Energy Consumption and Production with new Posibilities

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13 June 2025

Energy

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Summary:

Reducing harmful emissions and decreasing costs of large weather problems is the aim of today. This means new strategies and investment in renewable types of energy.

The most countries still linger in old system contributing to its own problems. If problems are not locally solved the world initiatives will reach the end point.

Energy

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0. HISTORY AND EXPLANATION

GDP rise on average throughout world means greater need for energy. In that respect we all put more and more emphasis on topics such as energy production and consumption with all related issues by side in that respect. We have connected two major dots in our world: energy and environment. In both ways as potential and as treat. But to see how we can harness energy with the minimum impact on nature we need to research what is present in today's world. We divide energy production into two major sources. One we call renewable sources and the other non-renewable. Using each group has different impact on climate and environment and different consequences of our future potentials.

Being aware of unwanted future scenarios, policy regulators tried to establish international bounding agreements, policies standards introducing notions such as: energy planning, emission reduction, so requires certain amount of minimum investment in renewables and reporting about results.
The most prominent meeting was held in Paris where 196 Parties at the UN Climate Conference COP21 Agreed legally binding international treaty. Its goal is to keep and hold the increase in the average temperature well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels."

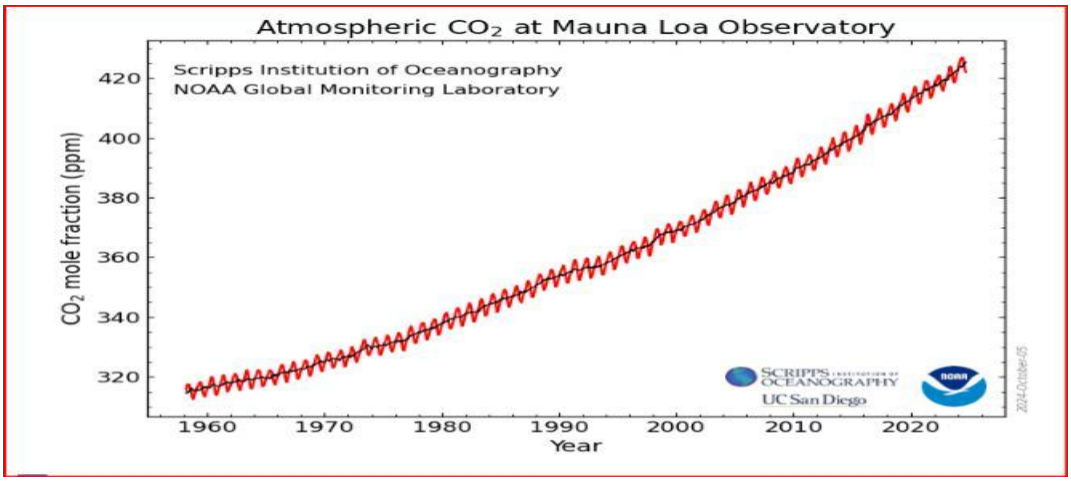
That's because the UN's Intergovernmental Panel on Climate Change indicates that crossing the 1.5°C threshold risks unleashing far more severe climate

change impacts, including more frequent and severe droughts, heatwaves and rainfall.

Another Important Meeting was held in Japan and is known under name the Kyoto protocol. These parties agreed to establish a rigorous monitoring, reporting verification system and to be held accountable for acts in the energy and environmental sector curbing emissions as a goal.

