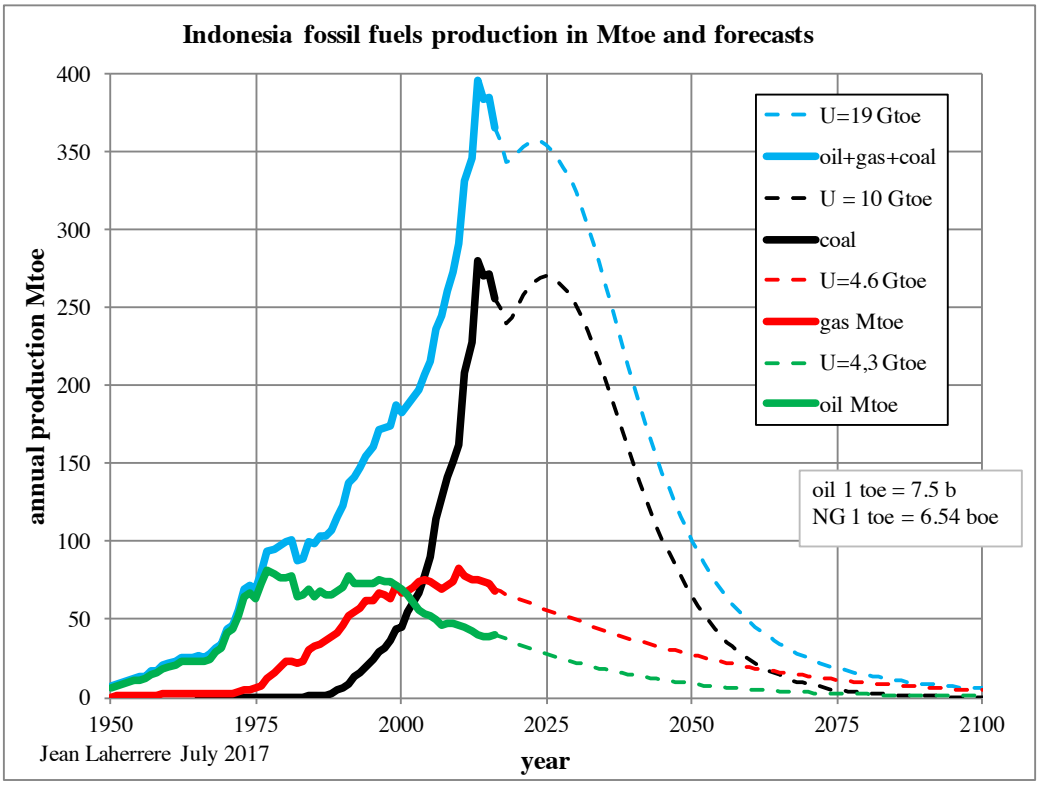


-fossil fuels production and consumption in Mtoe

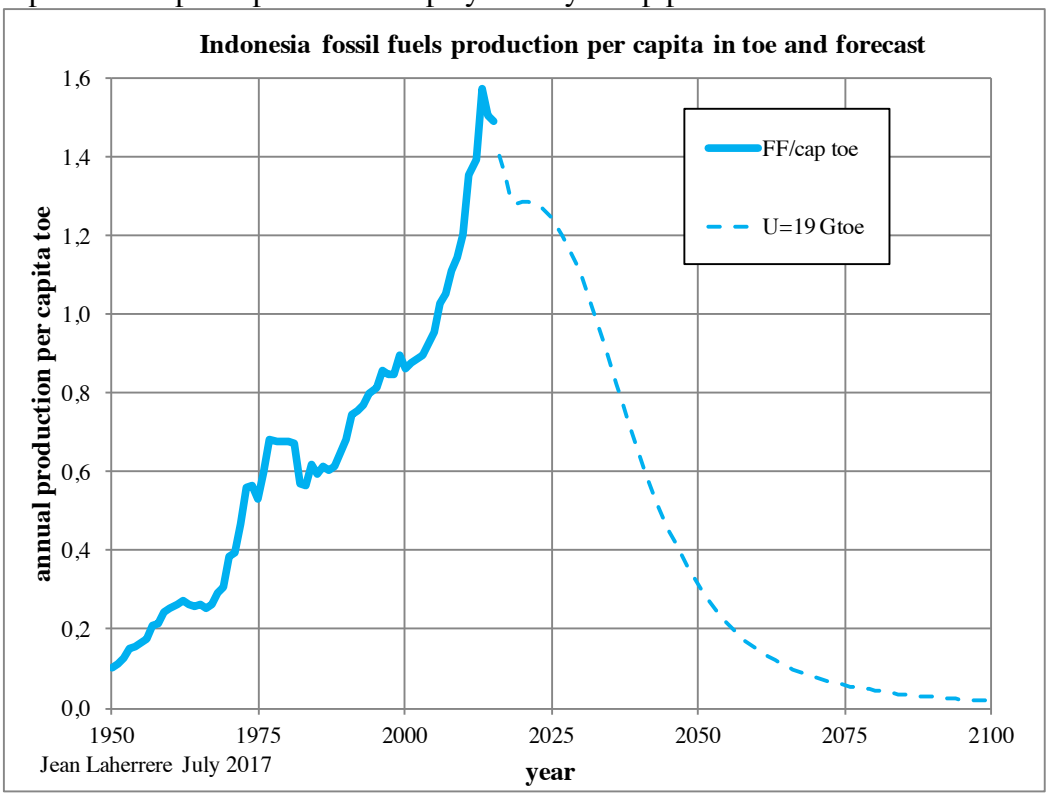
To aggregate oil, gas and coal (liquid, gas and solid), each item has to be measured in energy (unit being the Joule or the tonne oil equivalent with 1 toe = 42 GJ)

The above studies for oil and gas productions are in volume and the heat content leads for oil at 1 toe =7.5 boe and for natural gas at 1 toe = 6.54 boe

The conversion in toe of oil and NG production and the addition of coal in toe leads to the next graph where the importance of coal is obvious and will prevail in the future..



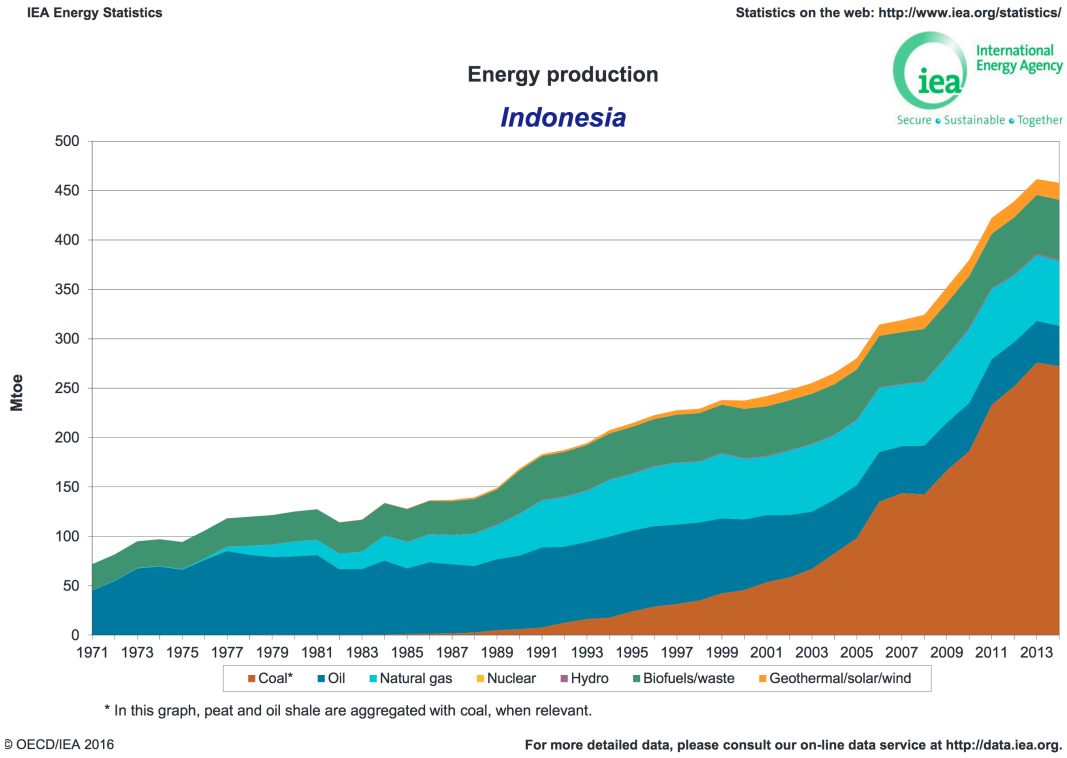
The FF production per capita in toe displays a very sharp peak in 2013



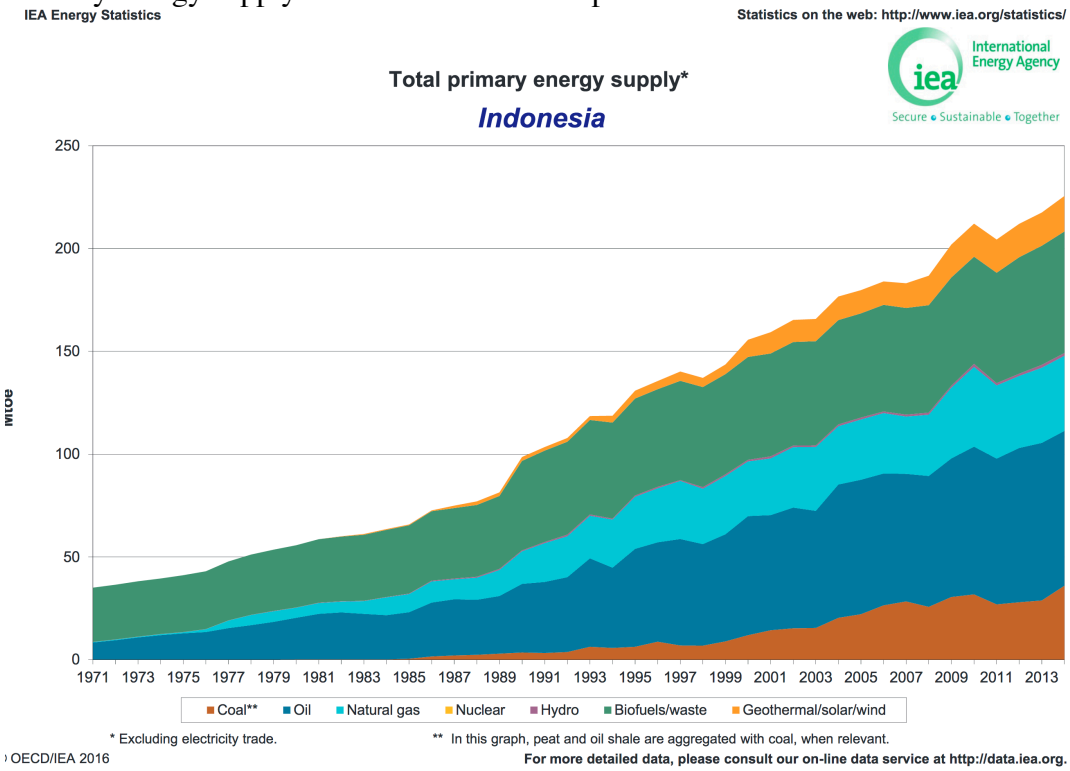
IEA displays graphs of energy production and primary energy supply for Indonesia in Mtoe, but the data stops in 2014, missing the sharp decline of coal in 2016!

http://www.iea.org/stats/WebGraphs/INDONESIA3.pdf

The importance of coal is obvious in production and looks minor in consumption, compared to oil and biofuels/waste.

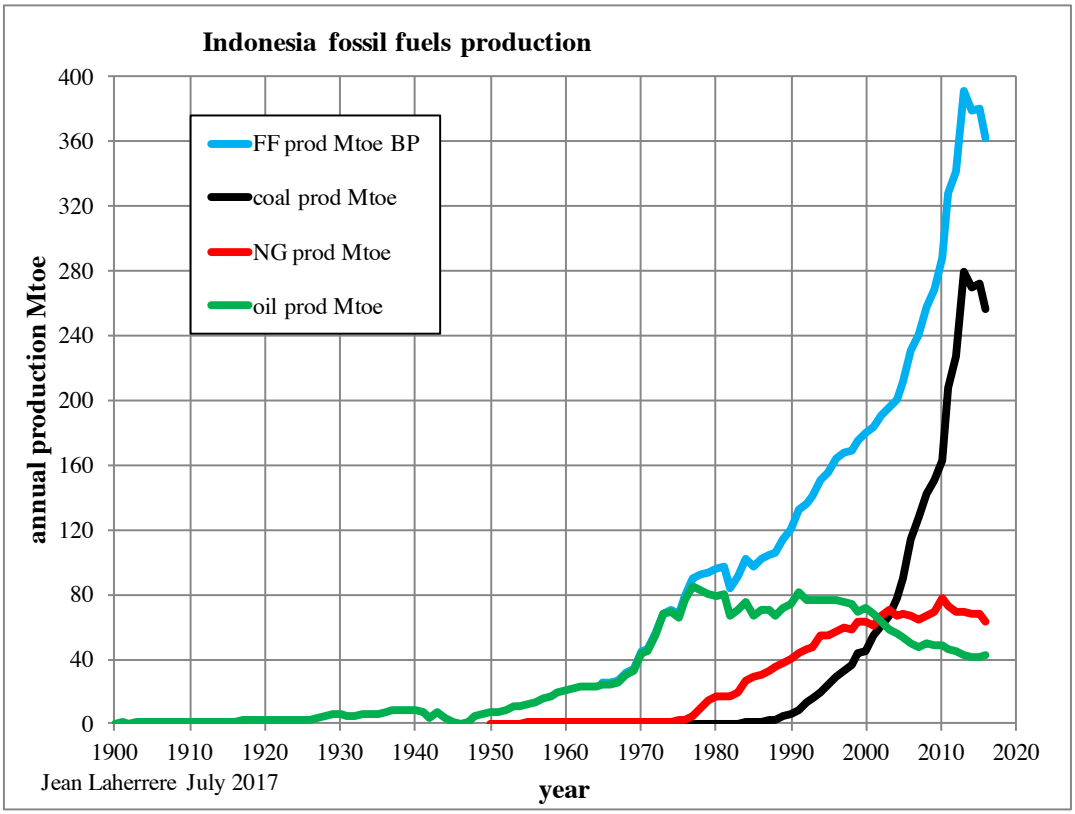


Primary energy supply means in fact consumption

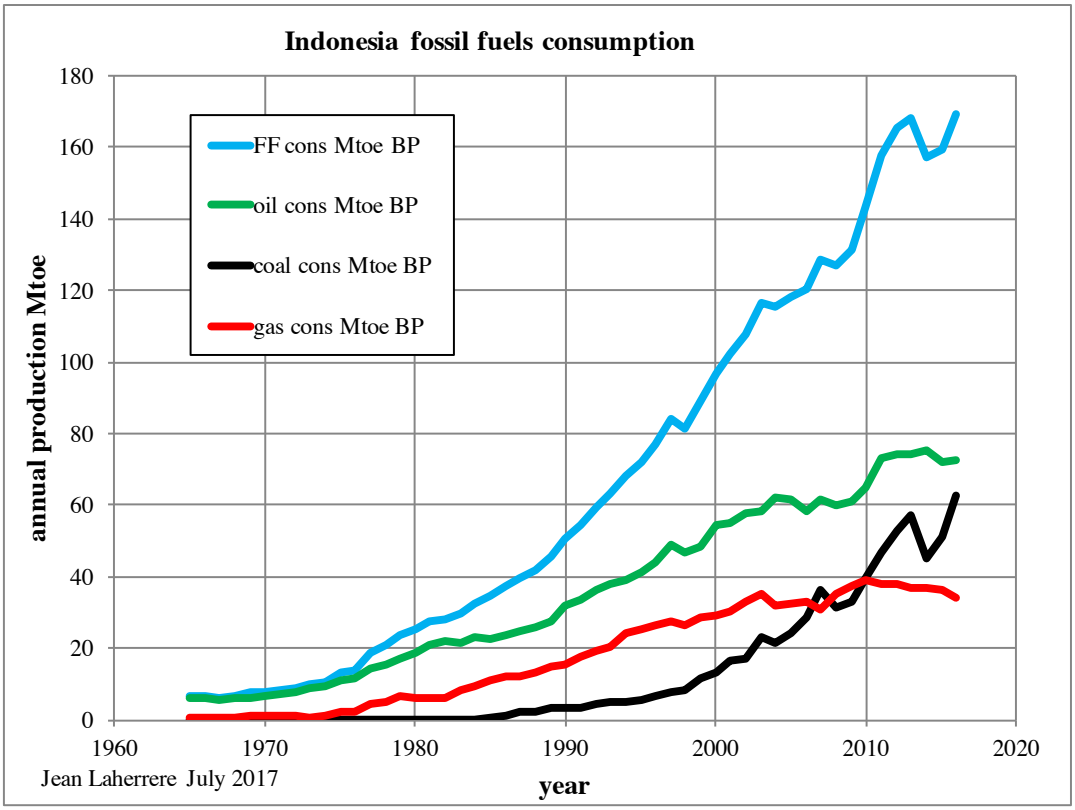


Looking at both graphs it is obvious that Indonesia exports coal and imports oil

Same graphs of FF production & consumption in Mtoe updated to 2016.



