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Predicting the Timeline for Earth Achieving Kardashev Scale Type 1 Status

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Abstract: *The Kardashev Scale is a method of measuring a civilization's level of technological advancement based on the amount of energy they are able to use.Kardashev's idea of classifying civilizations according to their ability to harness energy came up when he analysed how powerful an extra-terrestrial radio signal would have to be in order to be detected by conventional radio astronomical techniques. The numbers he came up with were quite high, and this furnished the basis of his tripartite division of civilizations into Type I, II, and III. Further scientists like Carl Sagan worked on finding out where exactly the earth stood in terms of usage of energy on the Kardashev Scale and came up with a formula for calculating the same. Physicist and futurist Michio Kaku suggested the number of years it would take the humans to attain Type I, II and III status if they consistently increased their energy consumption.Taking his study further, in this paper, based on time series algorithm, using such statistical tools as linear regression we try to calculate the year in which earth will attain Type I status. It was found that earth would reach Kardashev's Type 1 status in 327 years' time.*

Keywords*: Kardashev Scale,Extra-terrestrial Communication, Civilisation Type*

I. Introduction

Formulated around 50 years ago by the Russian radio astronomer Nikolai Kardashev his analysis of usage of energy by civilisations in the universe is still the gold standard. In this paper we discuss the Kardashev Scale, where our mother earth currently is on the Kardashev Scale, how it is progressing and when it will achieve the next level.

Sightings of Unidentified Flying Objects (UFOs), stories of aliens, extra-terrestrial life and communication with them have always fascinated scientists and common man alike. While the common man watched reels of films filled with the improbable, maybe even impossible accounts of humans becoming friends or bitter enemies with these aliens and poorly animated intergalactic wars, scientists silently went about understanding whether life was possible in other planets, how advanced were life in other planets and whether inter galactic travel and communication were possible.

1.1 Kardashev Scale

One such person was Nikolai Kardashev. The Kardashev Scale is a method of measuring a civilization's level of technological advancement based on the amount of energy they are able to use.He was one among the pioneers of the Search for Extra Terrestrial Intelligence (SETI) and his idea of classifying civilizations according to their ability to harness energy was directly related to his experience in radio telescopy. While Kardashev[1](1964) was conducting his studies he came across the question of how powerful an extra-terrestrial radio signal would have to be in order to be detected, by conventional radio astronomical techniques. The numbers he came up with were quite high, and this formed the basis of his division of civilizations into Type I, Type II, and Type III.

1.2 Types of Civilisations

According to Kardashev the three types of civilizations he recognized are:

Type I – whose technological level is close to the level presently attained on the earth, with energy consumption at ~4 x 10^{19} erg/sec.

Type II – a civilization capable of harnessing the energy radiated by its own star, with energy consumption at ~4 x 10^{33} erg/sec.

Type III – a civilization in possession of energy on the scale of its own galaxy, with energy consumption at ~4 x 10^{44} erg/sec.

Kardashev specified for a Type I civilization a, "technological level close to the level presently attained on the earth." Kardashev did not say what "close" means in this context.

II. Objective of The Study

The objective of this study was to understand if there was a relation between the change in energy consumption over the years, there by a change in K Values and if so is there a clear pattern that can be extrapolated into the future so that we can check out when the planet earth would achieve the Type 1 Civilisation levels.

III. Earth's Status on Kardashev Scale

Further scientists likeCarl Sagan, George Basalla and David Lamb worked on finding out where exactly the earth stood in terms of usage of energy on the Kardashev Scale. Lamb[2](2001) came to the conclusion that Type I would have a similar technological level to Earth, using 6.6×10^{12} watts. This civilization could engage in something akin to the present power output of Earth for the purpose of interstellar communication. Type I civilizations would have the power to restructure entire planets.

According to Basalla[3](2006), The Earth has not quite reached Type I status because its inhabitants are unable to capture all of the radiant energy streaming down upon it. For this reason, Sagan[4](2000) said that the Earth was more accurately called a Type .7 civilization. This is an entirely reasonable extrapolation of Kardashev.

The logic Sagangave is as follows: The energy gap between a Type I and a Type II civilization or between a Type II and a Type III civilization is enormous – a factor of about ten billion in each instance. It seems useful, if the matter is to be considered seriously, to have a finer degree of discrimination. I would suggest Type 1.0 as a civilization using 10^{16} watts for interstellar communication; Type 1.1, 10^{17} watts; Type 1.2, 10^{18} watts, and so on. He came up with figures of 0.7 based on the formula he created for calculating the same.

For the past decade, global energy consumption has been increasing at an average rate of 2.3 percent per year – more growth in years of economic growth or difficult winters, less in years of recession and mild winters. Roughly, this means that global energy consumption will double every thirty years, so that since the time Kardashev wrote his paper, global energy consumption is well on its way to quadrupling.

