

Is Coal Dead Yet Again?¹

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Received: Nov 23, 2017 Accepted: Dec 19, 2017 Published: Dec 20, 2017

Abstract

Is coal dead? This is a profound question that will affect investments, employment, climate change negotiations, future of energy debate. This article tries to dissect this question in to several parts, uses analytical tools, news items to reach a verdict. Coal may not be dead yet again, but high enough carbon prices may kill it. It provides security of supply, employment and other domestic gains. However, this doesn't mean solar, wind, batteries have no chance. On the contrary these technologies will be increasing their penetration with second and third waves of innovation. But coal in energy is like potato to the food sector. It will take a long time to kill it.

Keywords: energy, coal, energy resources

¹ Author thanks to Cunevt Kazokoglu and Mustafa Özgür Berke for their valuable criticism and contributions.

1. Introduction

The twenty first century started with growing demand for oil, followed by a record-high oil price, which then crashed to less than 1/3rd of that level in a matter of months. In the meantime, renewables started to gain, with solar at the frontline. As electric cars joined the chorus, everyone expected the funeral of coal. Interestingly enough there are discussions around peak oil but not peak coal.

Coal is the ultimate monster to the environmentalist groups, a guarantor of energy security for realist politicians and one of the building blocks of our modern society. It is very hard for anyone to find a right balance between these competing ideas. There is also risk of getting labeled in the simplistic minds. But this doesn't stop a critical mind to ask "what if coal is not dead, yet and again?"

I am rather asking a series of questions regarding "coal" being a resource of concentrated energy in a geographically diverse setting and "coal burning" as a technology. Also in this article I am trying to unmask the rhetoric from the reality derived from numbers. My last question to the reader is whether coal has a chance to make a come back with new technologies or policy settings.

As a disclaimer, my other writings acknowledge the solar, battery technology, electric car developments. But as an energy analyst, my aim is to present a critical narrative to the reader.

In this article, for analytical graphs and tables World Bank data services² were used. The tools are coded in R³, and a Turkish version of the coding tutorial for this article can be accessed online⁴.

2. Coal and Climate Change: German Case

No defense of coal can be expected from the environmental side. It may be equivalent to "climate change denial". The financial side targets coal with stranded asset based discussions and concerns.

There are two narratives of coal. One is the discussions we heard in the media with numerous academic articles and reports on "phasing out coal". The other is a reality that can be seen without prejudice.

2 "Data.worldbank.org. - World Bank Group." <https://data.worldbank.org/>. Accessed 22 Nov. 2017.

3 "R: What is R?." <https://www.r-project.org/about.html>. Accessed 22 Nov. 2017.

4 "R ile Enerji Analizi - Ders 13 - Dünya Bankası veri tabanından enerji verileri çekmek" <http://www.barissanli.com/calismalar/dersler/r/rders13.php>. Accessed 22 Nov. 2017.

Germany is the foremost example of this dilemma. While naming Angela Merkel as “Climate Chancellor”⁵, Germany is phasing out zero emission nuclear plants but not coal. Even phasing out coal looked like a distant target⁶ during coalition talks with the Greens(party).

During the recent Bonn Climate Conference (COP23), Merkel said “Climate change is an issue determining our destiny as mankind - it will determine the wellbeing of all of us”⁷. Two days before that speech however, influential Foreign Policy accused Germany as being a “Climate Change Hypocrite”⁸. It is not without basis that Germany is accused of betraying “climate change” cause. According to Agora Energiewende’s calculations Germany will miss the climate targets for 2020 with a margin of 10%⁹.

Adding to this debate is the famous emissions scandal of car manufacturers. It is not a secret that car manufacturers were gaming around emission tests. However the diesel engine nitrogen oxide (NOx) emission tests were deeply flawed. The software of the car checks whether the conditions resemble a test case, using pressure, temperature and speed sensors. If the car is not in the test setting, that means in real life, NOx emissions are up to 40 times above what is allowed in the US¹⁰. However instead of strengthening emission limits for cars, Germany lobbied to relax CO2 emission targets and didn’t push car manufacturers as US did.¹¹.