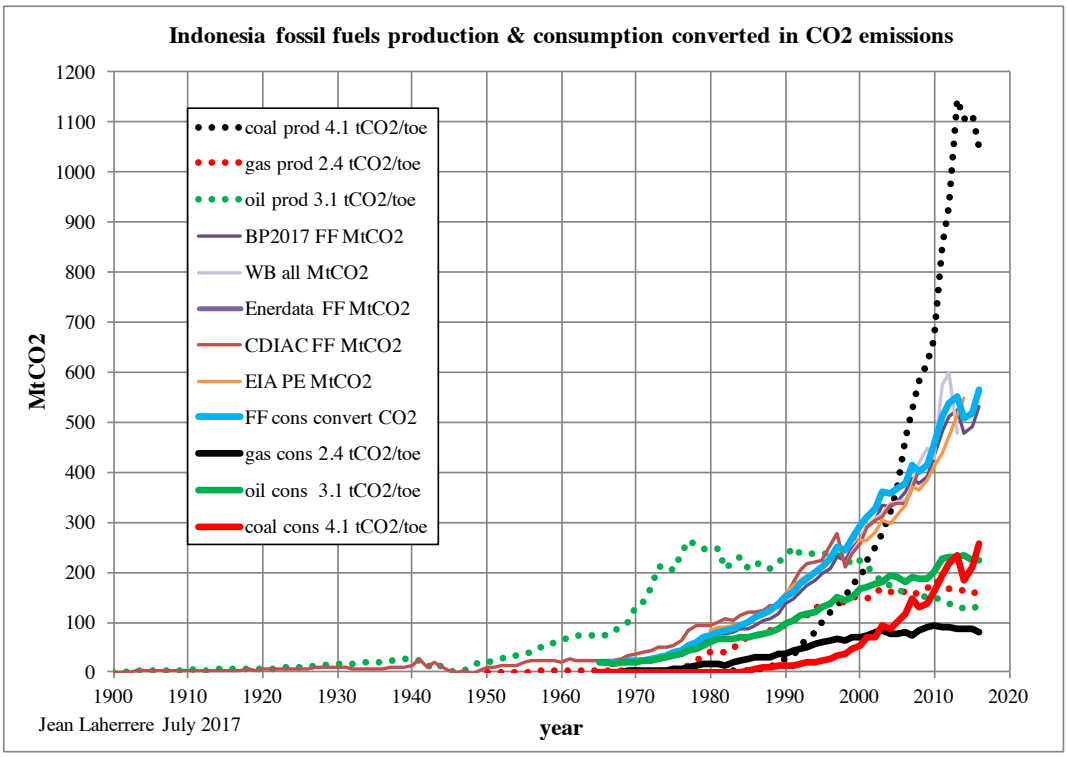
FF consumption has an exponential rise from 1970 to 2012, but is presently on a bumpy plateau



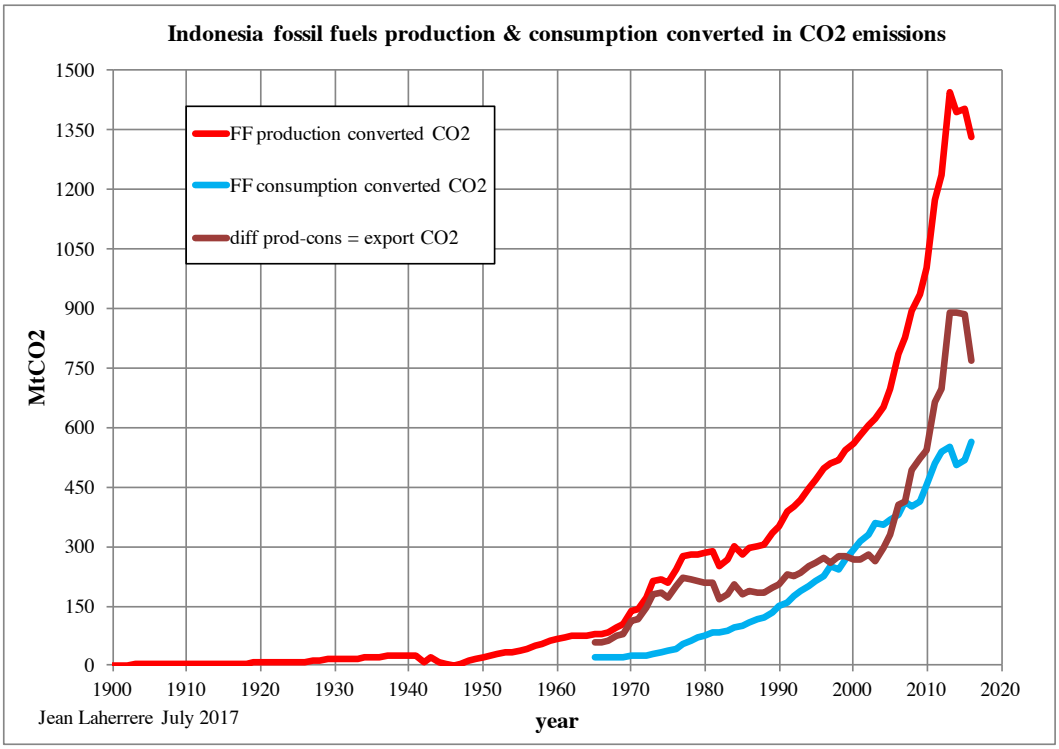
It is impossible to get the energy consumption before 1965.
Former sites as EIA/DOE-0219 International Energy Annual do not exist anymore.
In 2011 EIA has cut budgets of collecting data: it is a shame!

-fossil fuels CO2 emissions

Fossil fuels production and consumption in Mtoe are converted into CO2 emissions using the world ratio of tCO2 per toe of 2.2 for NG, 3.1 for oil and 4.1 for coal
The conversion of FF production in CO2 emissions is compared to the FF consumption converted in CO2 which fits well with the reported FF CO2 emissions by BP, WB Enerdata and EIA



Indonesia FF production converted in CO2 is by far higher than the FF consumption converted in CO2.
Indonesia has exported FF in 2014 representing about 900 MtCO2 when its FF consumption was about 500 MtCO2



-COP 21 INDC for Indonesia

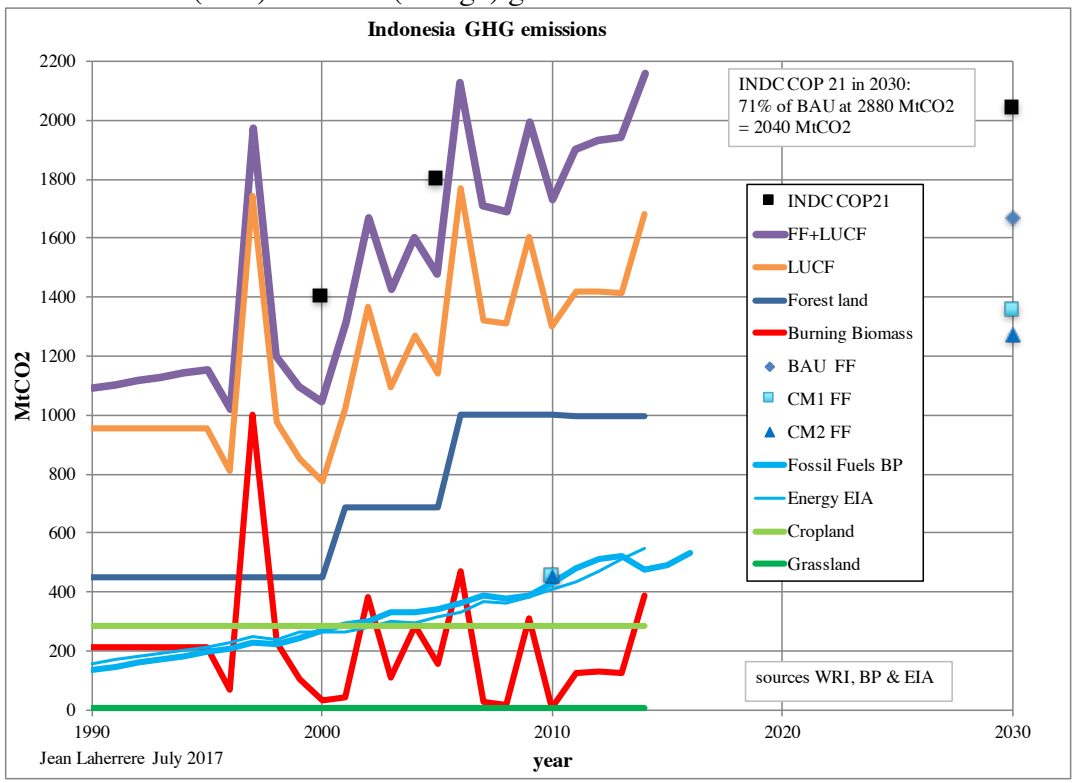
Indonesia's **Intended Nationally Determined Contribution** (INDC), released on 24 September 2015, includes an unconditional 2030 GHG emissions reduction target (including land-use, land-use change and forestry (LULUCF) emissions) of 29% below business-as-usual (BAU) and a conditional 41% reduction below BAU by 2030 (with sufficient international support). Indonesia had earlier already pledged a 26% reduction below BAU by 2020. These targets include deforestation emissions due to deforestation and peat land destruction, which account for the largest source of Indonesia's emissions, an average of 60% of total emissions over the last ten years (based on the national inventory). Recent data show no signs of deforestation slowing down.

http://www4.unfccc.int/submissions/INDC/Published%20Documents/Indonesia/1/INDC_REPUBLIC%20OF%20INDONESIA.pdf

According to Indonesia's Second National Communication of 2010, national greenhouse gas (GHG) emissions were estimated to be 1,800 $MtCO_2e$ in 2005. This represents an increase of 400 $MtCO_2e$ compared to 2000. Most emissions (63%) are the result of land use change and peat and forest fires, with combustion of fossil fuels contributing approximately 19% of total emissions. It is important to note that fossil energy resource extraction also contributes to land

As stated earlier, Indonesia is committed to reducing emissions by 29% compared to the business as usual (BAU) scenario by 2030, as a fair reduction target scenario based on the country's most recent assessment of the 2010's National Action Plan on GHG Reduction. The BAU scenario is projected approximately 2.881 $GtCO_2e$ in 2030.

Indonesia INDC past data = in 2000 1.4 GtCO2, in 2005 1.8 GtCO2
and in 2030 INDC = 2.88*0.71 GtCO2 = 2.04 GtCO2
The plot of FF CO2 (blue) + LUCF (orange) gives an emission in 2016 about 2.1 GtCO2



The past (red) "burning biomass" is the most chaotic and fires are difficult to control and to forecast. 1997 peat fire was the worst for the period 1990-2014, but despite being illegal, clearing peat land by fire is widespread and 2015 peat fire was again as nearly bad (2015 peat fires emissions in Indonesia exceeded those of the US economy)!

In fact peat fires are connected with El Nino (ENSO) (as IOD = Indian Ocean Dipole)
"Precipitation-fire linkages in Indonesia (1997–2015)" October 2016 Thierry Fanin Guido van der Werf https://www.researchgate.net/publication/310820892_Precipitation-fire_linkages_in_Indonesia_1997-2015

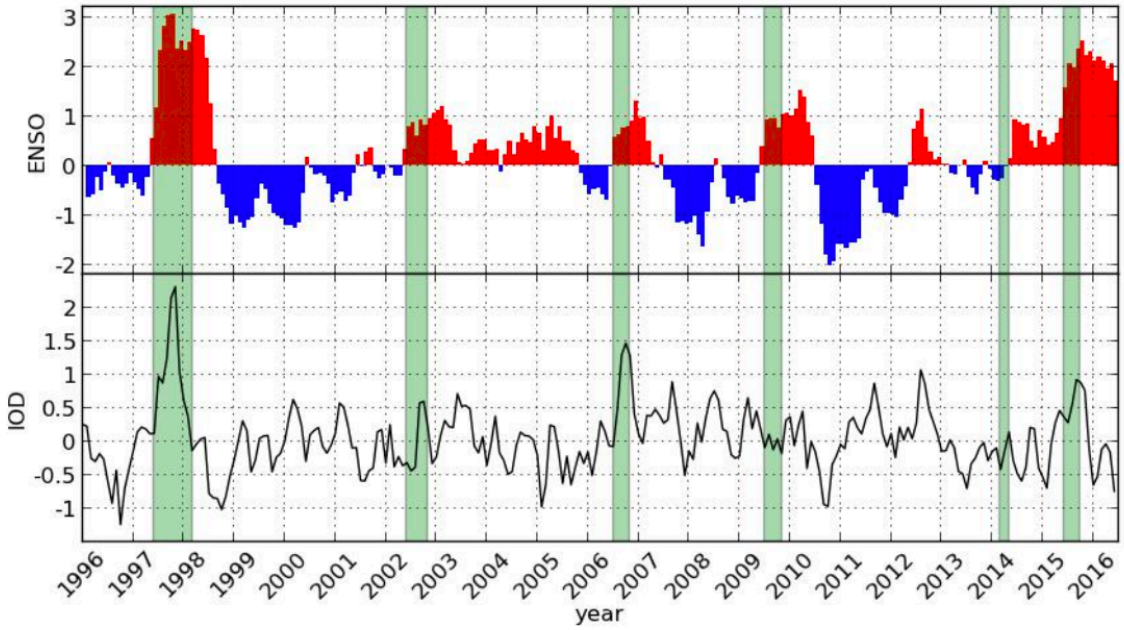


Figure 9: ENSO and IOD with periods of strongest fire activity in green.

There is no way to control El Nino (not connected with CO2), even to forecast it.