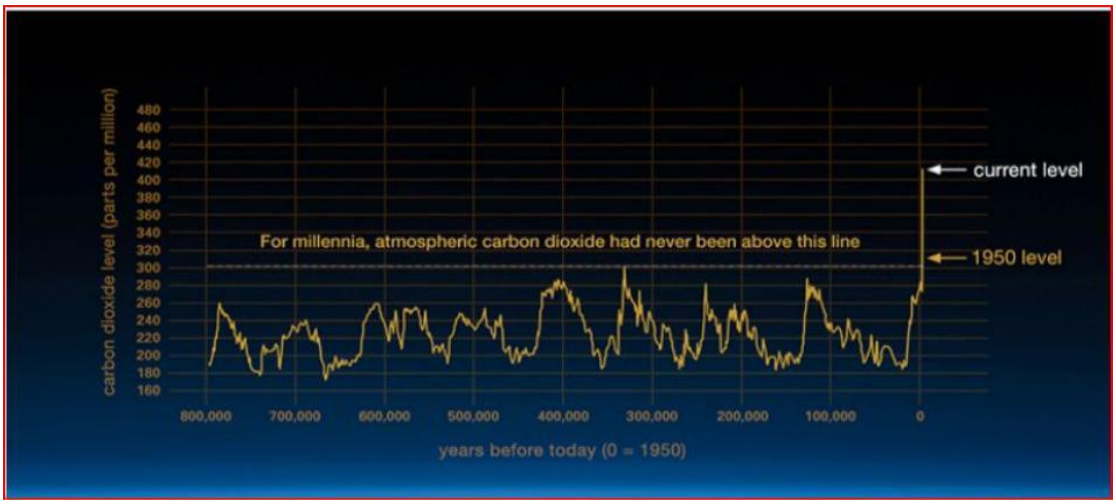
Besides having a reporting system, the Protocol targeted certain market-based mechanisms such as International Emissions Trading, Clean Development Mechanism CDM, and Joint Implementation JI programs.

This meeting was only the first steps in having environmental damage under control. As noted in the most economic prosperous countries, the number of CO_2 historical values from year to year go up. See: *Image 1.* Image 1: CO_2 Atmospheric



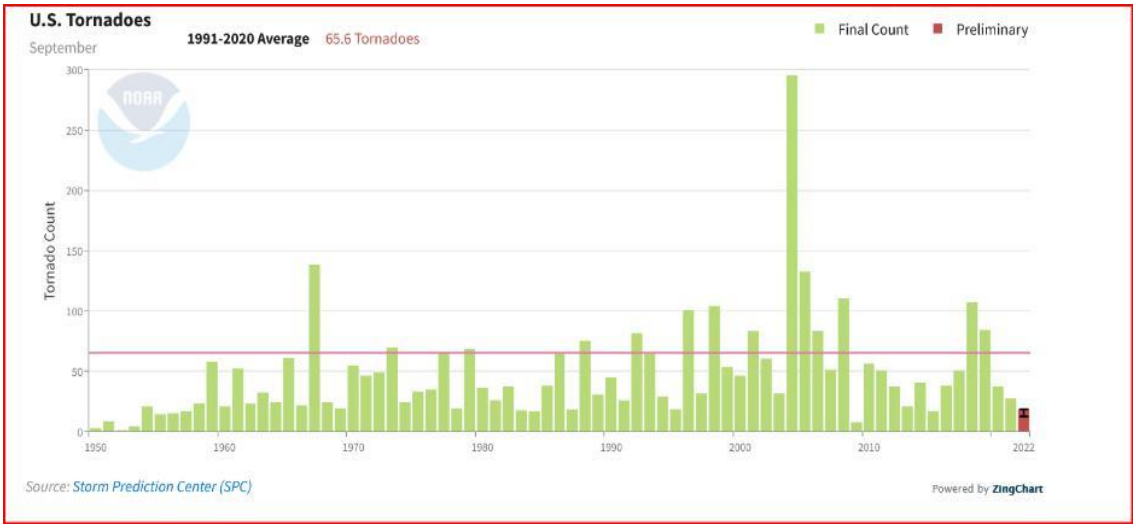
Source: www.wikipedia.org

Image 2: Historical value of CO_2 level



Source: www.earth.org

With rising harmful gases number of negative natural events are more frequent in occurrence. Such as: Tornados. See *Image 3*, flooding, dry periods, lower rate of rainfall, clean water in decreased mode etc. Image 3: Weather in USA -Tornados



Source: www.climate.map.gov USA

The most prosperous countries have done a huge lot in the last 10 years regarding renewables: Investment in solar technologies, wind, biofuels rose significantly, and this trend has steep slope while found usage by big rich 5

countries. Besides state policy investors, companies, government buildings, hospitals, stadiums, and even households are more and more opted to use solar as a solution to their energy supply.