5 "The story of "Climate Chancellor" Angela Merkel | Clean Energy Wire." 30 Oct. 2017, <https://www.cleanenergywire.org/factsheets/making-climate-chancellor-angela-merkel>. Accessed 22 Nov. 2017.

6 "Germany clings to coal at climate summit | DW Environment | DW" 19 Nov. 2017, <http://www.dw.com/en/germany-clings-to-coal-at-climate-summit/a-41445013>. Accessed 22 Nov. 2017.

7 "Climate change will determine humanity's destiny, says Angela Merkel" 15 Nov. 2017, <https://www.theguardian.com/environment/2017/nov/15/climate-change-will-determine-humanitys-destiny-says-angela-merkel>. Accessed 22 Nov. 2017.

8 "Germany Is a Coal-Burning, Gas-Guzzling Climate Change Hypocrite" 13 Nov. 2017, <http://foreignpolicy.com/2017/11/13/germany-is-a-coal-burning-gas-guzzling-climate-change-hypocrite/>. Accessed 22 Nov. 2017.

9 "Deutschlands Klimaziel 2020 ist noch weiter weg als gedacht - Agora" 7 Sep. 2017, <https://www.agora-energiewende.de/de/presse/agoranews/news-detail/news/deutschlands-klimaziel-2020-ist-noch-weiter-weg-als-gedacht/News/detail/>. Accessed 22 Nov. 2017.

10 "Volkswagen: The scandal explained - BBC News - BBC.com." <http://www.bbc.com/news/business-34324772>. Accessed 22 Nov. 2017.

11 "New EU car CO2 limits in danger amid German automaker lobbying" 2 Nov. 2017, <https://www.euractiv.com/section/climate-environment/news/new-eu-car-co2-limits-in-danger-amid-german-automaker-lobbying/>. Accessed 22 Nov. 2017.