Indonesia INDC in 2030 of 2.04 GtCO2 means a small decrease compared to 2016.
INDC are for consumption and not for production, it means that Indonesia can export coal as much as she wants.
The trend of FF is flat since 2013, if LUCF returns to the value of 2010 it should be easy.
The so called BAU (Business as usual) is a scenario not in line with past data. It is a crockery to take it as reference!
It is the same for the counter measures CM1 (unconditional) and CM2 (conditional): CM1 and CM2 are not in line for energy
http://www4.unfccc.int/ndcregistry/PublishedDocuments/Indonesia First/First NDC Indonesia_submitted to UNFCCC Set_November 2016.pdf

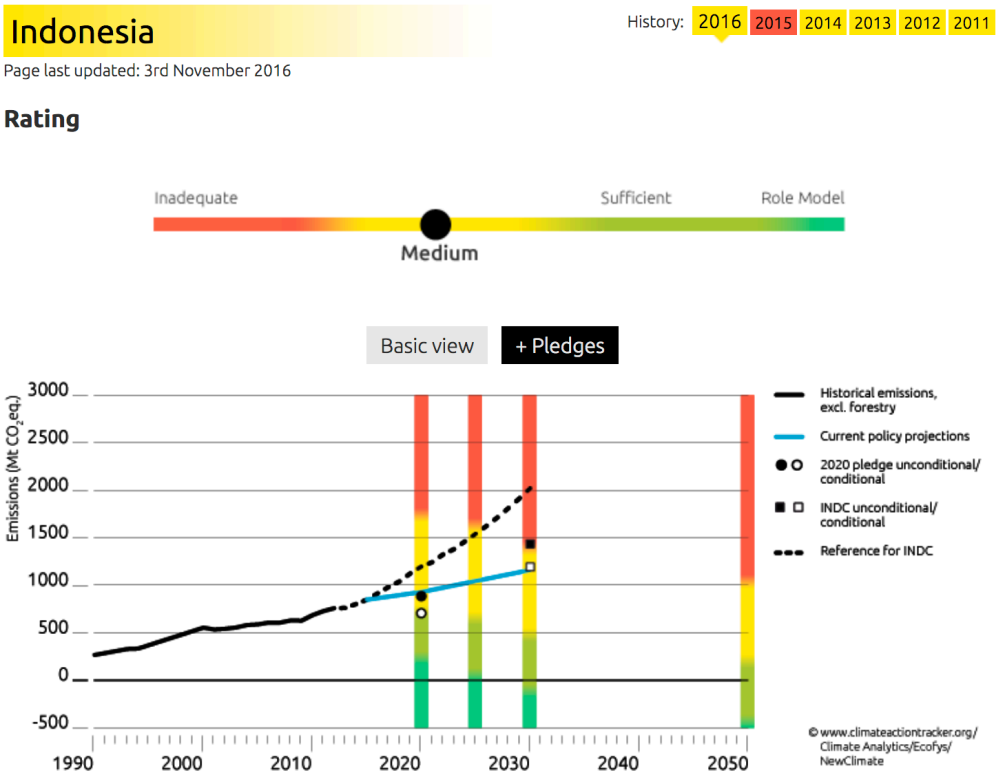
Table 1. Projected BAU and emission reduction from each sector category

No	Sector	GHG Emission Level 2010*	GHG Emission Level 2030 (MTon CO_2e)			GHG Emission Reduction (MTon CO_2e)		GHG Emission Reduction % of Total BaU		Annual Average Growth BAU (2010-2030)	Average Growth 2000-2012*
		MTon CO_2e	BaU	CM1	CM2	CM1	CM2	CM1	CM2		
1	Energy*	453.2	1,669	1,355	1,271	314	398	11%	14%	6.7%	4.50%
2	Waste	88	296	285	270	11	26	0.38%	1%	6.3%	4.00%
3	IPPU	36	69.6	66.85	66.35	2.75	3.25	0.10%	0.11%	3.4%	0.10%
4	Agriculture	110.5	119.66	110.39	115.86	9	4	0.32%	0.13%	0.4%	1.30%
5	Forestry**	647	714	217	64	497	650	17.2%	23%	0.5%	2.70%
	TOTAL	**1,334**	**2,869**	**2,034**	**1,787**	**834**	**1,081**	**29%**	**38%**	3.9%	3.20%

* Including fugitive **Including peat fire

Notes: **CM1** = Counter Measure (*unconditional mitigation scenario*)
CM2 = Counter Measure (*conditional mitigation scenario*)

The site Climate Action Tracker is run by Potsdam institute, close to the climate pessimists, supported by the German ministry of Environment, Nature Conservation displays a graph excluding forestry.
http://climateactiontracker.org/countries/indonesia.html



Note: Hover over the coloured bars for a pop-up with the fair emissions range per effort sharing category. More information here.

The value of historical emissions in MtCO2 (plain dark) excludes forestry and represents only fossil fuels up to 2013. Their extrapolation in blue is against the recent flattening of FF
The problem is deforestation and Potsdam Institute excludes it.

The 2017 paper "Low Carbon Scenario of Indonesia Energy Sector In Alignment With Its NDC by 2030" Retno G Dewi, Ucok Siagian, Bintang B Yuwono Bali" http://ifsfa2017.co.id/wp-content/uploads/2017/02/Retno-Dewi_Low-Carbon-Scenario-of-Indonesia-Energy-Sector.pdf

Indonesia NDC (Nationally Determine Contribution)

Sector	Base Year, 2010 MTon CO2e	GHG Emission 2030, Mton CO_2-e			% reduction of BaU	
		BaU	CM1	CM2	CM1	CM2
Energy*	453.2	1,669	1,355	1,271	11%	14%
Waste	88	296	285	270	0.38%	1%
IPPU	36	69.6	66.85	66.35	0.10%	0.11%
Agriculture	110.5	119.66	110.39	115.86	0.32%	0.13%
Forestry**	647	714	217	64	17.20%	23%
Total	1,334	2,869	2,034	1,787	29%	38%

*Including fugitive; **Including peat fire; CM1 = unconditional, CM2 = conditional

Source: Indonesia first NDC 2016; Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca

The table (below) reports annual energy growth of 4.5 % for the period 2000-2012, which is contrary to the annual growth of FF MtCO2 which was 0.5% for 2013-2016

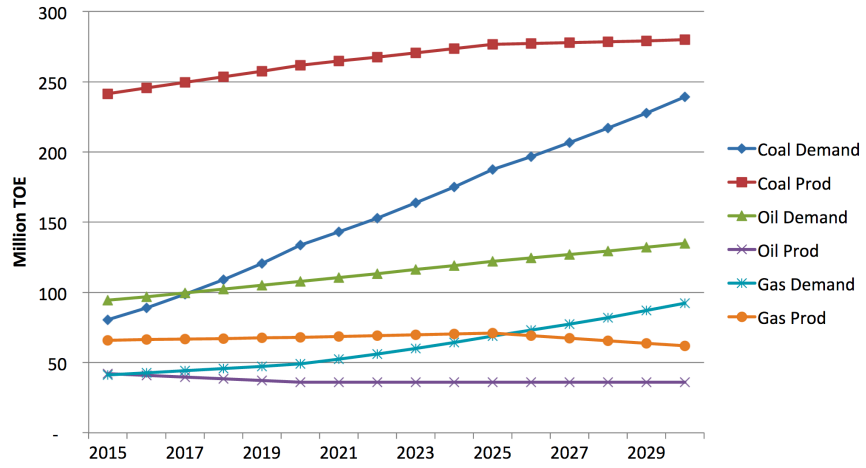
Sectors	MTon CO2e		%		Average Annual Growth
	2000	2012	2000	2012	
Energy	298	508	30	35	4.5%
IPPU	41	41	4	3	0.1%
Agriculture	96	113	10	8	1.3%
LULUCF *	505	695	51	48	2.7%
Waste	61	97	6	7	4.0%
Total	1,001	1,454			3.2%

*) including peat fire

GHG Energy will surpass GHG AFOLU

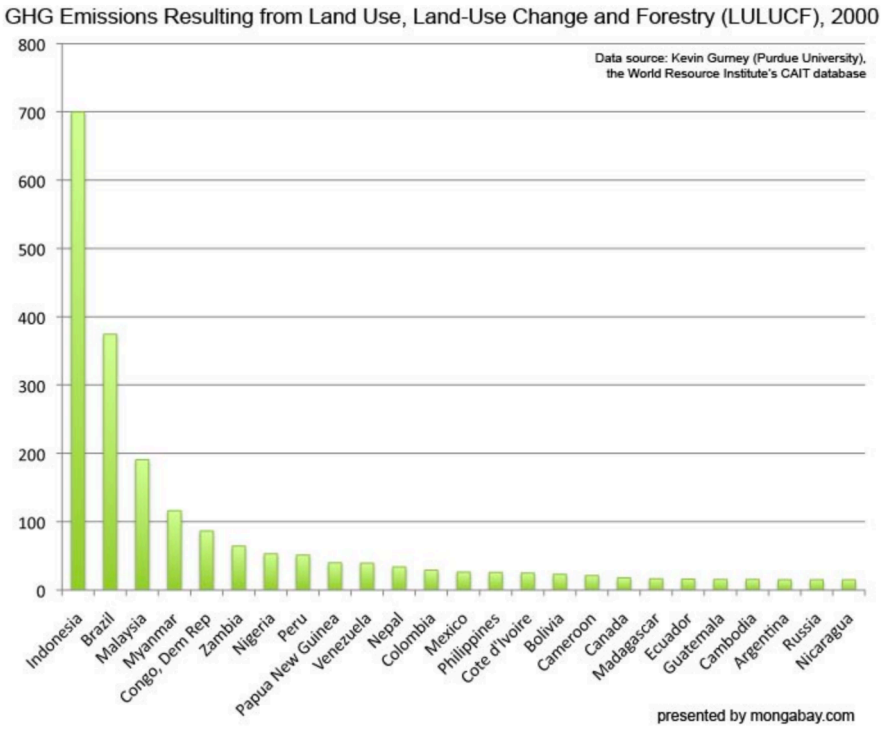
Their graph of FF supply for Indonesia disagrees with past data as shown in my above graphs

Domestic Supply - Demand



Remarks:
Oil - import will continue to increase
Gas - sufficient but need to import in the near future
Coal - sufficient

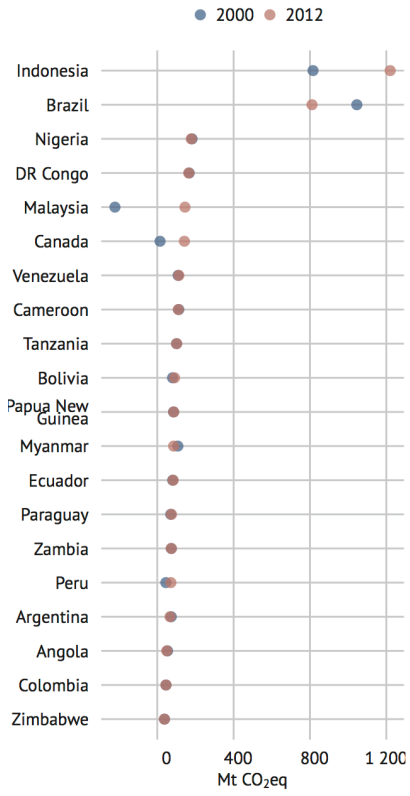
The problem is human deforestation and fires (in particular peat fires)
In the following graph Indonesia was the worst polluter in 2000 for LULUCF , twice Brazil
http://rainforests.mongabay.com/GHG_emissions.html



Greenhouse gas emissions resulting from Land Use, Land-Use Change and Forestry (LULUCF). LULUCF includes deforestation and forest degradation. The REDD mechanism seeks to reduce these emissions by compensating tropical countries for conserving their forests.

In FAO2016 land use total emissions Indonesia is the worst in 2012 and worse than 2000 (as Malaysia) and Brazil is number 2 (number 1 in 2000)

CHART 77: **Land use total emissions, highest 20 countries in 2012**



WRI reports for 2013 GHG = 2161 MtCO2, CO2 = 1826 MtCO2

http://cait.wri.org/historical/Country%20GHG%20Emissions?indicator[]=Total%20GHG%20Emissions%20Excluding%20Land-Use%20Change%20and%20Forestry&indicator[]=Total%20GHG%20Emissions%20Including%20Land-Use%20Change%20and%20Forestry&year[]=2013&sortIdx=NaN&chartType=geo

Country	Total GHG Emissions Excluding Land-Use Change and Forestry - 2013	Total GHG Emissions Including Land-Use Change and Forestry - 2013
	$MtCO_2e$	$MtCO_2e$
Indonesia	744.34	2,160.64

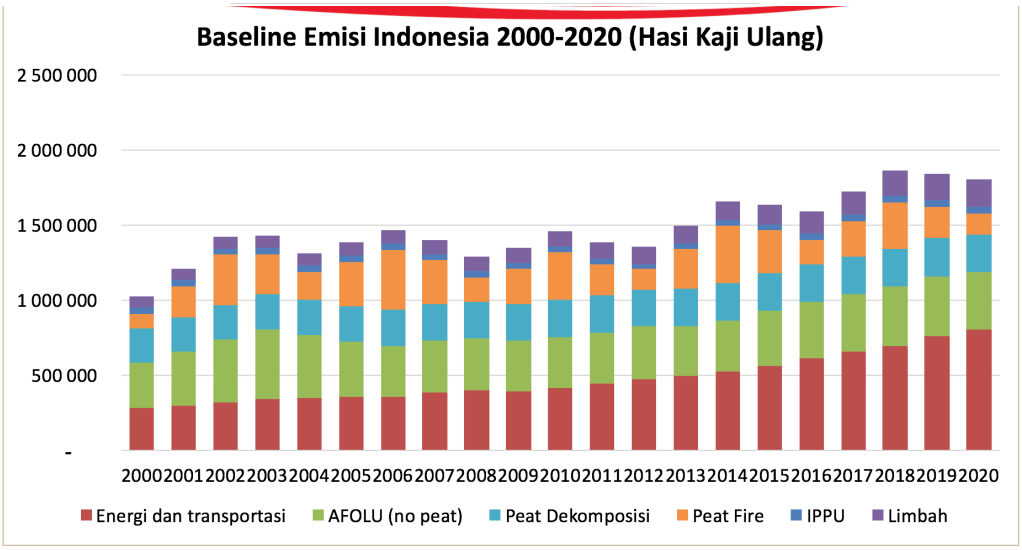
Country	Total GHG Emissions Excluding Land-Use Change and Forestry - 2013	Total GHG Emissions Including Land-Use Change and Forestry - 2013	Total CO_2 (including Land-Use Change and Forestry) - 2013	Add +
	$MtCO_2e$	$MtCO_2e$	$MtCO_2$	
Indonesia	744.34	2,160.64	1,826.07	

For 2013 GHG = 2161 MtCO2, CO2 = 1826 MtCO2
GHG emissions expressed in MtCO2 should not be confused with CO2 emissions!
CH4 and others emissions are not negligible

UPDATE PERKEMBANGAN PENYUSUNAN INDONESIA INTENDED NATIONALLY DETERMINED CONTRIBUTIONS (INDC)

Endah Murniningtyas
Deputi bidang Sumber Daya Alam dan Lingkungan Hidup
Badan Perencanaan Pembangunan Nasional (Bappenas)