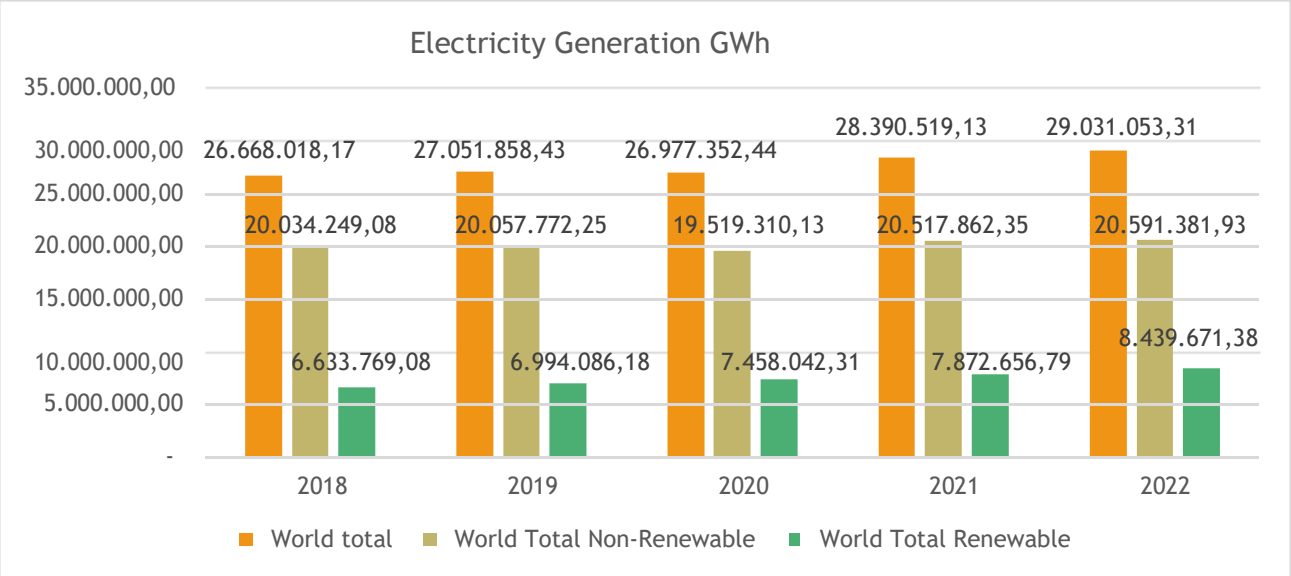
How the situation in that respect develops in the southern part of Earth, is there significant interest in renewables, or does this region continue with slow pace, lacking initiatives is the main topic that follows. At the end we can provide solutions and possibilities.

1. WORLD AND REGIONAL DATA

Before concentrating on Mauritius let us firstly examine some world and regional data connected to electricity production.

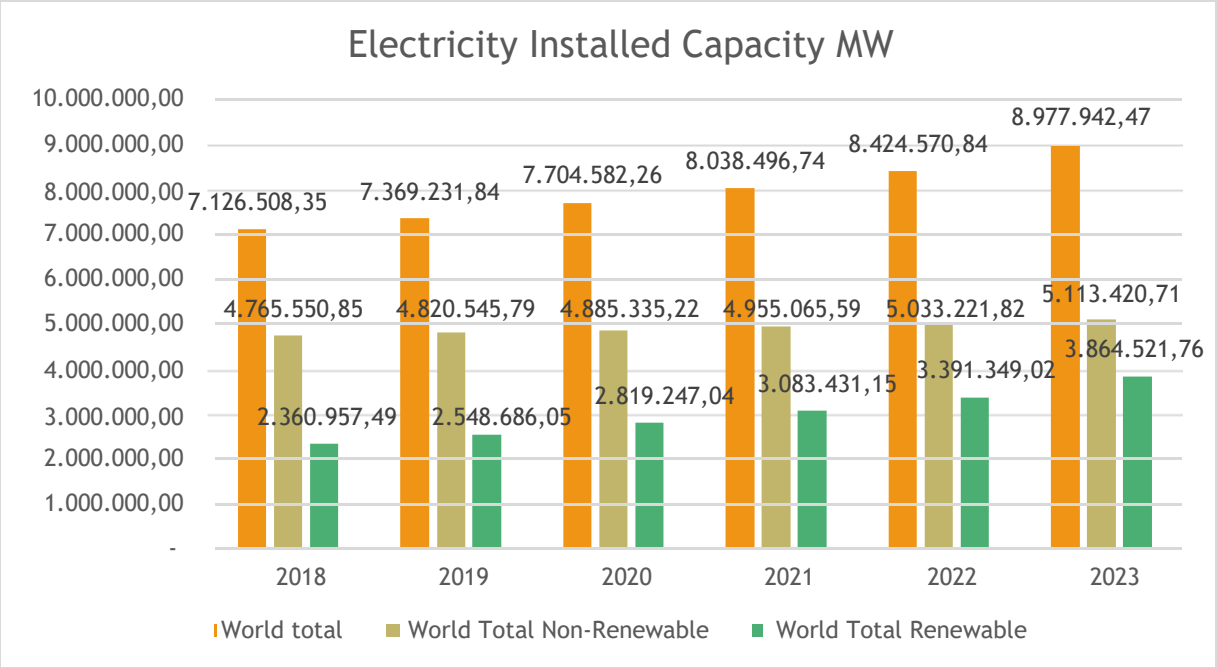
Looking at the last 5 years' world data we can observe a significant increase in installed capacity from 7,1 mil. MW to 8,9 mil. MW where the largest increase comes from renewable side of equation and marks rise from 2,3 mil. MW to 3,8 mil. MW in installed capacities.