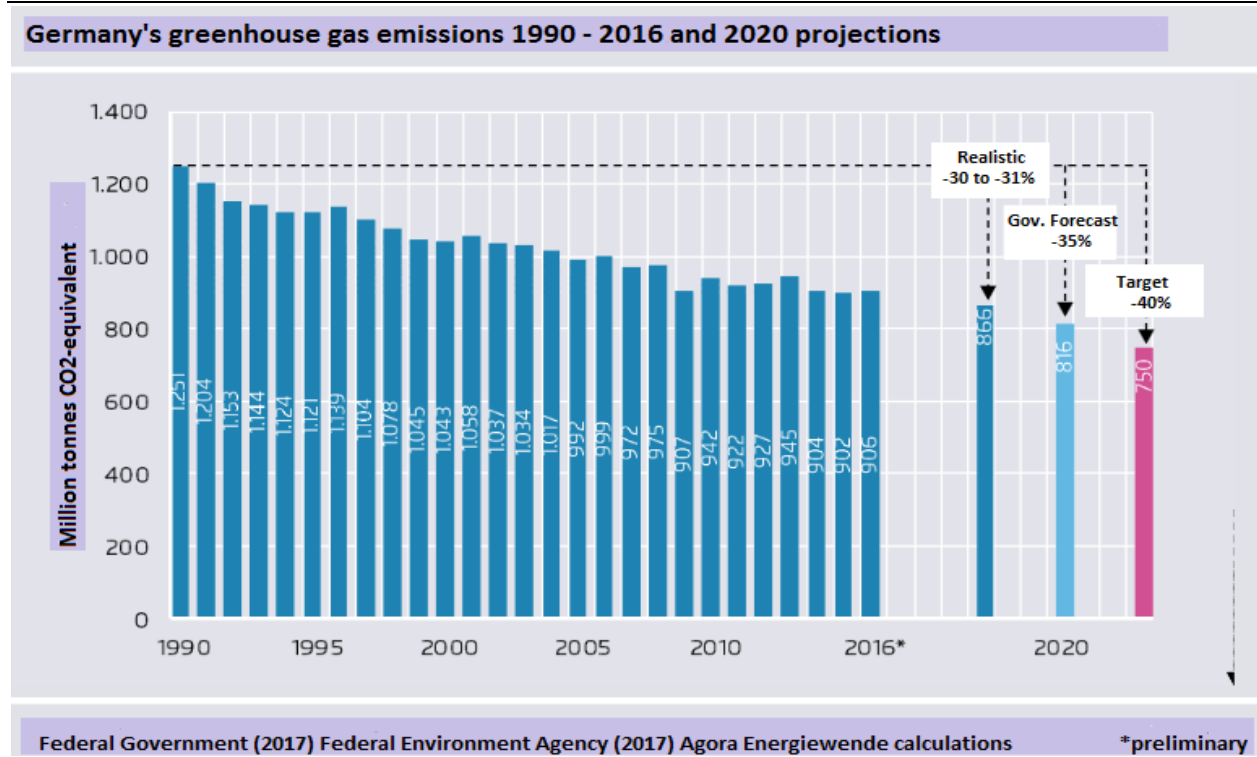


Figure 1 -Germany will miss climate change targets with a margin¹².

None of this is an evidence that German companies and politicians are against the “climate change policies”. But even as the powerhouse of the EU, Germany is struggling to give substance to its propaganda due to economic realities and realpolitik.

According to Fraunhofer’s latest energy charts, German installed capacity is more than 203,66 GW¹³. Solar is 42,45 GW and wind total is 54,43 GW¹⁴. In other words, nearly half of all the installed capacity is solar and wind. Generation wise however solar accounts for 7.8%, and wind for 17.6% off all generation¹⁵. Half of the installed capacity is equal to a quarter of generation share.

12 "Germany heads for "spectacular" 2020 climate target miss - study" 7 Sep. 2017, <https://www.cleanenergywire.org/news/germany-heads-spectacular-2020-climate-target-miss-study>. Accessed 22 Nov. 2017.

13 "Installed power in Germany | Energy Charts." https://www.energy-charts.de/power_inst.htm. Accessed 22 Nov. 2017.

14 "Installed Capacity per Production Type - ENTSO-E Transparency" <https://transparency.entsoe.eu/generation/r2/installedGenerationCapacityAggregation/show>. Accessed 22 Nov. 2017.

15 "Electricity generation in Germany | Energy Charts." https://www.energy-charts.de/energy_pie.htm. Accessed 22 Nov. 2017.

3. Solar is The Winner But...

During the recent solar auctions, solar prices have dropped to record lows of 17.7 USD/MWhs¹⁶. The price drop is dramatic and solar is gaining speed. IEA's latest World Energy Outlook 2017 hailed the solar as the winner for future: "Over the next 25 years, the world's growing energy needs are met first by renewables and natural gas, as fast-declining costs turn solar power into the cheapest source of new electricity generation."¹⁷.

Solar does not only provides a viable energy source to the developed countries but to the developing countries as well. African countries with lower rural electricity access can use solar to provide cheap and clean energy to their populations. It creates employment and does not require expensive infrastructure.

While reading solar news, one should be careful about how solar is presented to the masses. It is "the cheapest" source. So, the main selling point of solar is not the ideological rhetoric of "sun is not owned by anyone, it is a common good". It is the economic reality of being cheap. Energiewende is one of the enablers of scaling down the costs of solar technology.

In "Energy Democracy" authors Arne Jungjohann and Craig Morris discuss in detail the origins and dynamics of German Energiewende¹⁸. Most importantly they emphasize the distributive effect of German experience. It wasn't for the climate but for citizen democracy that Energiewende has become a success. That is why "auction"ing of solar capacity has not been seen as an "Energiewende" way according to authors.

But are there limits to renewable growth?

16 "Mexico's Energy Auction Just Logged the Lowest Solar Power Price" 21 Nov. 2017, <https://www.greentechmedia.com/articles/read/mexico-auction-bids-lowest-solar-wind-price-on-the-planet>. Accessed 22 Nov. 2017.

17 "A world in transformation: World Energy Outlook 2017." <https://www.iea.org/newsroom/news/2017/november/a-world-in-transformation-world-energy-outlook-2017.html>. Accessed 22 Nov. 2017.

18 "Energy Democracy - Germany's Energiewende to | Craig Morris" <https://www.palgrave.com/de/book/9783319318905>. Accessed 22 Nov. 2017.