3.1 Progression of energy consumption and Kardashev Values

In the following table the researchers have calculated the Kardashev Values from the energy consumed over the years from 1965, the year after Kardashev published his paper to 2019. The energy components we considered when calculating the total energy consumption were: Coal, Oil, Gas, Hydropower, Nuclear, Solar, Wind, Traditional Bio mass, Bio fuels and other renewables. The energy consumption and K value calculations are given in the Table 1 below.

Table 1.K Value Calculated from Energy Consumption

Year	Total(TWh)	Total(TW)	K value		Year	Total(TWh)	Total(TW)	K value
1965	50681	5.785502	0.676234		1993	100322	11.45228	0.705889
1966	52945	6.04395	0.678132		1994	101592	11.59726	0.706436
1967	54668	6.240639	0.679523		1995	103370	11.80023	0.707189
1968	57484	6.5621	0.681704		1996	106244	12.12831	0.70838
1969	60803	6.940982	0.684142		1997	107301	12.24897	0.70881
1970	64105	7.317922	0.686439		1998	107962	12.32443	0.709077
1971	66327	7.571575	0.687919		1999	109833	12.53801	0.709823
1972	69413	7.923858	0.689894		2000	112381	12.82888	0.710819
1973	72939	8.32637	0.692046		2001	113558	12.96324	0.711271
1974	73005	8.333904	0.692085		2002	115844	13.2242	0.712137
1975	73205	8.356735	0.692204		2003	119927	13.6903	0.713641
1976	76762	8.762785	0.694264		2004	124931	14.26153	0.715417
1977	79119	9.031849	0.695578		2005	128829	14.70651	0.716751
1978	81347	9.286187	0.696784		2006	132161	15.08687	0.71786
1979	83842	9.571005	0.698096		2007	136141	15.54121	0.719148
1980	83167	9.49395	0.697745		2008	137309	15.67454	0.719519
1981	82609	9.430251	0.697452		2009	135185	15.43208	0.718842
1982	82038	9.365068	0.697151		2010	141057	16.1024	0.720689
1983	83018	9.476941	0.697667		2011	144327	16.47568	0.721684
1984	86344	9.856621	0.699373		2012	145975	16.66381	0.722177
1985	88124	10.05982	0.700259		2013	148182	16.91575	0.722829
1986	89819	10.25331	0.701086		2014	148955	17.004	0.723055
1987	92616	10.5726	0.702418		2015	149653	17.08368	0.723258
1988	95720	10.92694	0.70385		2016	151254	17.26644	0.72372
1989	97517	11.13208	0.704658		2017	153513	17.52432	0.724364
1990	98551	11.25011	0.705116		2018	157366	17.96416	0.725441
1991	99086	11.31119	0.705351		2019	158839	18.13231	0.725845
1992	99892	11.4032	0.705703					

Energy Consumption Data Set Source: Our World in Data (http://ourworldindata.org/)

Calculations

$K=(\log_{10}(P)-6)/10$
where,
K is Kardashev Value
P is Power in Watts
TWh/8760=TW
$TW \times 10^{12}$= Watts
$K_{1973}= (\log_{10}(8.33 \times 10^{12}) - 6)/10= 0.69$
$K_{2019}= (\log_{10}(18.13 \times 10^{12}) - 6)/10= 0.73$

IV. Extrapolation of Kardashev Values

Now if Sagan and the rest spoke about where the earth stands in terms of Kardashev Scale vis-a-vis energy consumption Michio Kaku went ahead and worked out the extrapolation of Kardashev Values.
Kaku[5](2008), a futurist besides being a physicist is poetic in drawing out the implications of Kardashev's civilization types as he sees them. For example, here is how Kaku defines a Type I civilization: those that harvest planetary power, utilizing all the sunlight that strikes their planet. They can, perhaps, harness the power of volcanoes, manipulate the weather, control earthquakes, and build cities on the ocean. All planetary power is within their control.

Kaku[6] (2011) goes into much more detail in Chapter 8, "The Future of Humanity," in his book *Physics of the Future*, where he interprets and extrapolates Kardashev civilization types. Kaku suggested that, if humans

increase their energy consumption at an average rate of 3 percent each year, they may attain Type I status in 100–200 years, Type II status in a few thousand years, and Type III status in 100,000 to a million years.

4.1 K Value Forecast

Taking his study further we calculated the year in which earth will attain Type I status, as shown in Figure 1 below. The dataset for the same is given in Table 2.