Graph 1: World Total Electricity generation MW



Source: www. Irena.com

Graph 2: World Total Electricity Installed Capacity MW



Source: www. Irena.com

Table 1: Electricity Installed Capacity MW

	Electricity Installed Capacity (MW)					
	2018	2019	2020	2021	2022	2023
Total Non-Renewable	4.765.551	4.820.546	4.885.335	4.955.066	5.033.222	5.113.421
Fossil fuels	4.217.789	4.271.415	4.337.977	4.397.545	4.452.038	4.528.065
Coal and peat	1.813.321	1.852.640	1.892.383	1.932.408	1.959.489	2.010.005
Oil	327.443	324.360	327.872	335.534	337.315	347.709
Natural gas	1.262.195	1.284.275	1.310.085	1.339.180	1.359.818	1.396.562
Fossil fuels n.e.s.	814.830	810.141	807.638	790.423	795.415	773.789
Nuclear	405.198	403.682	398.902	401.078	399.757	397.807
Pumped storage	120.366	120.612	122.319	127.223	136.654	142.121
Other non-renewable energy	22.198	24.837	26.136	29.220	44.773	45.427

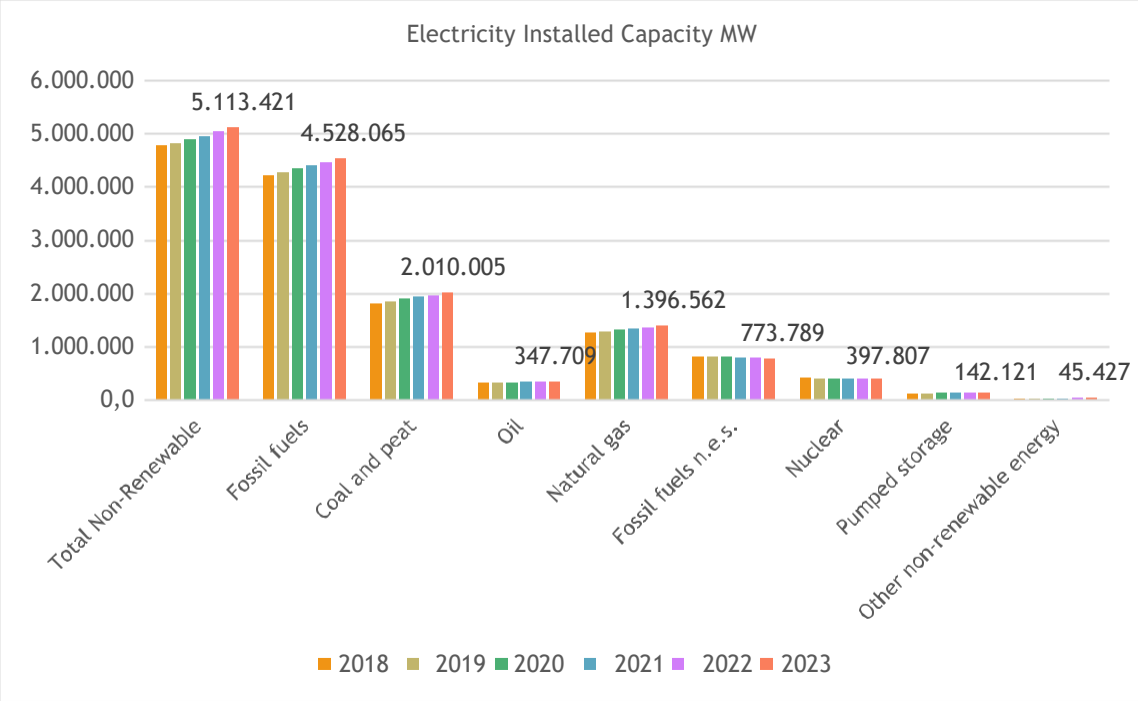
Source: www. Irena.com

Table 2: Electricity Generation GW

	Electricity Generation (GWh)				