4. Hydrocarbon Society

In his famous book about oil history Daniel Yergin calls our society as a “Hydrocarbon Society”¹⁹. From mobility to the tools we use, hydrocarbons are everywhere. To exemplify, we should look to the developments this year. As the oil consumption from transport is speculated to peak in the near future, we see more companies investing in petrochemicals²⁰. So either burning or for industrial usage, oil finds a place in this society.

What makes oil so essential for the society is its compactness, simplicity and energy content. 1 litre of diesel is equivalent to 11.1 kWh's of energy. One can hardly find such an easily displaceable, compact and dense energy source.

According to Vaclav Smil²¹, “a donkey powered mill (energy input at the rate of 300 W) produced from less than 10kg/h to 25 kg/h while millstones driven by a small waterwheel (1.5 kW) would grind flour at rates between 80 and 100kg/hour”. When you compare a waterwheel or a donkey to a litre of diesel, there are at least 7 times difference on an hourly basis. Smil argues in his book about how fossil fuels made the modern civilization.

Modern society is built on the multiplier effect of the power gained by fossil fuels. The technology and the energy to power that technology has given human kind an ability to increase his powers for better or worse.

Solar energy on the hand, is not that concentrated. It cannot be dispatched smoothly, you have to set up control mechanisms to manage solar powered generation. But it is abundant and easily accessible. With record low prices no resource seems to withstand solar. Assuming the innovation in solar technology continues its course, second or third generation solar panels may disrupt the whole system.

However, in today's world, neither China nor India is showing any radical slowdown in their coal usage. Solar is cheaper than 2 cent/kWh and Germany is not phasing out coal, US are bringing

19 "The Prize: The Epic Quest for Oil, Money, and Power - Wikipedia."

https://en.wikipedia.org/wiki/The_Prize:_The_Epic_Quest_for_Oil,_Money,_and_Power. Accessed 22 Nov. 2017.

20 "Big Oil To Bet On Petrochemicals As Demand Peak Looms | OilPrice" 17 Oct. 2017,

<https://oilprice.com/Energy/General/Big-Oil-To-Bet-On-Petrochemicals-As-Demand-Peak-Looms.html>.

Accessed 22 Nov. 2017.

21 "Energy and Civilization | The MIT Press." <https://mitpress.mit.edu/books/energy-and-civilization>. Accessed 22 Nov. 2017.

new regulations to protect coal and nuclear²², India's coal demand may peak in the next 10 years²³. China's coal demand has been thought to have peaked²⁴. The stagnation of global emissions has probably come to an end this year²⁵. In 2017 emissions are set to rise by 2%. Chinese emissions are expected to increase by 3.5%. The tides are changing.

These arguments boil down to the question of "if people want a modern life, the only concentrated power source to provide it is the fossil fuels or they should change their lifestyles and choices in a system hardwired for consumption and fossil fuels".

5. Looking to Data: From "Limits to Growth" to "Limits to Renewable"

The whole debate does not go anywhere. If the developed countries are the holy grail of science and if they are scientific facts based societies, scientists urge to end fossil dependency for human survival. Politicians of the same developed countries pay their lip service to climate change but policy wise, even the Norwegians cannot do without oil²⁶. Climate change is just another political reality where promises are exciting but realities are harsh.

So rich countries and their economic warehouses cannot make the transition, neither show the real courage to do it. Although they are reluctant, household and industrial energy prices may justify the transition for citizens themselves. Yet, even German Energiewende is out of steam²⁷.

This doesn't mean solar is bad, coal is good, climate change is faux, and politicians are liars. Just as the solar makes headlines with its "lowest" auctions, economic realities always make way for the future development.

22 "Notice of Proposed Rulemaking - Department of Energy." 28 Sep. 2017, <https://energy.gov/sites/prod/files/2017/09/f37/Notice%20of%20Proposed%20Rulemaking%20.pdf>. Accessed 22 Nov. 2017.

23 "IEEFA India: Peak Coal Demand in 10 Years - Institute for Energy" 21 Nov. 2017, <http://ieefa.org/ieefa-india-peak-coal-demand-10-years/>. Accessed 22 Nov. 2017.