Jakarta, 2 Juli 2015

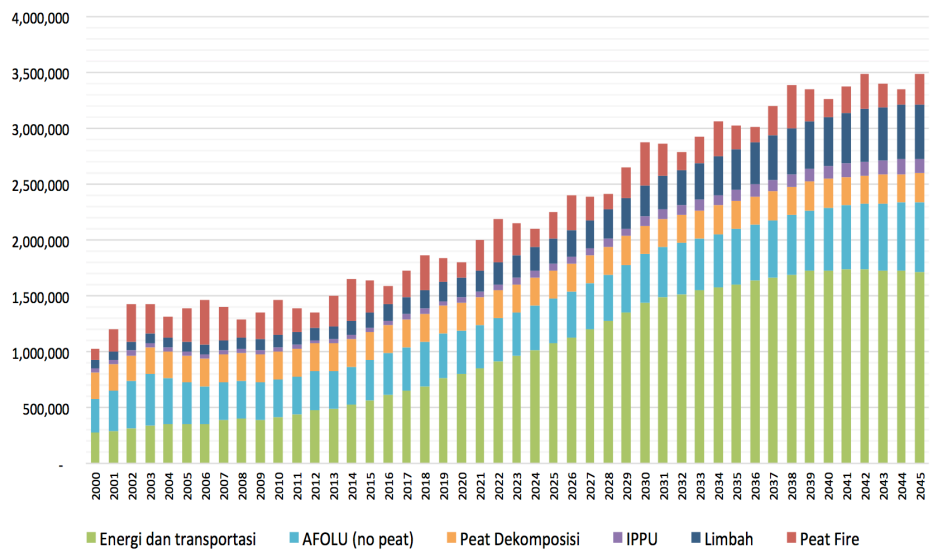


Hasil Simulasi Baseline Total Emisi GRK 2000-2045 (Kaji Ulang) dalam ribu ton CO2e:

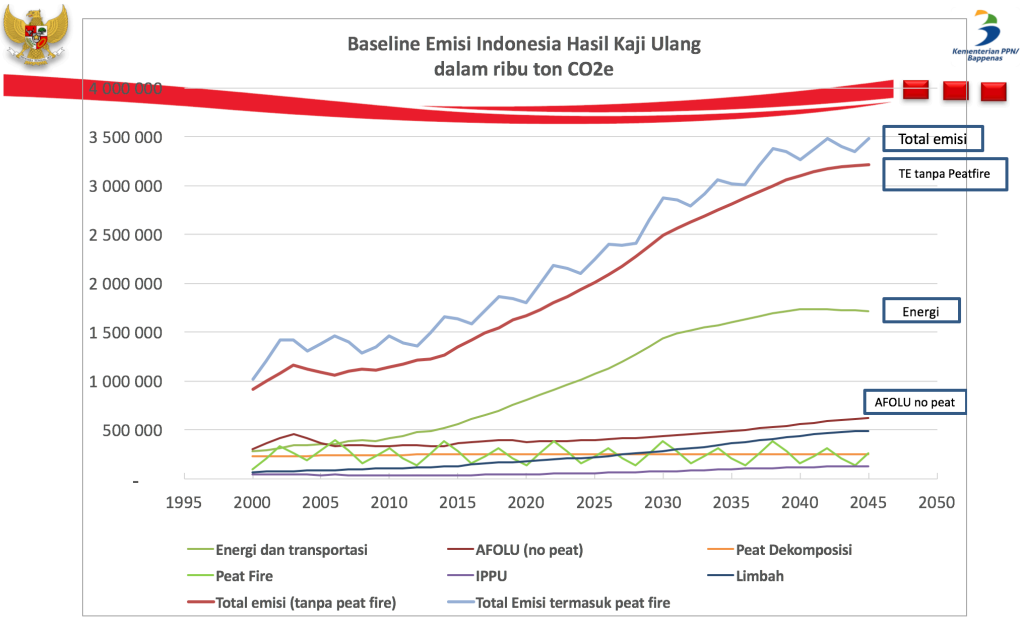
Sektor	2010	2015	2020	2030	2045
IPPU	37.749	37.717	47.876	78.205	130.658
Energy	414.786	560.282	806.081	1.438.629	1.712.274
Waste	108.156	133.432	182.027	284.886	491.897
Afolu (no peat)	339.804	367.130	379.803	436.171	625.235
Peat Decomposition	245.411	249.546	251.093	254.047	257.230
Peat Fire	314.467	288.445	137.171	385.709	266.998
Total Emisi (tanpa peat fire)	**1.145.906**	**1.348.107**	**1.666.880**	**2.491.938**	**3.217.294**
Total Emisi (termasuk peat fire	**1.460.373**	**1.636.552**	**1.804.051**	**2.877.647**	**3.484.292**

Keterangan: - Perhitungan tanggal 24 Juni 2015

Baseline Emisi Indonesia Pasca 2020: 2000-2045 (Hasil Kaji Ulang) dalam ribu ton CO2e



- **Kontribusi sektor energi meningkat cukup signifikan**
- **Peak Emisi Indonesia diperkirakan berada pada tahun 2045**



Pola/ pattern emisi baseline sangat dipengaruhi oleh proyeksi terhadap peat-fire, mengingat kejadian peat fire memberikan dampak emisi GRK yang sangat tinggi

This kind of graph is too short in historical years, a minimum of 30 years is needed to understand history!
http://www.incas-indonesia.org/wp-content/uploads/2015/11/1.-INCAS-National-Inventory-of-Greenhouse-Gas-_web.pdf

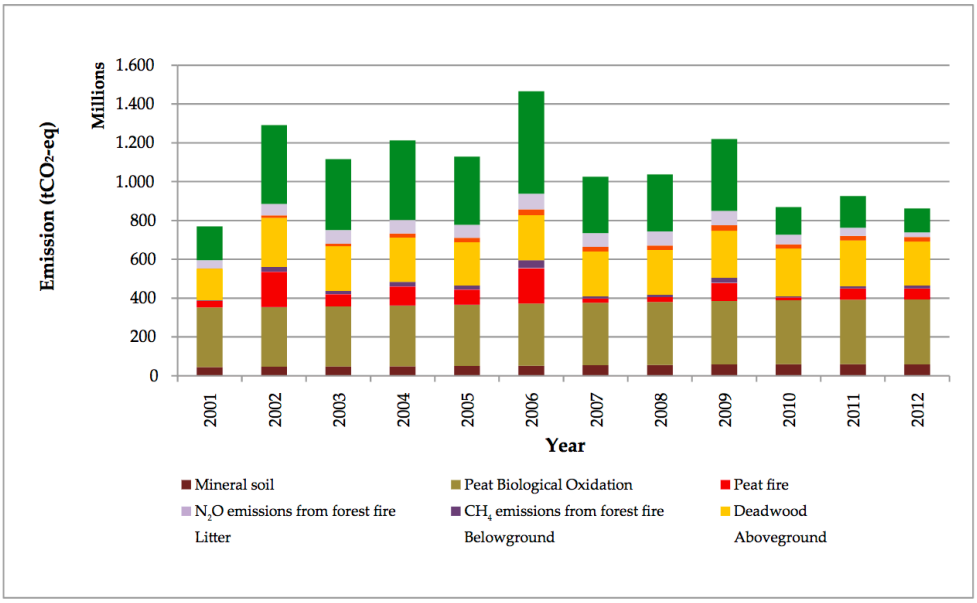


Figure 5. Total annual net GHG emissions estimates in Indonesia for the period 2001 to 2012 from all pools

"Greenhouse gas emissions from tropical forest degradation: an underestimated source"
Timothy R. H. Pearson, Sandra Brown, Lara Murray and Gabriel Sidman 2017
https://cbmjournal.springeropen.com/articles/10.1186/s13021-017-0072-2
They provide a consistent estimation of forest degradation emissions between 2005 and 2010 across 74 developing countries covering 2.2 billion hectares of forests.

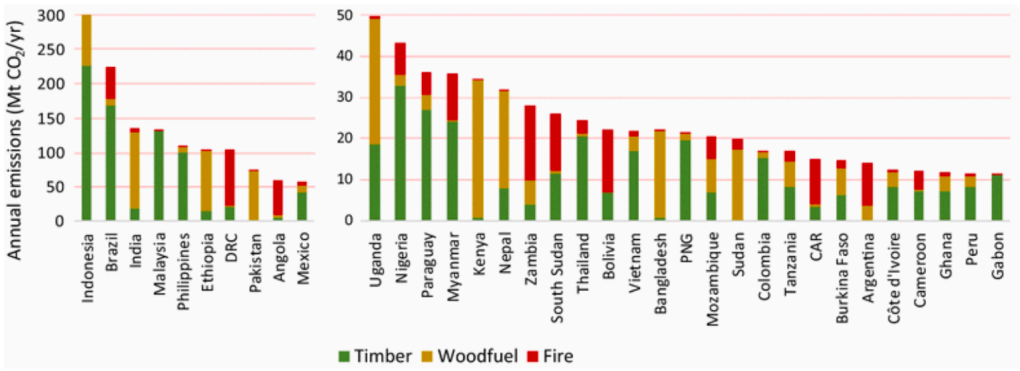


Fig. 4
Annual forest degradation emissions disaggregated by cause for the 35 countries with the highest emissions

Indonesia is first but without any fire (red): it look against other papers, in particular in 1997 on my above graph of GHG emissions where fire (1000 MtCO2) is half of the GHG total, but almost zero in 2008, 2009 and 2010.
An average should be taken on a large period representative of the history!

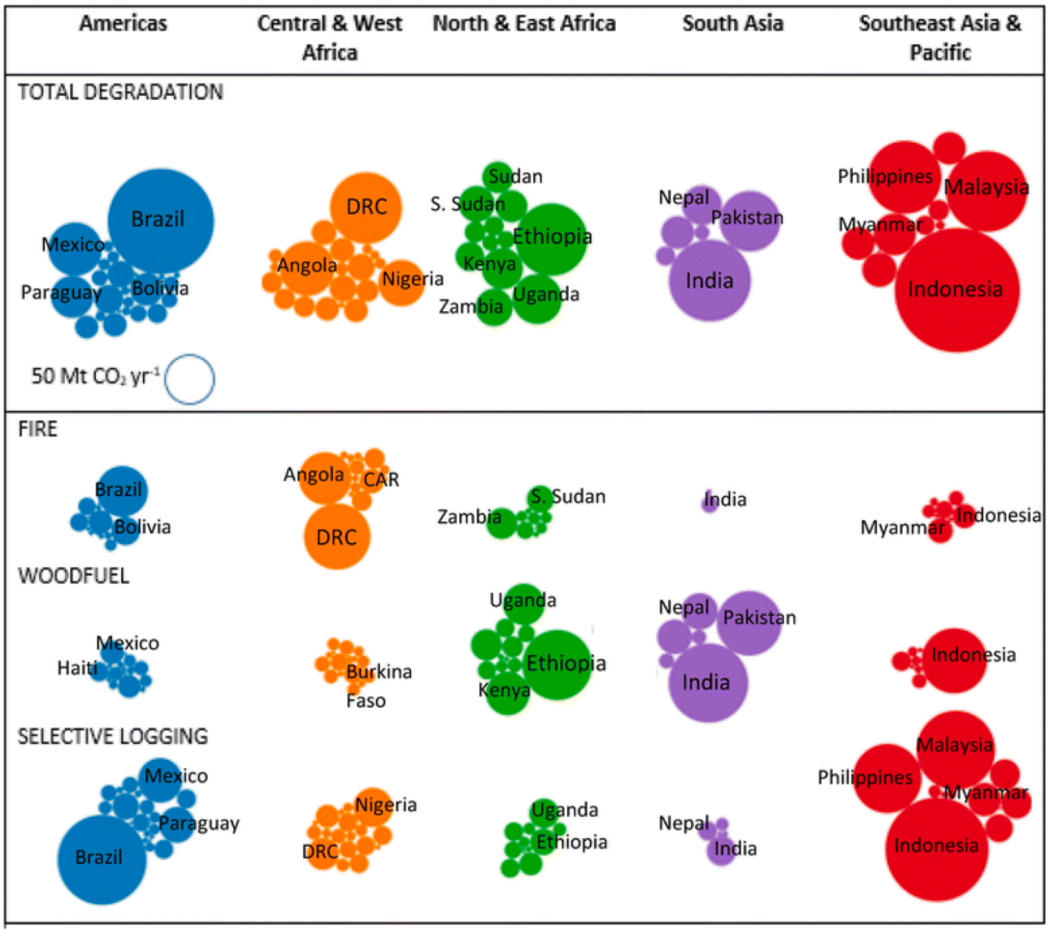
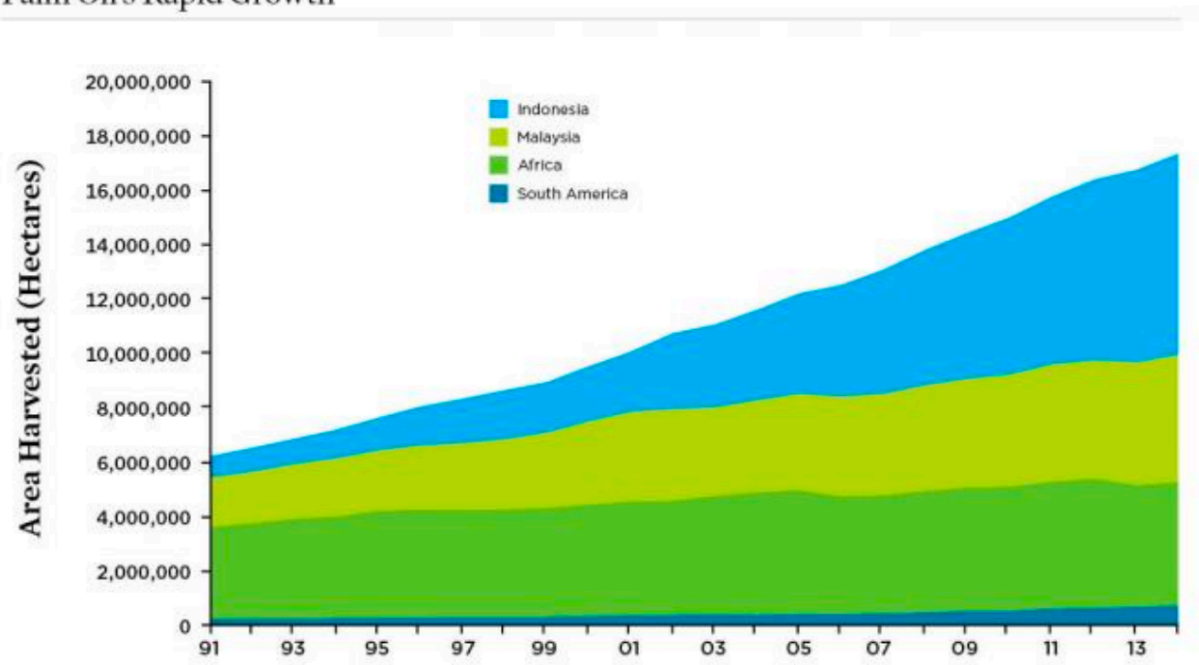


Fig. 5
Bubble charts showing degradation emissions by region. The *size of the bubbles* represents the relative magnitude of annual emissions

-palm oil

There are many papers connecting deforestation and the growth of palm oil (or oil palm) production, in particular in Indonesia first producer since 2007 ahead of Malaysia.
In 2017 Indonesia and Malaysia produce 85% of the world palm oil. In 1991 the majority of palm oil production was in Africa.