	2018	2019	2020	2021	2022
Total Non-Renewable	20.034.249	20.057.772	19.519.310	20.517.862	20.591.382
Fossil fuels	17.062.508	17.007.864	16.574.023	17.438.974	17.599.224
Coal and peat	9.753.311	9.533.219	9.120.448	9.795.345	10.051.203
Oil	779.477	717.935	658.376	704.746	722.824
Natural gas	6.028.170	6.235.104	6.238.033	6.386.900	6.489.402
Fossil fuels n.e.s.	501.551	521.606	557.165	551.982	335.795
Nuclear	2.708.822	2.780.489	2.679.047	2.788.686	2.676.106
Pumped storage	117.466	114.164	120.106	124.571	141.345
Other non-renewable energy	145.453	155.255	146.134	165.631	174.707

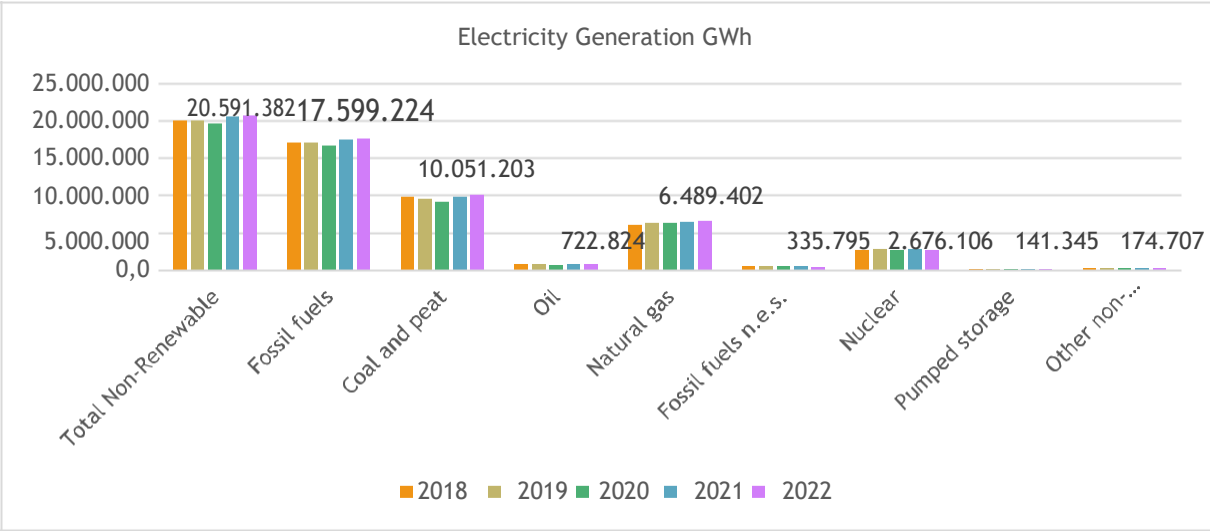
Source: www. Irena.com

Graph 3: Electricity Installed Capacity MW



Source: www. Irena.com

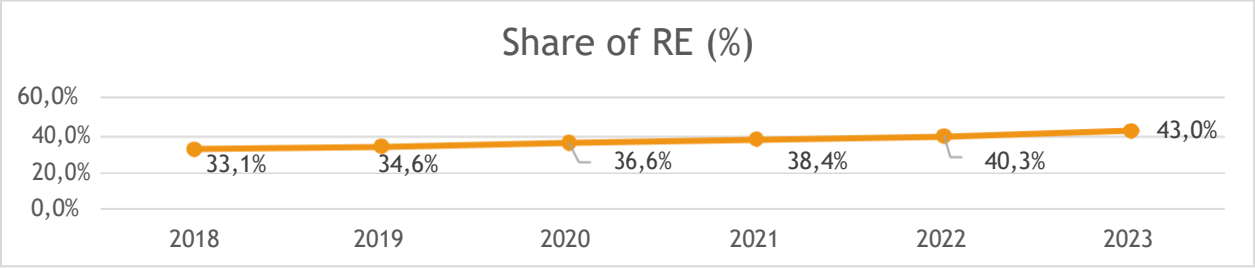
Graph 4: Electricity generation GWh



www. Irena.com

This recent trend and events brought us to the level where we mark an increase in electricity production from 33% to 43%, which is a good result considering the large investment needed.