24 "China says coal consumption falls for third year - Phys.org." 28 Feb. 2017, <https://phys.org/news/2017-02-china-coal-consumption-falls-year.html>. Accessed 22 Nov. 2017.

25 "CO2 Emissions Were Flat for Three Years. Now They're Rising Again" 13 Nov. 2017, <https://www.nytimes.com/interactive/2017/11/13/climate/co2-emissions-rising-again.html>. Accessed 22 Nov. 2017.

26 "No, Norway Isn't Turning Away from Fossil Fuels - Bloomberg." 21 Nov. 2017, <https://www.bloomberg.com/view/articles/2017-11-21/no-norway-isn-t-turning-away-from-fossil-fuels>. Accessed 22 Nov. 2017.

27 "Running out of Steam: Taking Stock of Germany's Energiewende" <http://www.strategie.gouv.fr/english-articles/running-out-steam-taking-stock-germanys-energiewende>. Accessed 22 Nov. 2017.

6. Data Tells a Different Story

Therefore data is essential. In this part, an analysis based on historic data from World Bank data set is presented. GDP, population, electricity production, share of renewables and share of renewable energy in total final energy consumption are some of the data that can be reached from its website. As explained in the analysis available online²⁸, after removing all “not available data” and subsetting the data to the data after year 2000 the data set is ready for analysis.

One of the most striking graphs is the share of renewables in total final consumption versus GDP graph below. Generally conventional renewables like biomass, dung etc are the main energy source in low income countries. We can see this trend from the graph. However, as income increases renewable share does not increase and seems to be stuck somewhere around 30%. The data span is 2001-2015. More energy usage (coloring) corresponds to relatively higher GDP and lower renewables in total final energy consumption (TFEC).

There is also a clear inverse relation between wealth and use of renewables. Higher energy usage is related to less renewable share. It is particularly important that both wealth and energy usage is historically moving in opposite directions to renewable usage.

This is historical data. That is to say that if we were Romans and made an analysis regarding energy needs, the results will show that mule, horse, wood and waterwheels are correlated with wealth.

28 "R ile Enerji Analizi - Bölüm 13" 21 Nov. 2017, <http://www.barissanli.com/calismalar/dersler/r/rders13.php>. Accessed 22 Nov. 2017.