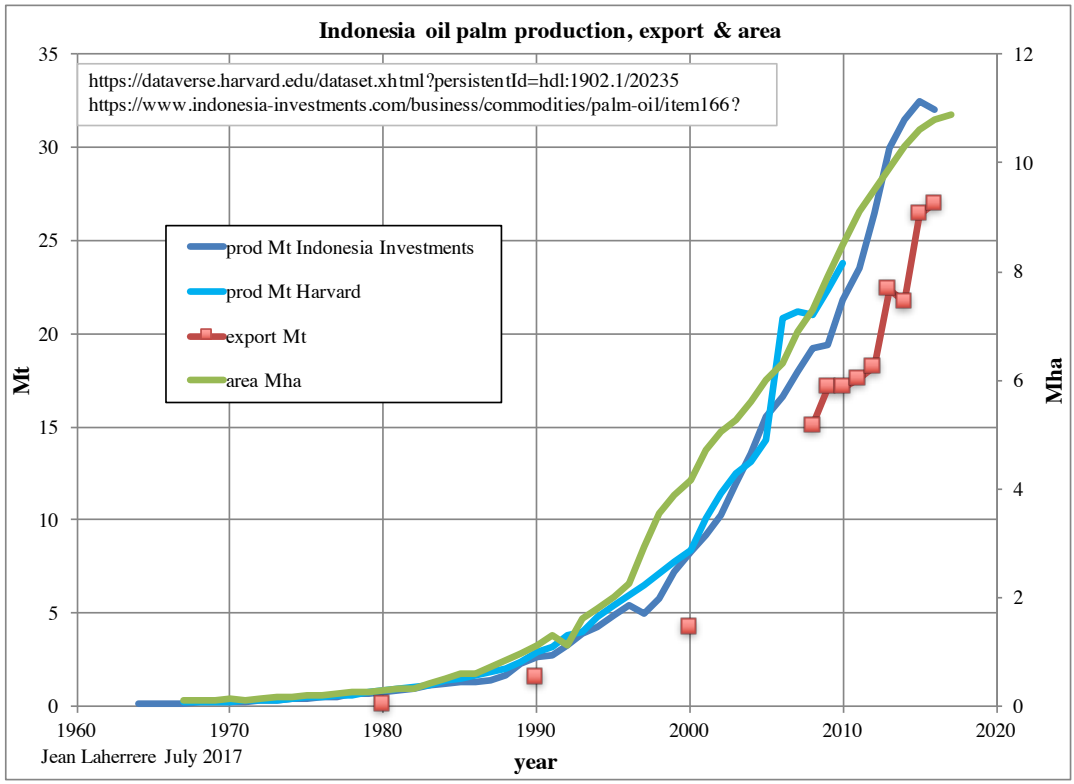


FAO reports palm oil production, export and consumption from 2013 to 2017

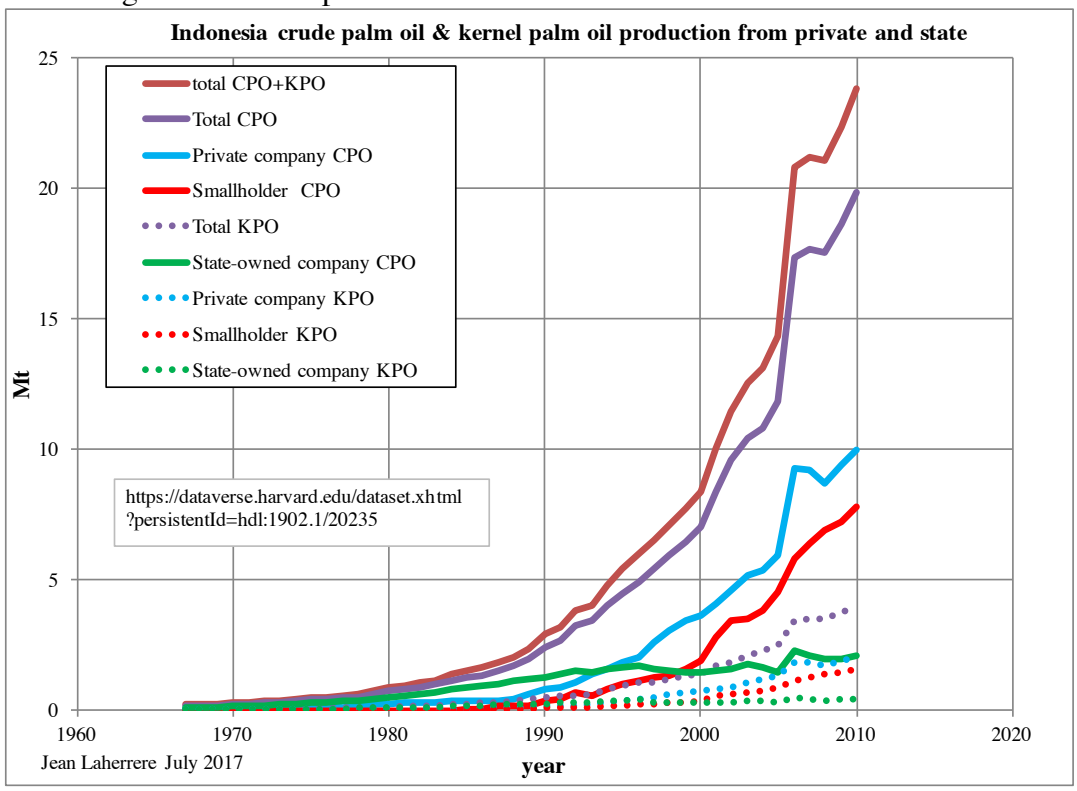
https://apps.fas.usda.gov/psdonline/circulars/oilseeds.pdf						
palm oil	Mt	2013	2014	2015	2016	2017
prod	Indonesia	30,5	33	32	34	36
	Malaysia	20,2	19,9	17,7	19,3	21
	Thailand	2,0	2,1	1,8	2,0	2,2
	total	59,3	61,8	58,8	62,7	66,8
export	Indonesia	21,7	26	22,9	25,0	25,5
	Malaysia	17,3	17,4	16,6	16,6	17,3
	Guatemala	0,4	0,5	0,6	0,7	0,7
	total	43,2	47,4	43,7	46,0	47,2
cons	Indonesia	8,8	7,5	9,4	9,5	9,6
	India	8,3	9,2	9,1	9,3	9,6
	EU	6,6	6,9	6,7	6,5	6,5
	China	5,7	5,7	4,8	4,9	5
	Malaysia	2,9	2,9	3,0	3,3	3,6
	total	57,5	58,7	59,9	61,4	63,3

"Roundtable on Sustainable Palm Oil" (RSPO) was established in 2004 to promote the sustainable use of palm oil with about 3000 members.
https://en.wikipedia.org/wiki/Roundtable_on_Sustainable_Palm_Oil

In Indonesia, 3.7 million people are believed to be employed in the palm oil industry.
Palm oil production was about 3 Mt in 1990 and 32 Mt in 2015: data from Harvard and Indonesia investments differs on 2006!
The production follows the area, the yield does not change much.
Most of the oil palm production is exported.

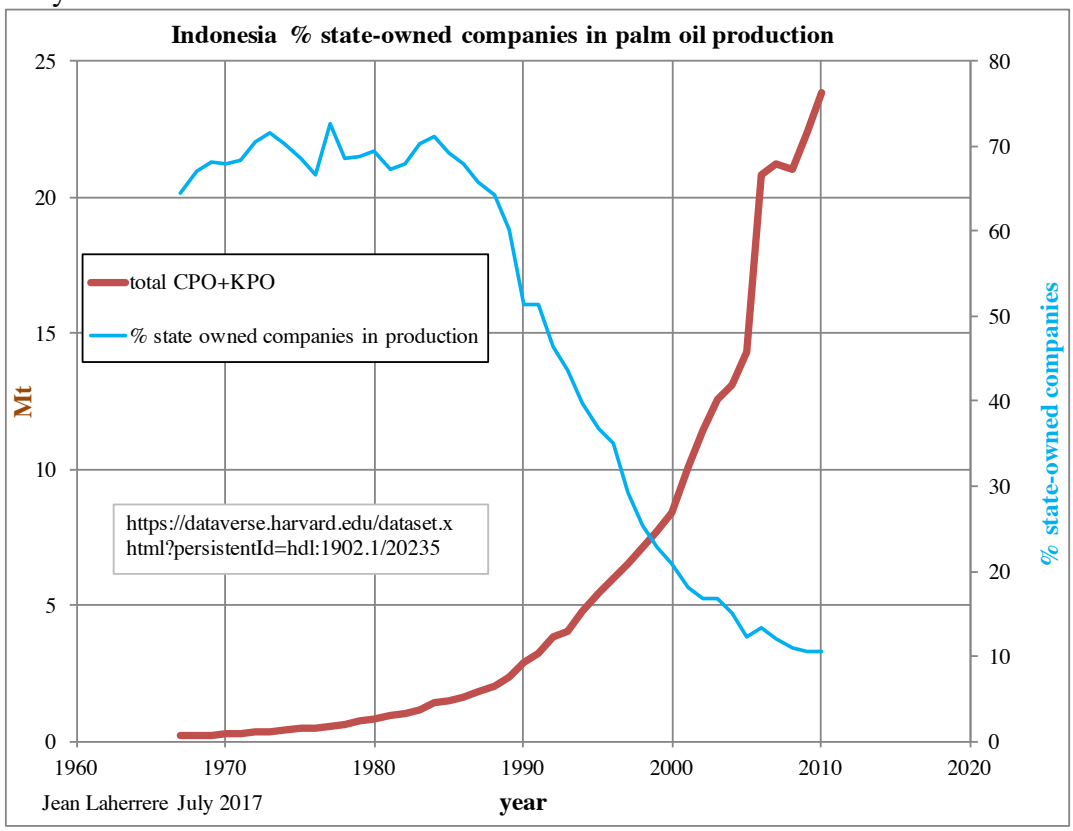


There are two kinds of palm oil: crude palm oil and kernel palm oil, and three operators: state-owned companies, smallholders and private company, but in 2010 crude palm oil production was 5 times larger than kernel palm oil.

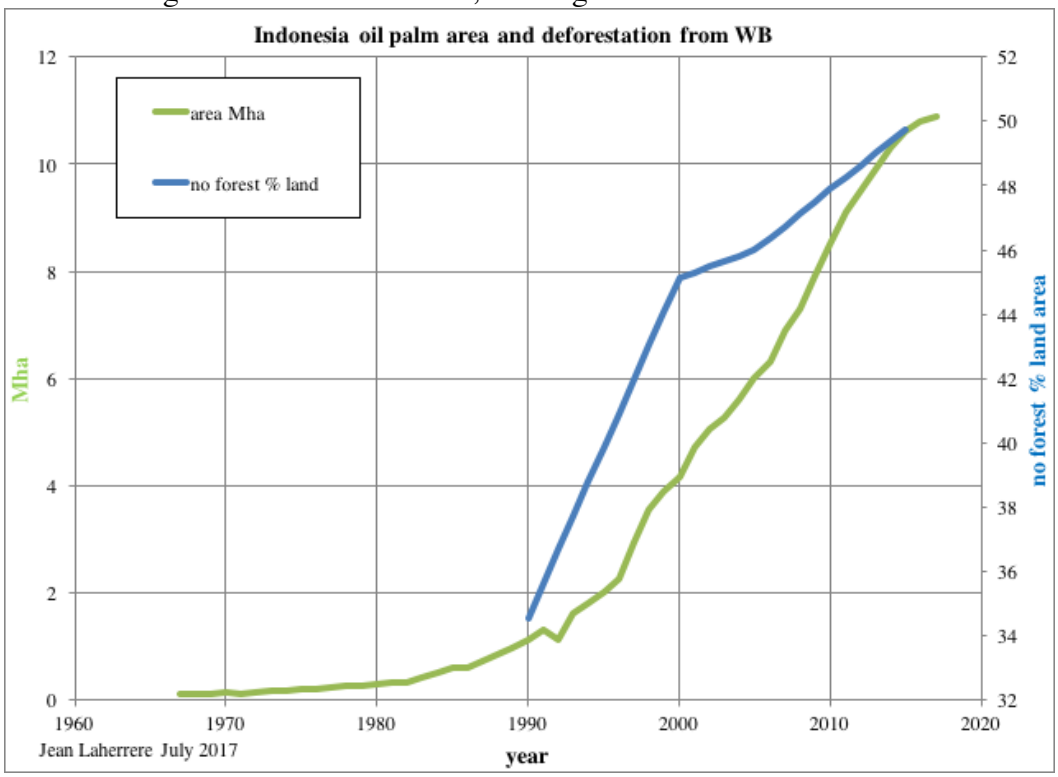


From 1967 to 1990 the state-owned companies were producing above 60 % of the total palm oil, but in 2010 the percentage is only 10%.

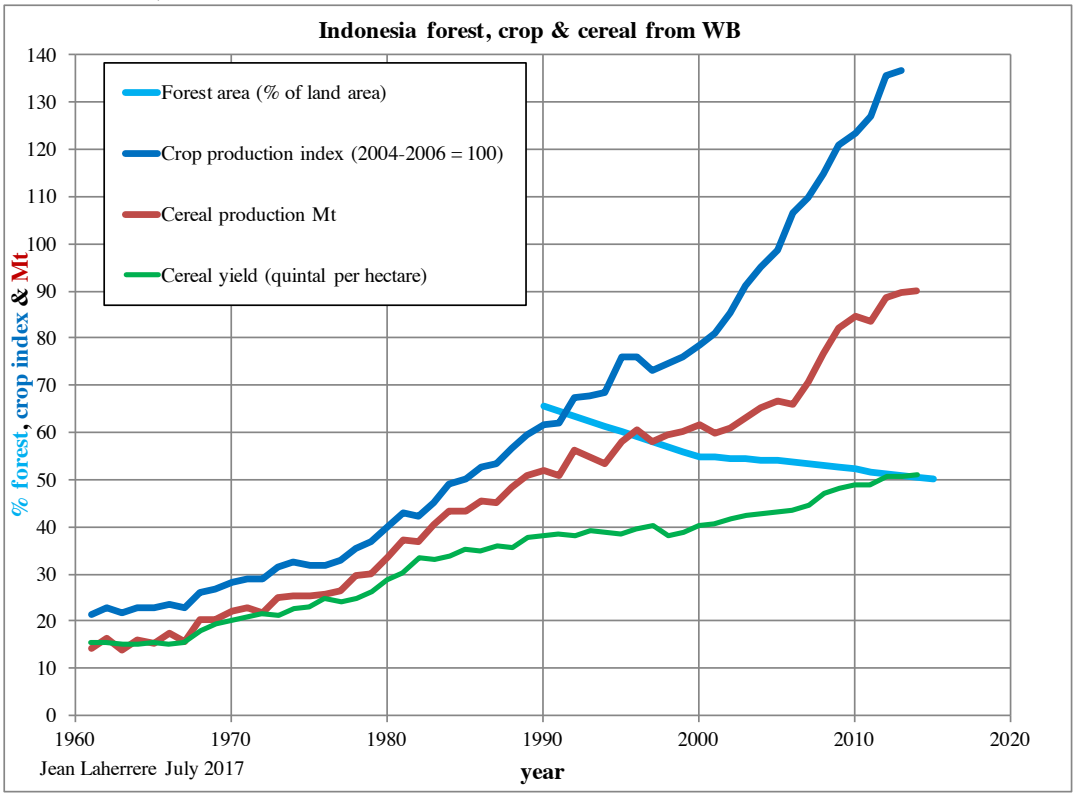
If is obvious that palm oil production jumped when state-owned companies lost their supremacy!



The area occupied by the palm oil is plotted with the percentage of no forest (harvest = 100 - % forest)) taken as the complement of the forest percentage of the land area from the WB
The correlation is good for 1990 and 2015, not so good for 2000!