Graph 5: World Electricity Generation from Renewables as % of Total



Source: www. Irena.com

What is to be noted is that installed capacity does not provide clear images or notion about the result in electricity generation. Renewables generation potential rose from 6,6 mil. GWh to 8,4 mil. GWh what implies different efficiency possibilities of different technologies used.

The table that follows further explains different strategies in technology invested and result. At the world's calculation we can merk significant increase in solar technology implemented from 491 MW to 1.070 MW what is by far the largest increase in technology implemented on ground. Wind doubled its presence from 563 th. MW to 902.th MW. The largest single historical input in producing clean energy was from water. Hydropower started with1,173 mil. MW and ended 1,258 th. MW.

So, it is still re-laying a great deal on hydropower but with less new technologies on that side. Further to note is a significant rise in renewable municipal waste capacity that rose from 12 th. MW to 20 th. MW and is expected to grow more. Other significant renewable resources are recognized on market, and they also continue with growth but at a much slower pace like: Geothermal energy that grew from 13 th .MW, to 14 th. MW, Biogas 18 th. MW to 20 th. MW, solid biofuels 84 th. MW to 100 th. MW.

Table 3: Electricity Installed Renewable Technologies World Base MW

	Electricity Installed Capacity (MW)				
	2018	2019	2020	2021	2022
Solar	491.987,91	595.027,29	726.229,01	870.642,62	1.070.851,05
Hydropower (excl. Pumped Storage)	1.173.784,12	1.192.480,65	1.212.866,15	1.235.192,88	1.258.170,03
Marine	527,65	526,13	505,04	504,47	506,04
Wind	563.680,06	622.730,32	733.472,53	824.320,86	902.883,37
Geothermal energy	13.156,66	13.824,04	14.157,34	14.432,04	14.652,91
Biogas	18.511,82	19.320,48	20.205,34	20.381,86	20.826,66
Liquid biofuels	2.428,23	3.326,47	3.235,19	2.738,15	2.761,67
Solid biofuels	84.254,12	87.321,14	92.638,28	96.302,40	100.413,71
Renewable municipal waste	12.626,93	14.129,52	15.938,17	18.915,88	20.283,58

Source: www. Irena.com

As Table 4 shows, still largest part in renewable production comes from hydropower, followed by wind production and solar. After this big three inputs follows solid biofuels as base for additional source of input for electricity production.

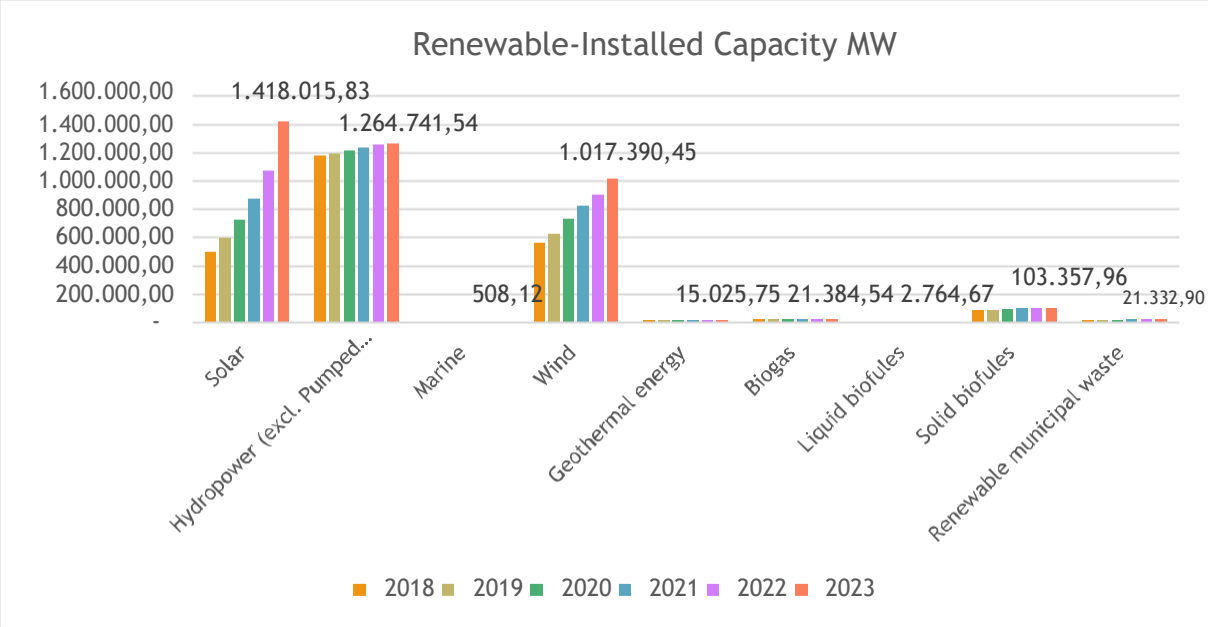
Table 4: Electricity Generation GWh World Base