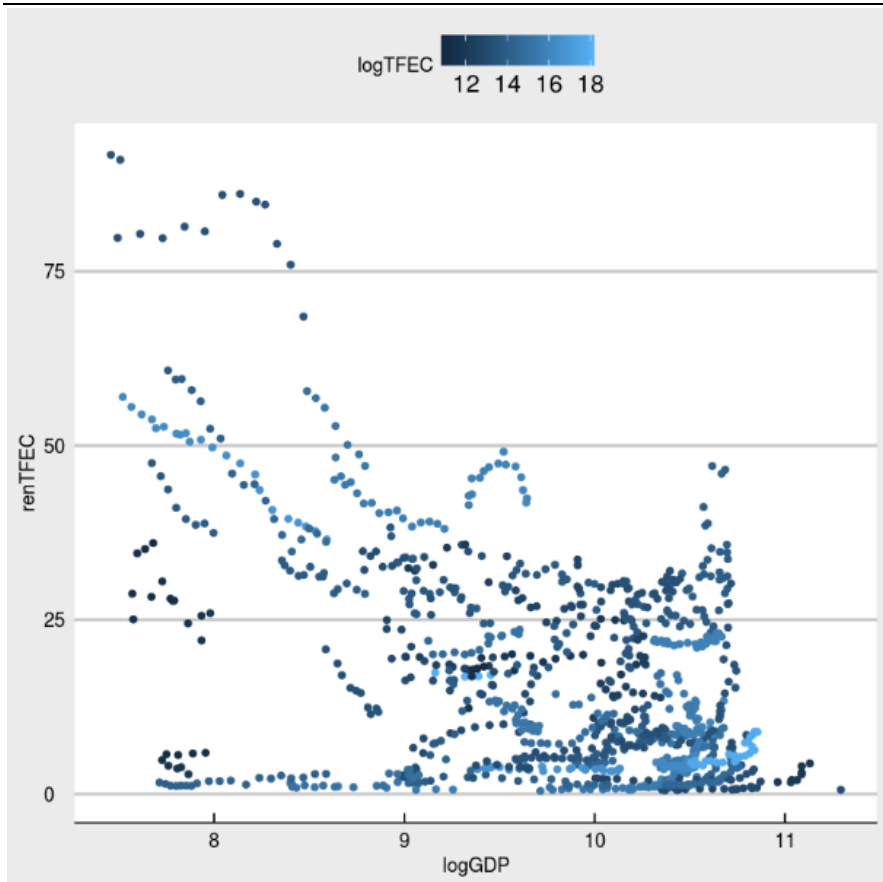


Figure 2: logarithm(ln) of per capita GDP versus renewable share in Total Final Consumption.

We can also check per capita GDP versus per capita electricity consumption. As the graph below shows both variables are positively correlated. Meanwhile more coal usage is weakly correlated with higher GDP and electricity consumption.