WB reports for the period 1961-2014 many items on agriculture: the plot of the crop production index, cereal production and cereal yield displays large increase when the percentage of the forest of the m land area has declined for the period 1990-2014 (no data before 1990)

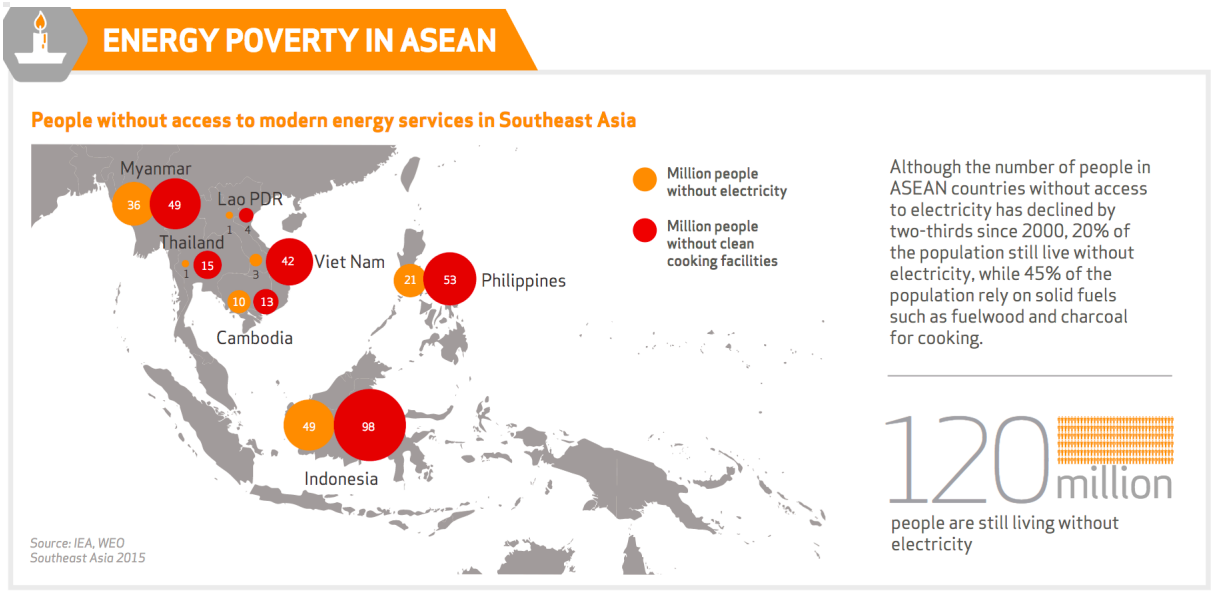


"World Bank Development Policy Finance and Climate Change: Is the Bank providing the Right Incentives for Low-Carbon Development in Indonesia?"
http://www.bankinformationcenter.org/wp-content/uploads/2017/01/INDONESIA-DPF-FORMATTED-PUB-1.6.17.pdf
The largest source of Indonesian GHG emissions stem from land use change and forestry (LUCF) – mainly the cutting and burning of tropical forests and peat lands – accounting for 62 percent of Indonesia's emissions in 2011 or 945 MtCO2
Unfortunately, Indonesia has the highest rate of forest loss in the world, making it also the world's largest GHG emitter from deforestation. In 2012, the annual loss of primary rain forest in Indonesia (840,000 ha) was much higher than in Brazil (460,000 ha).

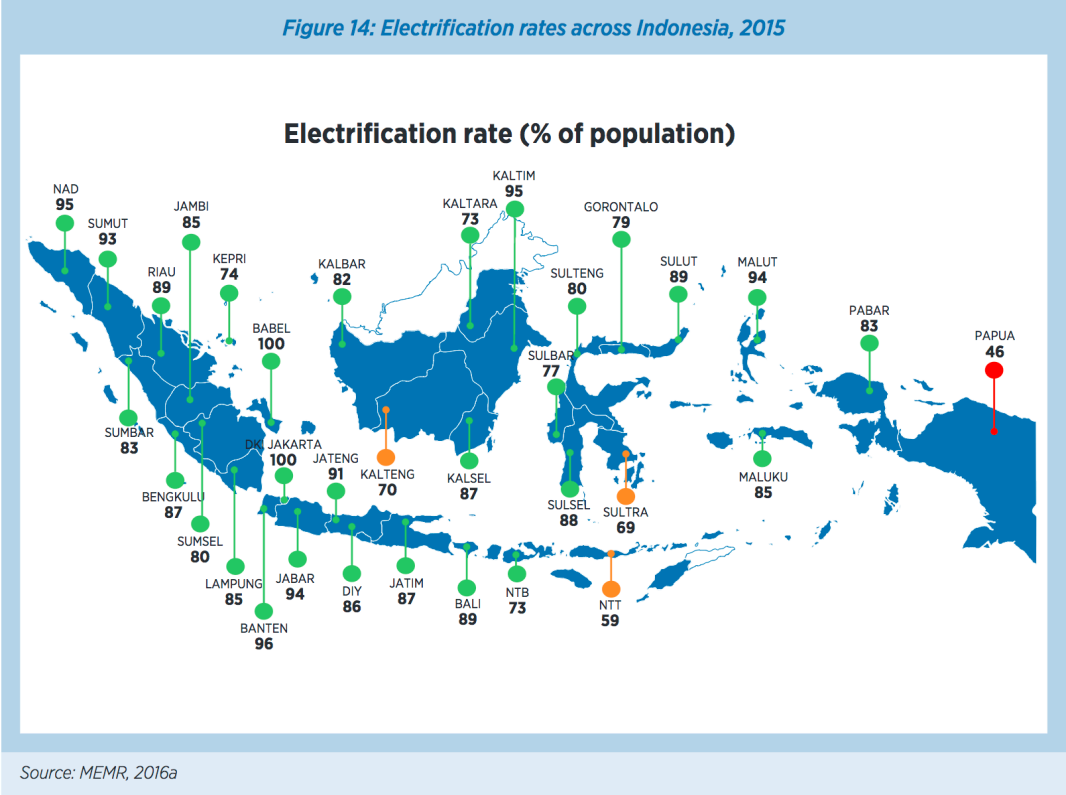
Indonesia should take care better of the growth of the palm oil production and the deforestation!

-electricity & geothermal

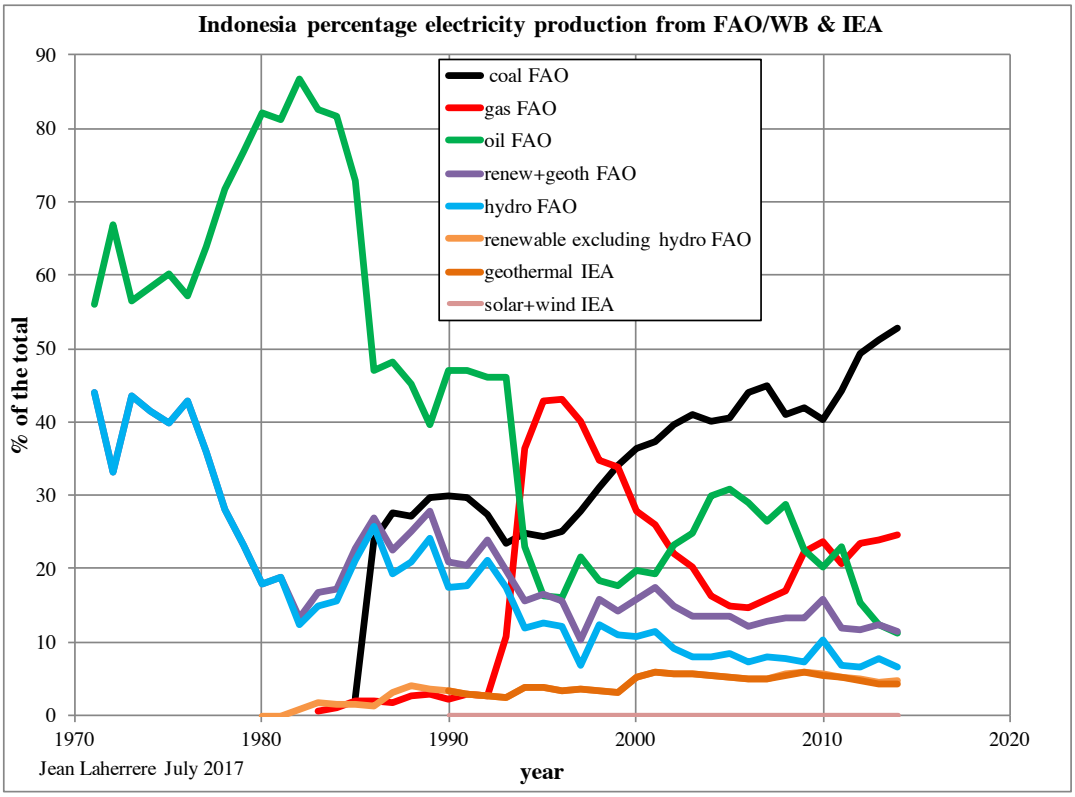
IEA WEO2015 reports that 49 M Indonesians live without electricity and 98 M without clean cooking facilities.
https://www.worldcoal.org/sites/default/files/resources_files/ASEAN%20factsheet.pdf



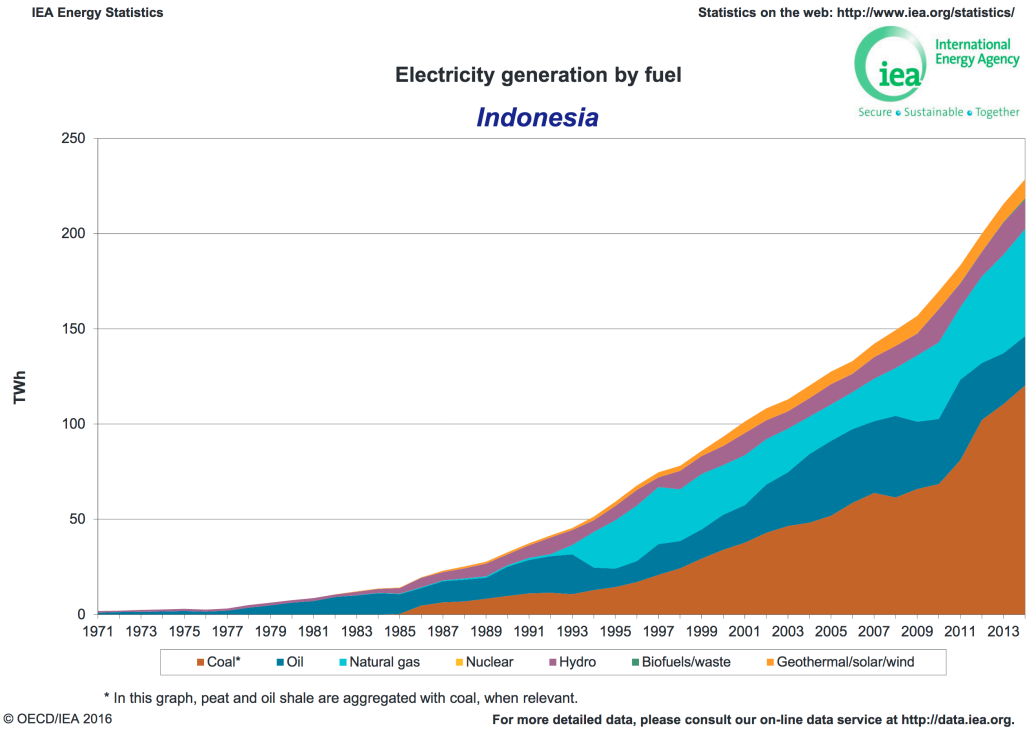
Some parts of Indonesia lack electricity like Papua in tis graph of 2016!
http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_Indonesia_report_2017.pdf



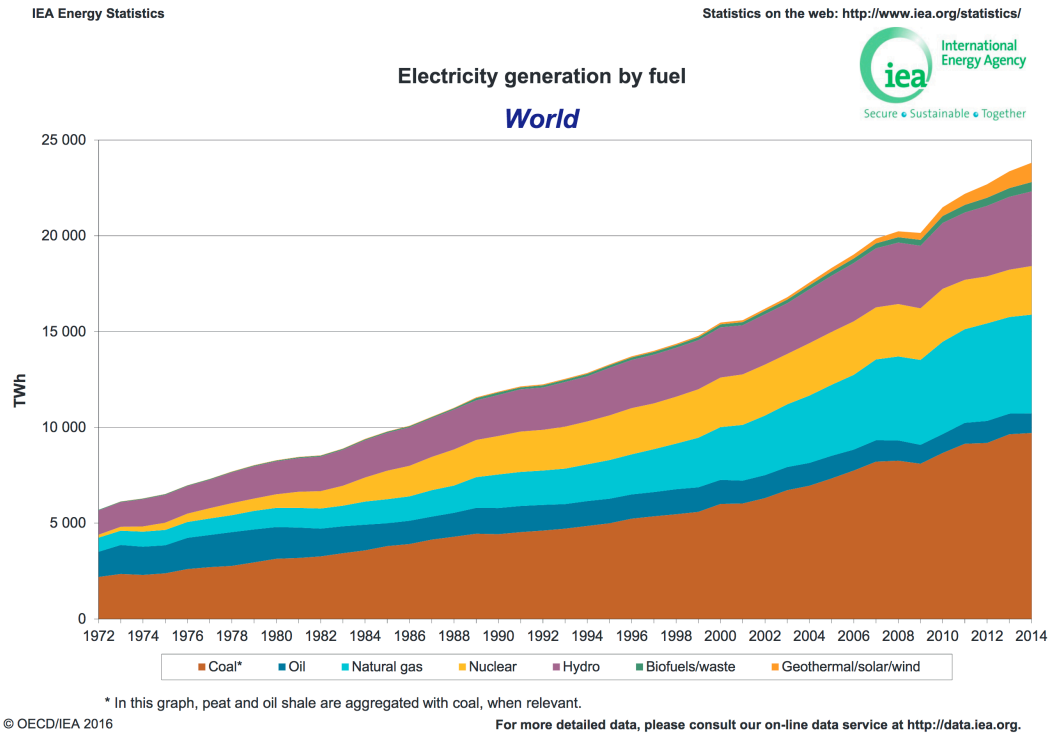
The evolution of electricity fuels from 1970 to 2014 shows the decline of oil (green) and of renewable + geothermal (purple) and the increase of coal (black) NG after a peak in 1995 and a low in 2006 is on the increase



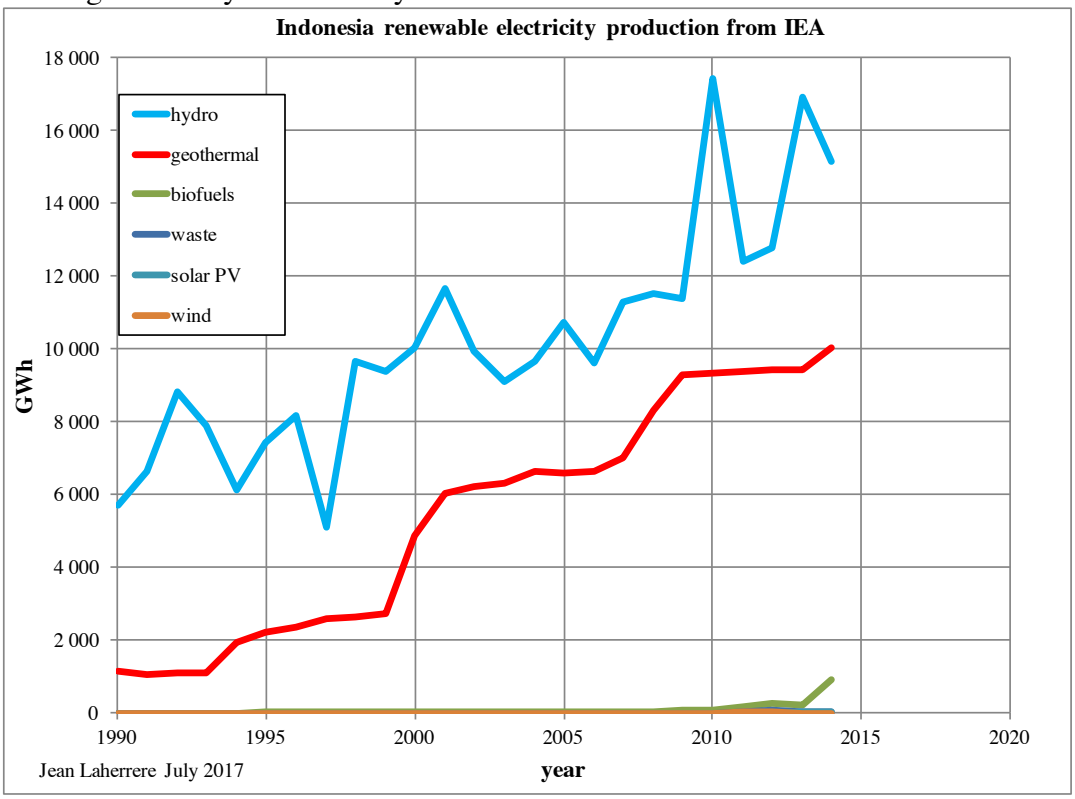
IEA displays the same data on aggregation in TWh and not in percentage



This EIA Indonesia graph could be compared to the same display for the world
Indonesia renewable is mainly geothermal, when for the world it is mainly wind and solar.
Geothermal is better than wind and solar, not being intermittent!