Figure 1.K Value Forecast

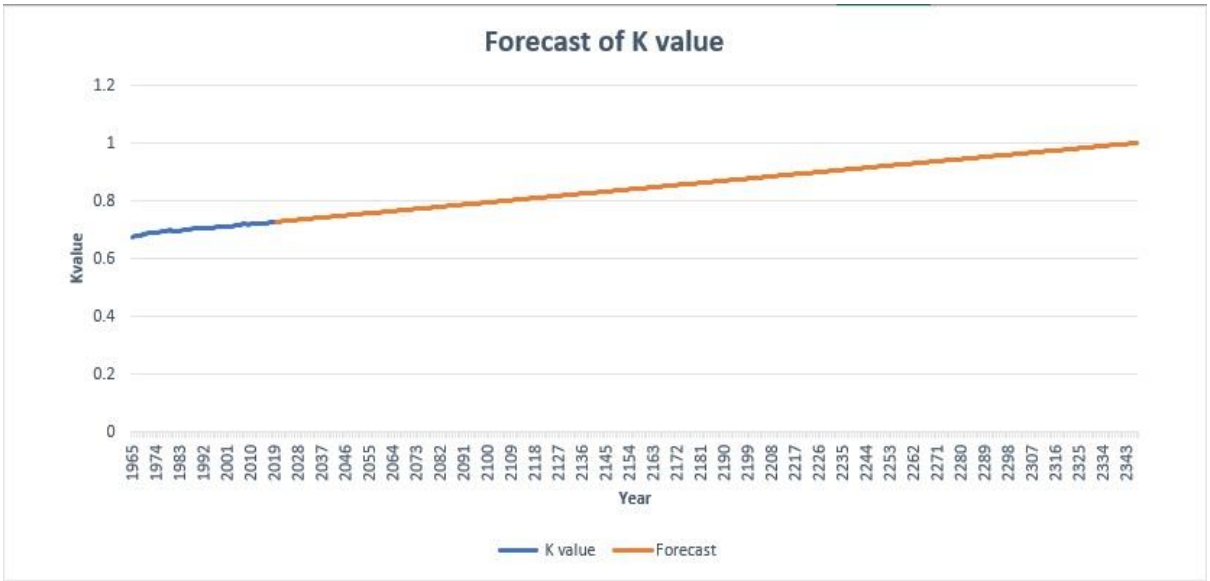

Table 2. K Value Forecast

Year	Forecasted K value		Year	Forecasted K value
2020	0.72852789		2195	0.87422001
2025	0.732690522		2205	0.882545274
2035	0.741015786		2215	0.890870538
2045	0.74934105		2225	0.899195802
2055	0.757666314		2235	0.907521066
2065	0.765991578		2245	0.91584633
2075	0.774316842		2255	0.924171594
2085	0.782642106		2265	0.932496858
2095	0.79096737		2275	0.940822122
2105	0.799292634		2285	0.949147386
2115	0.807617898		2295	0.95747265
2125	0.815943162		2305	0.965797914
2135	0.824268426		2315	0.974123178
2145	0.83259369		2325	0.982448442
2155	0.840918954		2335	0.990773707
2165	0.849244218		2345	0.999098971
2175	0.857569482		2346	0.999931497
2185	0.865894746		2347	1.000764023

*The Kardashev scale is predicted to reach Type 1 civilization in the year 2347 i.e., after 327 years to reach type I civilization.

4.2 Analysis Methodology

Linear regression was the statistical tool used to forecast the K values from 2020 to 2347. Linear regression in this case was used in the modelling of the relationship between years 1965 and 2019 and K Values. It was obvious there was a clear pattern of relationship between the two variables and the best fitwas plotted and extrapolated, to predict the K Value. The equation is in the form Y= a + bX, where Y is the dependent variable,X is the independent variable, b is the slope of the line and a is the y-intercept.

4.3 Scope and limitation of the study

We have extrapolated the K Values based on the historical data available on energy consumption. First of all there could be further energy sources than those we have considered. If not presently there could be in the future which would accelerate the energy consumption. There could be other factors or events in play in the external environment which could either accelerate or decelerate energy use in the future.

To that extent this study can only be taken as an academic exercise. We can see that we are moving fast and growing in energy use yearly to the extent that at one time in the not too distant future (as early as 2347) we would be using the energy resources available in our Mother Earth to the maximum.

V. Conclusion

It was while doing a study on sustainable development of the earth's resources and usage of renewable energy that the researchers came across the word Kardashev Scale and going through researches on the same excited their interest in the direction energy consumption was taking.

However, we choose to interpret and extrapolate Kardashev, we need to accustom ourselves to thinking as rigorously about civilization as we do about science. The use of energy resources have to be in a sustainable manner and it is obvious that this is not being done. If we don't do so we may reach Type I by 2347 but may never see Type II as we may destroy ourselves by our carelessness and indifference to the environment.

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