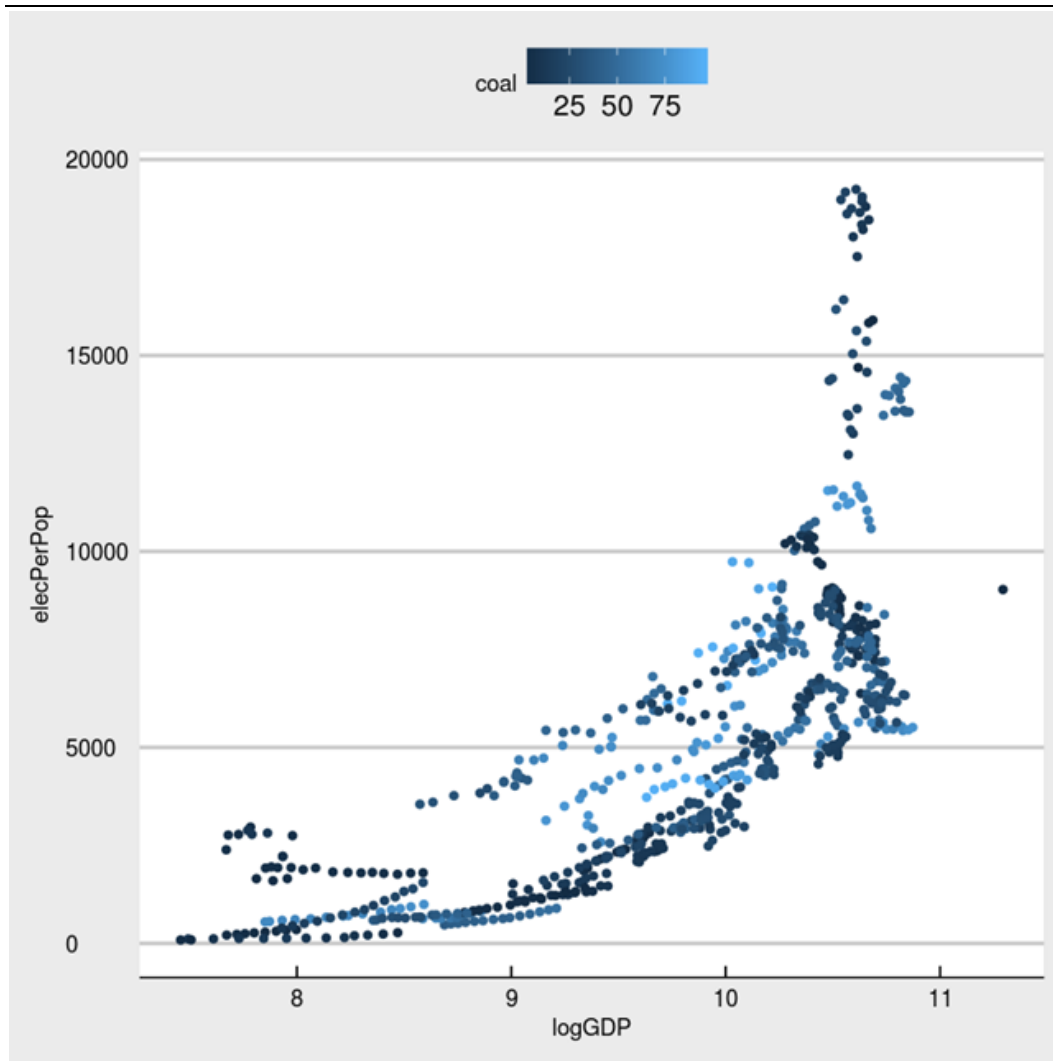


Figure 3 : logarithm(ln) of per capita GDP versus per capita electricity generation colored with coal share.

When we look at the correlation table from the analysis, coal is practically positively correlated with all variables except for renewable and natural gas share in electricity generation. One must not forget correlation is not causation.

Table 1: How coal is related to other variables.

	coal	gas	gdp	raccess	uaccess
coal	1.00000000	-0.249834831	0.02328390	0.17787919	0.09448646
gas	-0.24983483	1.000000000	0.36006542	0.25551126	0.18332611
gdp	0.02328390	0.360065419	1.00000000	0.51061984	0.36076442
raccess	0.17787919	0.255511261	0.51061984	1.00000000	0.78807211
uaccess	0.09448646	0.183326114	0.36076442	0.78807211	1.00000000
ren	-0.39242469	-0.402218559	-0.27306619	-0.31885798	-0.24488729
TFEC	0.18890813	0.004571554	0.12171639	0.13801542	0.10889748
renTFEC	-0.28325301	-0.351673536	-0.47461212	-0.77630611	-0.64488873
elec	0.18682479	-0.015528385	0.15295673	0.15998241	0.12029398
pop	0.19009804	-0.004611034	-0.09313894	-0.03684994	0.01407148
logTFEC	0.22160976	0.143687148	0.17106637	0.26171615	0.21064511
logGDP	0.17867476	0.253767402	0.84278274	0.76100278	0.61114590
elecPerPop	0.04197416	0.066263007	0.65355469	0.47167661	0.33043191
TFECPerPop	0.07542586	0.259728808	0.81117274	0.49756093	0.34507919
logelec	0.26660477	0.141924238	0.30491340	0.55685895	0.47209715

In the table, coal's share in electricity is more strongly correlated with electricity, population, energy consumption. Renewable is negatively correlated with GDP. Maybe GDP is not a good measure of wealth, but numeric results are as given. Human Development Index can be an alternative.

Why is this so? Why are renewables not the source of wealth and look like an indicator for poverty? The variable ren is renewables in electricity generation and renTFEC is renewables share in total final energy consumption (TFEC). Both are negatively correlated with GDP. In TFEC the correlation is stronger than electricity.

The other explanation is that, this is the result of historic data and testimony to exactly what Daniel Yergin claims: "modern society is a hydrocarbon society". It is addicted to abundant and dense energy sources, solar may not feed its hunger. When prices are low, it prefers SUVs. If there is budget, the indoor temperature should be 27 C. Energy transformation does not only need infrastructure and technology shift but also a cultural shift.

The other important parameter is the import dependency. If policy makers are stuck between indoor air quality and import dependency, they will find the balance like Turkey in the 1990s or

China now²⁹. Coal will be used in the sparsely populated regions and industrial areas, but cities will enjoy natural gas, electric cars, solar and batteries.

The other qualities of coal such as employment, accessibility and being a domestic resource are highly valuable. The most spectacular example is during COP23 in Bonn, while climate change negotiations were proceeding, nearby villages were emptied to make space for coal mining³⁰. The East Asian economic engines such as Japan³¹ and Korea³² are no different as they increase their coal imports. The evidence turns the COP and climate change events to showcases, where everyone nods and continue what they are doing. If Germany misses its 2020 targets, even the signatures do not mean anything.