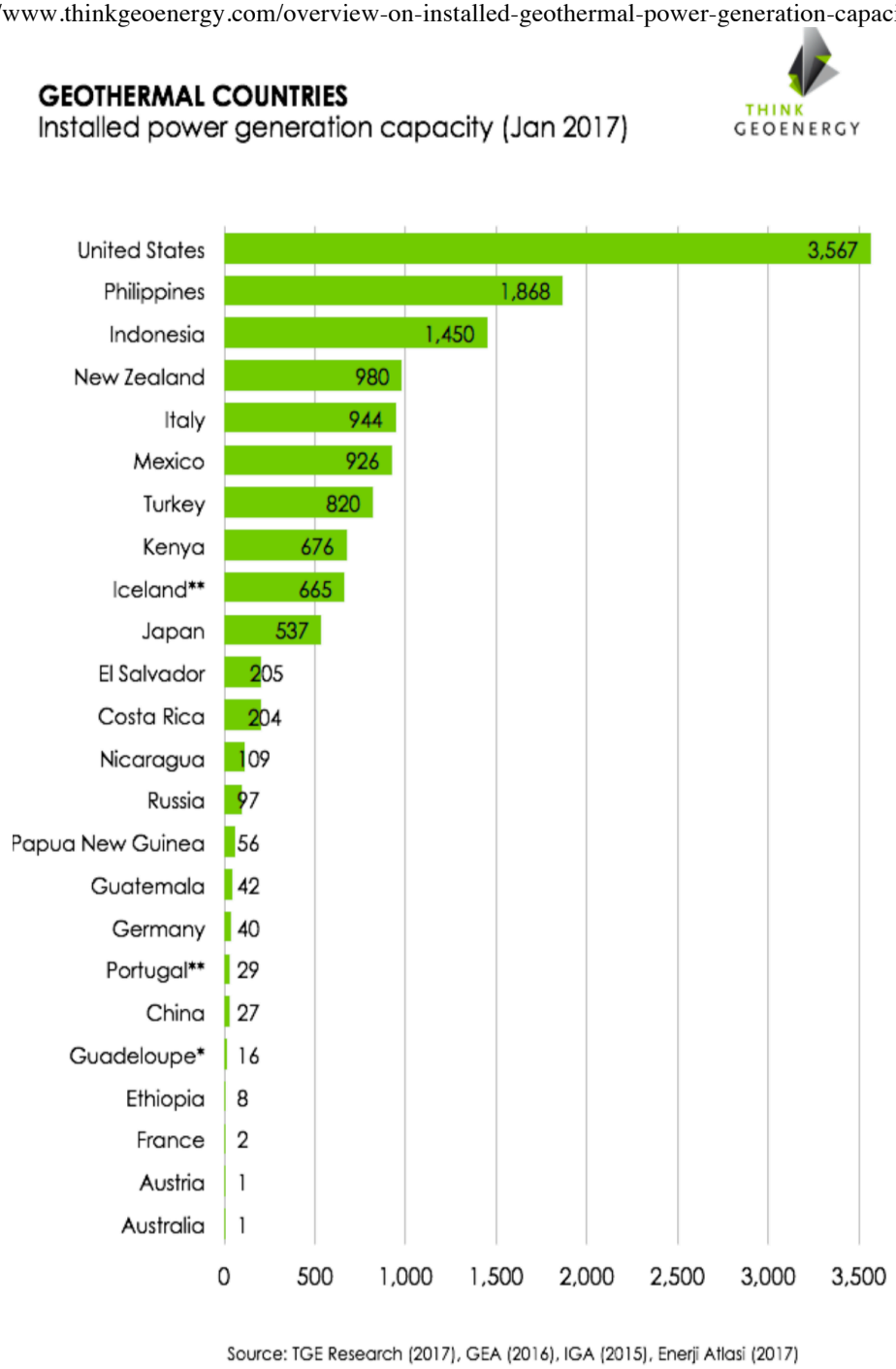


For the period 1990-2014 IEA data on renewable electricity shows that wind and solar are negligible!
Geothermal grows as hydroelectricity!

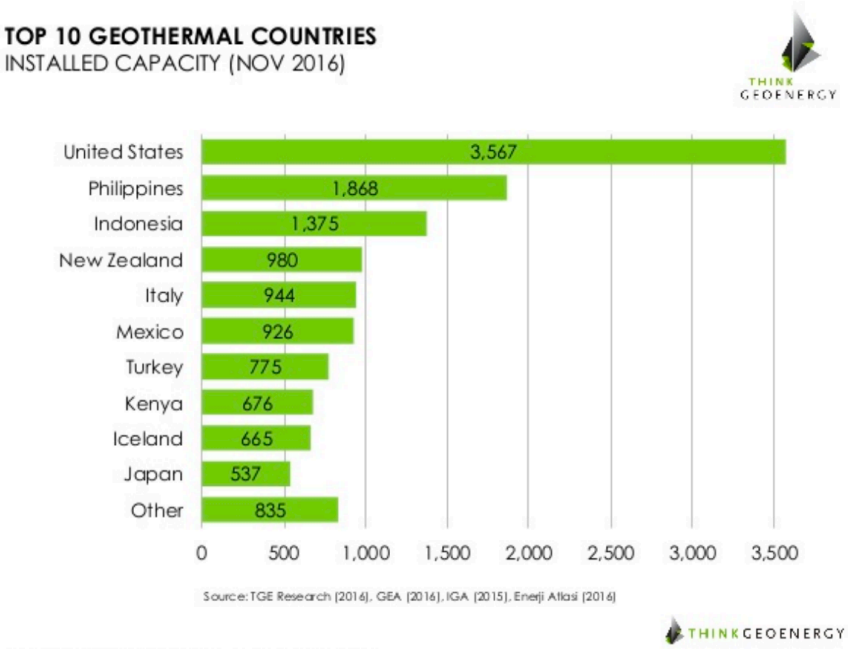


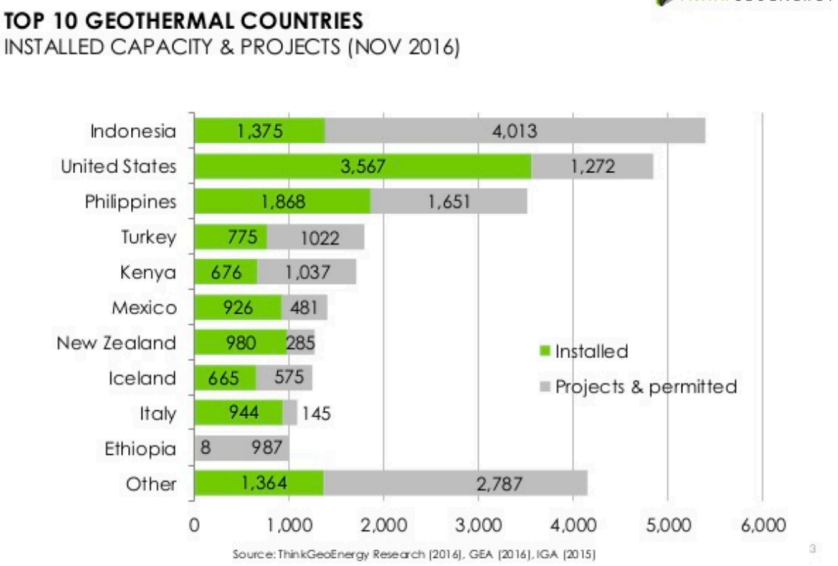
The site "thinkgeoenergy.com" reports that in 2017 the geothermal "installed capacity" of the US was first followed by Philippines, Indonesia, New Zealand and Italy.

They forget to report the unit MW!
Happily geothermal is not intermittent as sun and wind!
http://www.thinkgeoenergy.com/overview-on-installed-geothermal-power-generation-capacity-worldwide/

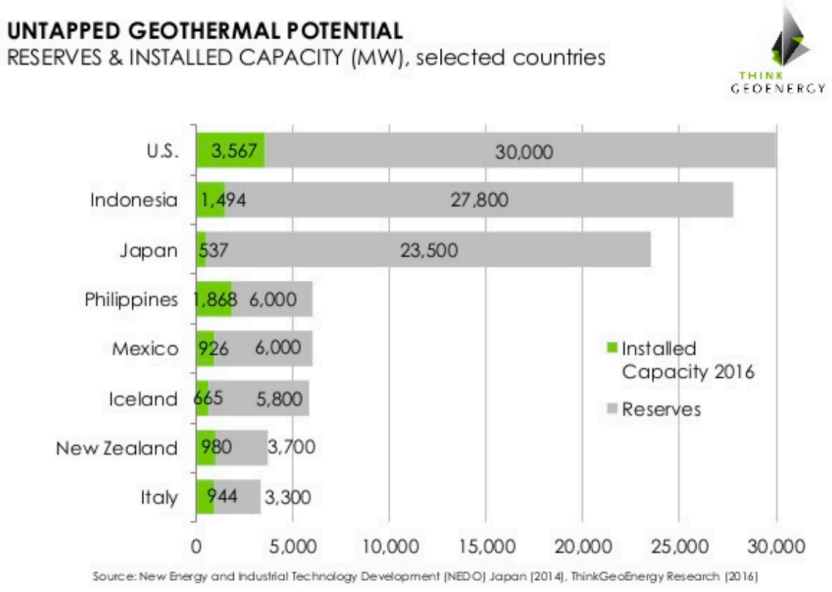


But with new projects (4013 MW) Indonesia will be in the future number one
https://www.slideshare.net/thinkgeoenergy/geothermal-energy-global-development-status





But on the geothermal potential (this time the unit is there) US is back number one.



The site irena.org geothermal MEMR No. 17/2014
http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_Indonesia_report_2017.pdf
table 2 target for 2025 renewable energy in power generation = 25% RUKN 2015-2034
2030 = 28,6% when 2014 = 12.4%

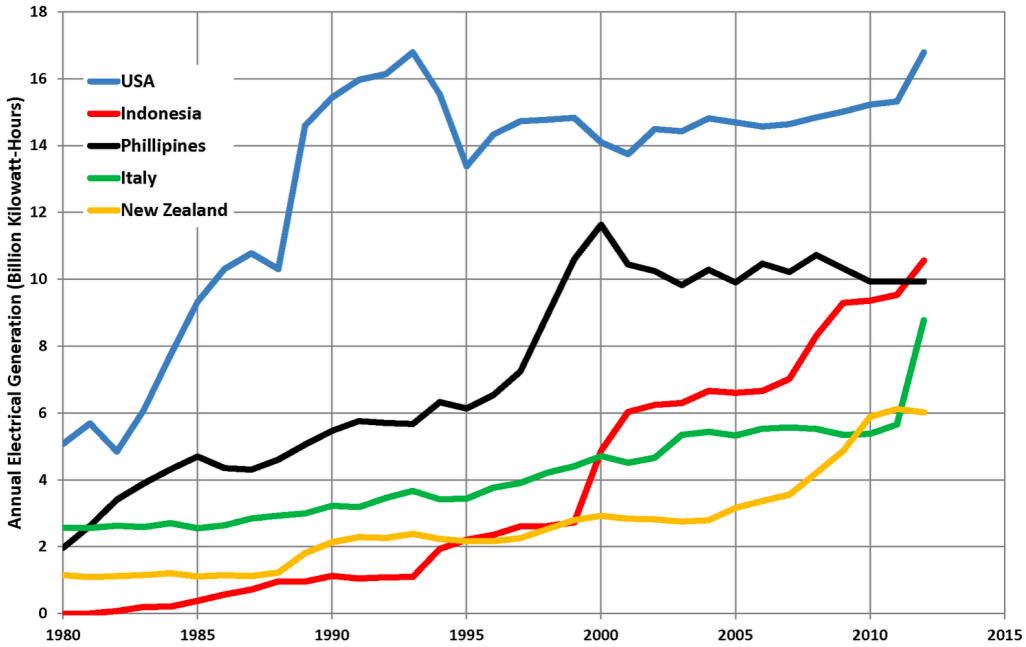
Many papers report geothermal capacity, but not production, this one reports both
https://sites.google.com/a/ngaphil.org/www/in-the-news/2015geothermalinstalledcapacityandthetopfivecountriesforinstalledcapacity
2015 Geothermal Installed Capacity and the Top Five Countries for Installed Capacity
posted Sep 14, 2016, 2:49 PM by Eugene Sunio

COUNTRY	2010 MWe	2010 GWh	2015 MWe	2015 GWh
USA	3,098	16,603	**3,450**	16,600
PHILIPPINES	1,904	10,311	**1,870**	9,646
INDONESIA	1,197	9,600	**1,340**	9,600
MEXICO	958	7,047	**1,017**	6,071
NEW ZEALAND	762	4,055	**1,005**	7,000

It is interesting to compute the number of hours and it appears that Indonesia is the most efficient with 22 hours per day in 2010 and 20 h/d in 2015.