7. The Dark Side of Coal

The dark side of coal is its emissions. It pollutes air, water, environment. It causes respiratory problems. So do the diesel cars. Despite US stance against dirty diesel cars with 40 times higher emissions than the legal limits, no environmentalist action is seen around the world against diesel engines except for a few web posts. Diesel being dirty does not make coal clean. However if coal is dirty so is diesel. If a resource is harmful to human quality of life, the name should not matter.

But why coal is dirty? Because coal is burned and there are no other economically sound technology to do otherwise. Burning is the simplest of all. Coal to liquids is not a widely available commercial technology and carbon capture and storage is in infancy.

Will there be new methods to extract more energy from coal? That is the question. Because coal is a material of dense energy content. Coal in energy is what potato is to the food industry. Nearly all countries have at least moderate quality coal resources.

Coal is not by itself dirty but burning coal produces the dirt. If prices give enough incentives, it is a domestically accessible, cheap energy source and it may produce addiction.

29 "TAKE A LOOK-China pollution fight - Country turns to gas to cut smog." 11 Oct. 2017,

<https://uk.reuters.com/article/china-pollution-take-a-look/take-a-look-china-pollution-fight-country-turns-to-gas-to-cut-smog-idUKL4N1MM1VD>. Accessed 22 Nov. 2017.

30 "In shadow of Germany's climate conference, a village disappears to" 11 Nov. 2017,

https://www.washingtonpost.com/world/europe/in-shadow-of-germanys-climate-conference-a-village-disappears-to-make-way-for-coal/2017/11/11/82deb030-c18b-11e7-9294-705f80164f6e_story.html. Accessed 22 Nov. 2017.

31 "FACTBOX-Japan plans to build new coal-fired power stations." 29 Jun. 2017,

<https://www.cnbc.com/2017/06/29/reuters-america-factbox-japan-plans-to-build-new-coal-fired-power-stations.html>. Accessed 22 Nov. 2017.

32 "UPDATE 1-S.Korea set for record coal imports on nuclear outages as" 30 Oct. 2017,

<https://www.reuters.com/article/south-korea-coal/update-1-s-korea-set-for-record-coal-imports-on-nuclear-outages-as-winter-looms-idUSL4N1N52RC>. Accessed 22 Nov. 2017.

The only remedy practiced is not solar but carbon price. British energy transformation from being pioneers of coal usage to %0 coal usage in electricity is probably as a result of carbon price³³. Coal share in UK electricity generation hit zero for the first time in 100 years this year in certain days. But carbon price does not achieve it all alone, the price must be sufficiently high to enable a transition. Coal's economic advantage can even stand against low carbon prices. Enemy of the coal is not environmentalists, COPs, solar or wind but economic realities. Either the playing field should be set to pave the way for a non-coal energy system, or coal will continue to show its strength. It will age but killing it may take a long time.

8. Conclusion

The current transformation towards renewables in the energy sector is more of a lip service than reality. But there is basis for that transformation, as such technological foundations, roadmaps are readily available. Solar will prevail more than anyone can imagine, electric cars are coming, and batteries will disrupt the energy system. But when the data and countries' policies are examined, it looks as if "lip service" has reached its limits. Economic push for a new energy system is needed. Yet we are not seeing it. On the contrary, there is a slow but gradual reluctance against climate change issues among big players. It is strengthening. These leaders and their parties are not against solar, wind or climate change policies as long as they are economical. Most probably they are concerned with economic realities more than the environmentalists.

Therefore it is not an exaggeration to claim that coal may not be dead. The main cause is the society we live in. It is deeply embedded with concepts such as economies of scale, cost-benefit analysis and preferring domestic interests to common goods. The second concern is there may be limits to renewables, even with sub 1 cent/kwh auction prices. The third concern is level playing field is again shifting in favor of fossil fuels. Skillful politicians learned the trick of the game, speak boldly, move silently.

Solar, wind, batteries, electric cars are the future but it will take time. Meanwhile "Is Coal Dead Yet Again?" never surprise with a comeback. We can only kill coal, when a global carbon price is enforced.

33 "UK energy from coal hits zero for first time in over 100 years" 13 May. 2016, <https://www.theguardian.com/environment/2016/may/13/uk-energy-from-coal-hits-zero-for-first-time-in-over-100-years>. Accessed 22 Nov. 2017.

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