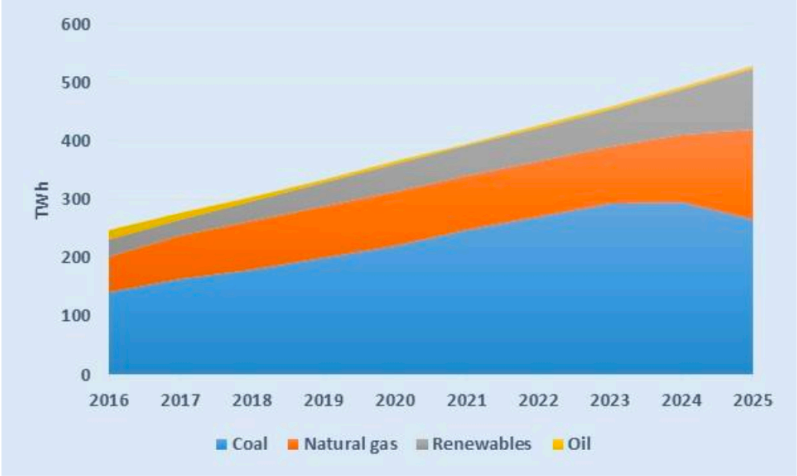
country	2010 MW	2010 GWh	2015 MW	2015 GWh	2010 h/yr	2015 h/yr	2010 h/d	2015 h/d
US	3098	16603	3450	16600	5359	4812	15	13
Philippines	1904	10311	1870	9646	5415	5158	15	14
Indonesia	1197	9600	1340	9600	8020	7164	22	20
Mexico	958	7047	1017	6071	7356	5970	20	16
New Zealand	762	4055	1005	7000	5322	6965	15	19

The Wiki graph reports for 1980-2012 geothermal generation of the 5 above countries, which Indonesia showing the larger increase on the last 10 years.
https://en.wikipedia.org/wiki/File:Top_5_Geothermal-Electric_Countries.png



The Oxford Institute displays for Indonesia future electricity generation up to 2025 with peak of coal in 2024 but compensated by NG and renewable (geothermal)
https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/03/Indonesias-Electricity-Demand-and-the-Coal-Sector-Export-or-meet-domestic-demand-CL-5.pdf
RUPTL2016-2025 is found http://www.djk.esdm.go.id/pdf/RUPTL/RUPTL%20PLN%202016-2025.pdf

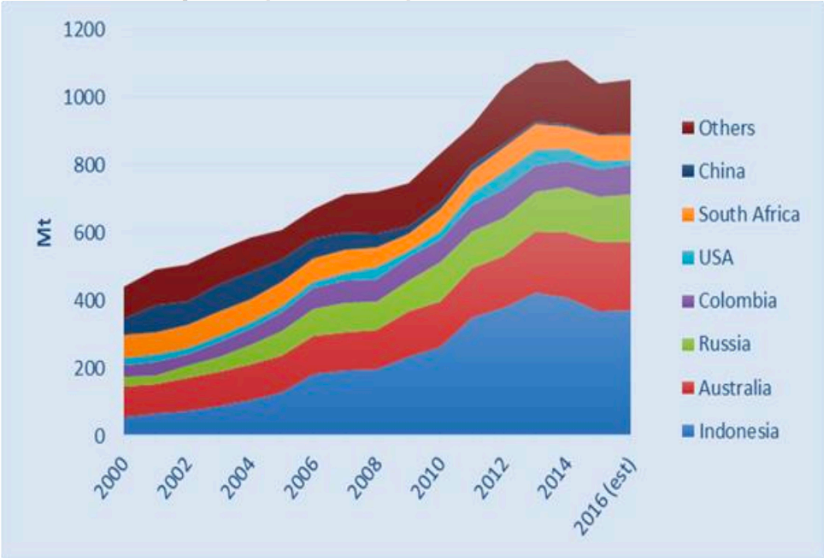
Figure 5: Projection of electricity generation in RUPTL 2016-2025



Source: PLN

Indonesia is number one for steam coal export since 2005.

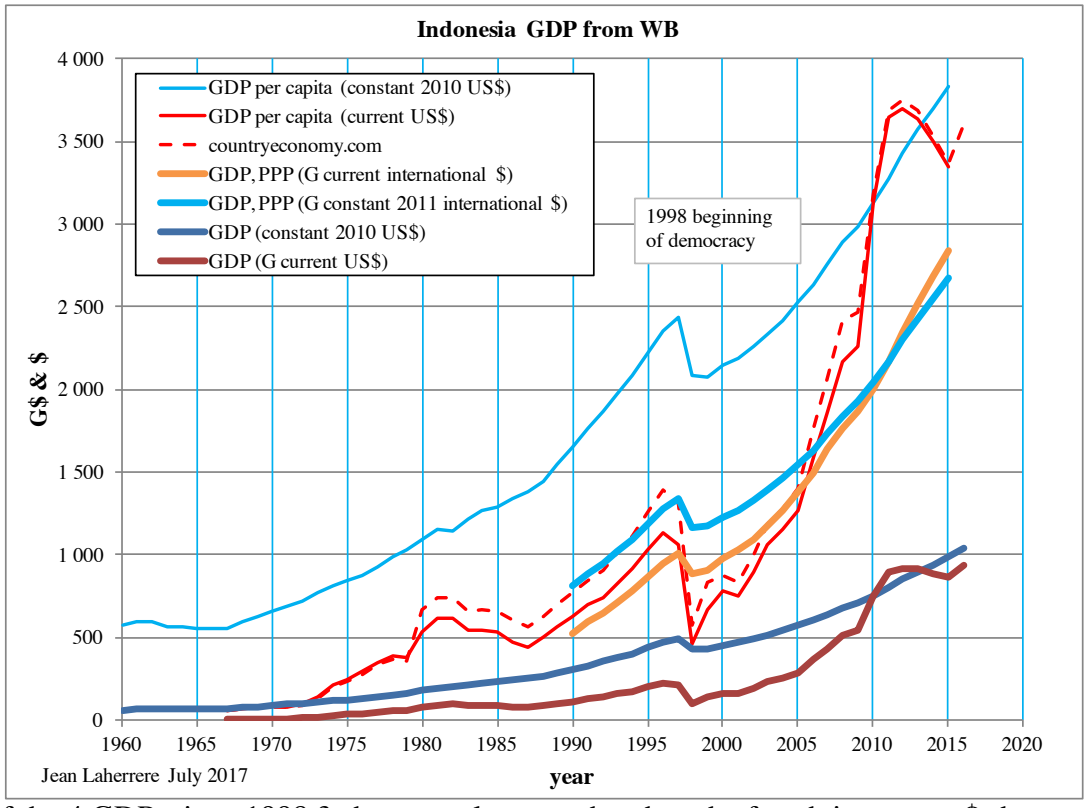
Figure 8: Global steam coal exports (2000-2016), Mt



Source: 2000-2015: IEA, 2016 estimated.

-GDP

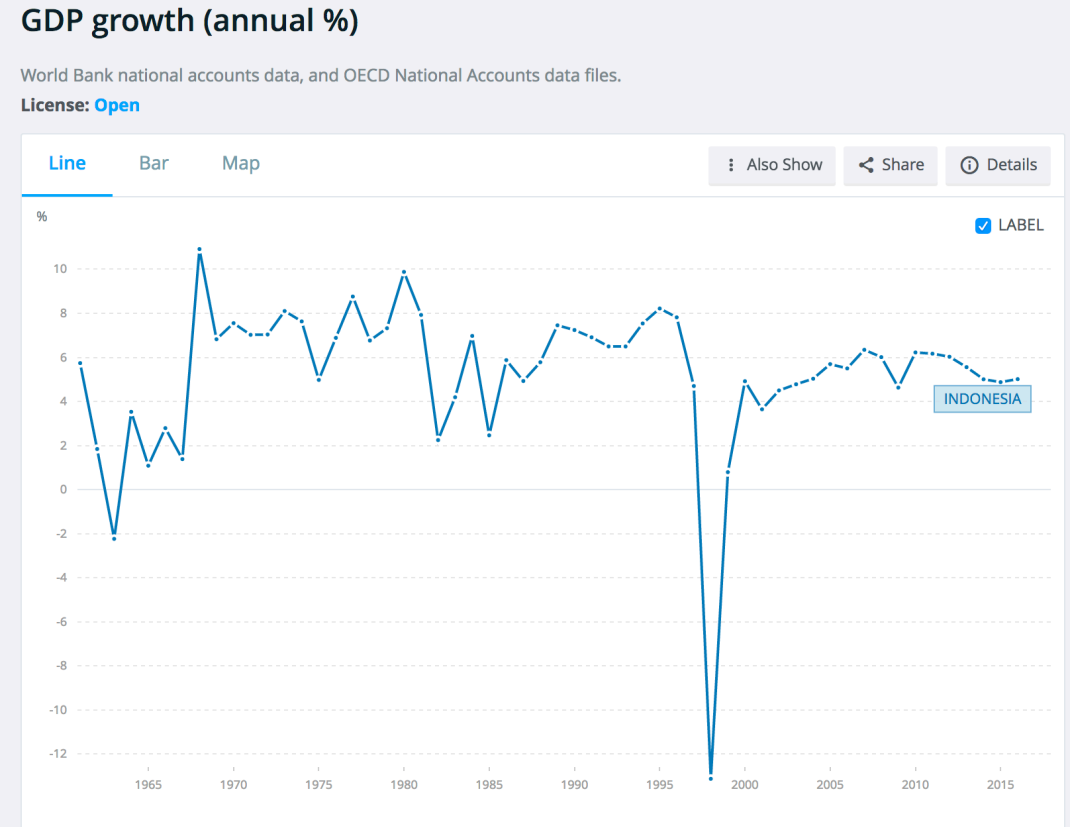
Indonesia GDP is reported as 4 different items by the World Bank in current or constant $ and also as PPP = purchase parity power: the values change drastically and it is amazing to see people quoting one GDP without telling which one!
Current GDP (brown) peaked in 1996, and also in 2012 (918 G$), but current 2016 (932 G$)is higher than 2012.
Constant GDP (dark blue) peaked in 1997 but not in 2012.
Current GDP per capita (red) displayed a strong rise from 1998 to 2011 with a peak in 2012 at 3700 $, with a low in 2015 and small rise in 2016, but still lower than 2012 at 3600 $.
Constant GDP per capita did not peak in 2012 as the current one.
The sharp trough in 1998 is the departure of Suharto and the beginning of democracy!



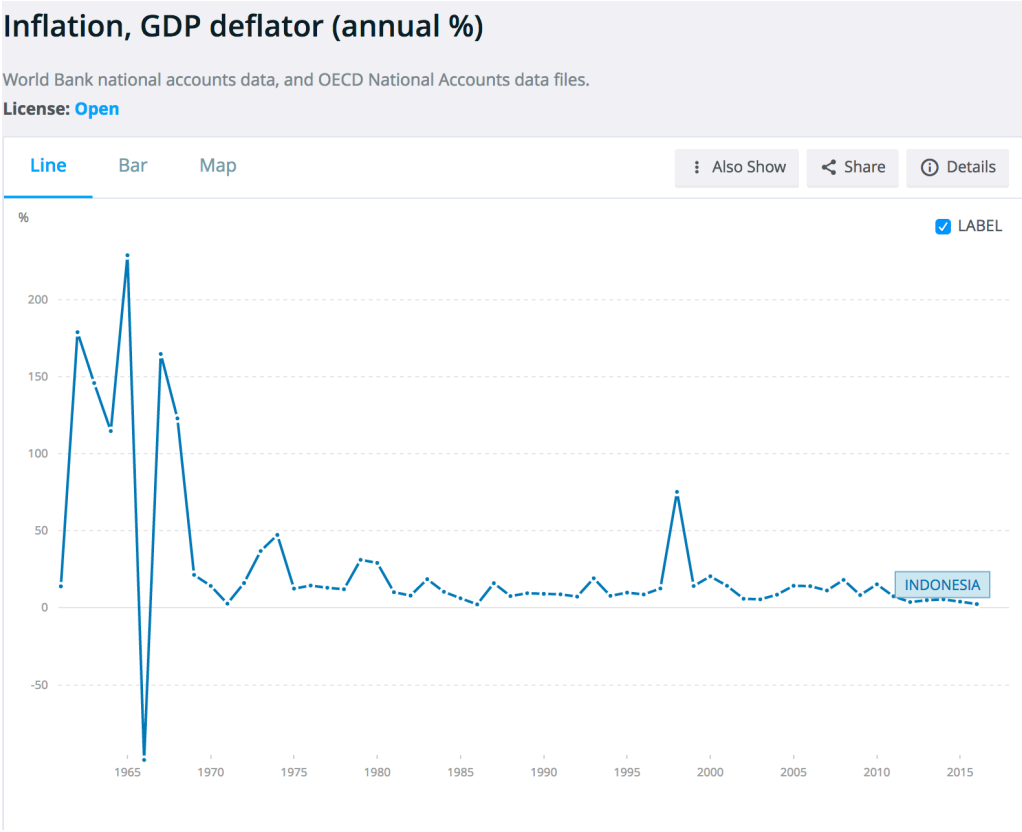
Out of the 4 GDP, since 1998 3 show regular growth, when the fourth in current $ shows flattening since 2011

GDP annual growth in % is different if constant or current $, more chaotic!

WB displays Indonesia GDP growth for constant $ without telling which one of the 4 GDP, omitting to display the chaotic growth for current $!



Indonesia has lived two periods of strong inflation 1960-1969 with a peak of GDP deflator = 250% in 1965 and 1998 with 75%.



-democracy: religion mandatory

Democracy begun in 1998 with the departure of Suharto (after 32 years !), based on tolerance and a moderate interpretation of Islam.

But an Indonesian is not free to say that he is an atheist (in 1965 communists were assumed to be atheists).

The Indonesian government makes religious education mandatory. Students can choose from Islam, Hinduism, Buddhism, Confucianism, Roman Catholicism or Protestant Christianity. All six religions are recognized and celebrated by the state. The Indonesian government obliges citizens to declare adherence to one of those recognized religions, restricts interfaith marriage and limits activities that it sees as interfering with communal rights, such as interfaith proselytizing (attempting to convert people) and blasphemy.

Blasphemy exists also in Greece and India

http://theconversation.com/is-indonesias-pious-democracy-safe-from-islamic-extremism-79239

In May 2017 Ahok (Christian governor of Jakarta) was found guilty of blasphemy (2 years in prison) by saying that "a Muslim can vote for a non-Muslin", quoting the Coran.

-Conclusion

Indonesia energy data is uncertain, as her number of islands.

Indonesia ministry of energy and mineral resources publishes a handbook, but in 2016 data is only for the period 2000-2015: long historical series are needed to understand the past.

Indonesia has produced about three quarters of her oil ultimate, but only half of her gas ultimate and one quarter of her coal ultimate.

Indonesia GHG emissions come mainly from land use change and forestry, about three times fossil fuels emissions. Forest land emissions has more than doubled from 1990. Burning biomass (mainly peat fires after drying peat to grow oil palm) emissions are chaotic (correlating with El Nino), but should be better controlled.

Indonesia renewable production is geothermal, which is not intermittent, when the intermittent wind/solar is negligible.

Indonesia is number one in the world for the number of Muslims (190 M out of 250 M), number of islands, steam coal export, palm oil production (also vanilla, cinnamon, cloves & coconut) and third-largest democracy (after India and USA).

Indonesia is ranked 61 in the world (worldaudit.org) with corruption problems (rank 73) and press freedom (rank 64). Transparency International ranks Indonesia at 90 for corruption (over 176, improving slowly).

Indonesia should reduce the inequality, which is on the increase and reduce the poverty, which is flattening.

Compared to the present Middle East religious wars, Indonesia is today a peaceful country and hopefully will stay this way, despite the recent attempts of some hardline Islamic groups to restraint freedom.

PS: sorry for my broken English.

Symbols used with units follow the rules of the SI = International System of Units which are legally adopted by every countries in the world, except nonfederal US, Liberia and Myanmar.

In fact Liberia and Myanmar use metric system, but they are not declared it officially.

The most opposed to the metric system (SI) is the US industry because the huge cost of changing units, but US scientists use the SI.

Indonesia adopted the SI in 1923, which is compulsory since 1938: k = kilo = thousand = 10^3, M = mega = million = 10^6, G = giga =10^9, T = tera = 10^{12}