Electricity Generation (GWh)					
	2018	2019	2020	2021	2022
Solar	560.035,88	689.902,38	835.685,14	1.030.570,53	1.294.481,37
Hydropower (excl. Pumped Storage)	4.208.483,36	4.253.382,82	4.369.055,00	4.296.551,04	4.330.106,89
Marine	1.022,42	996,03	985,12	971,36	956,79
Wind	1.258.925,98	1.412.635,71	1.588.318,71	1.840.364,15	2.098.332,16
Geothermal energy	89.464,19	92.001,02	95.444,69	94.653,53	96.878,35
Biogas	91.252,50	92.502,69	94.339,27	95.533,44	93.502,32
Liquid biofuels	7.382,51	8.453,22	8.065,67	7.178,98	5.755,60
Solid biofuels	355.719,80	376.840,29	394.136,92	421.417,55	426.221,76
Renewable municipal waste	61.482,46	67.372,04	72.011,80	85.416,21	93.436,14

Source: www. Irena.com

The whole situation is presented in *Graph 4.* It is visible how solar technology grew by far the largest to 1,4 mil. MW overpassing all other technological inputs. Hydro input is rising at a much slower rate and wind energy grew at a steady rate allowing solar to overpass its presence.

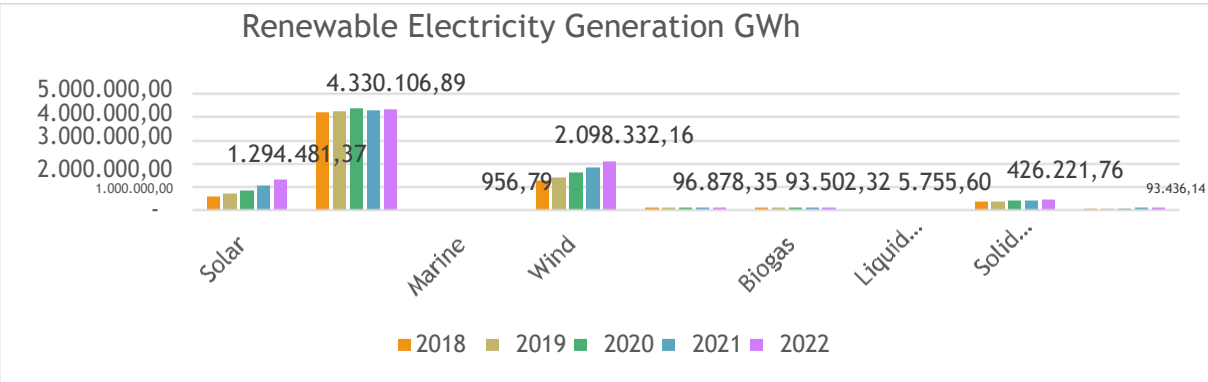
Graph 6: Renewable Installed Capacity MW



Source: www. Irena.com

What the next Graph 5 shows is a large discrepancy between installed capacity and actual output where solar technology is greater, but production is four times bigger in hydro energy. Also, wind energy is double productive than solar energy.

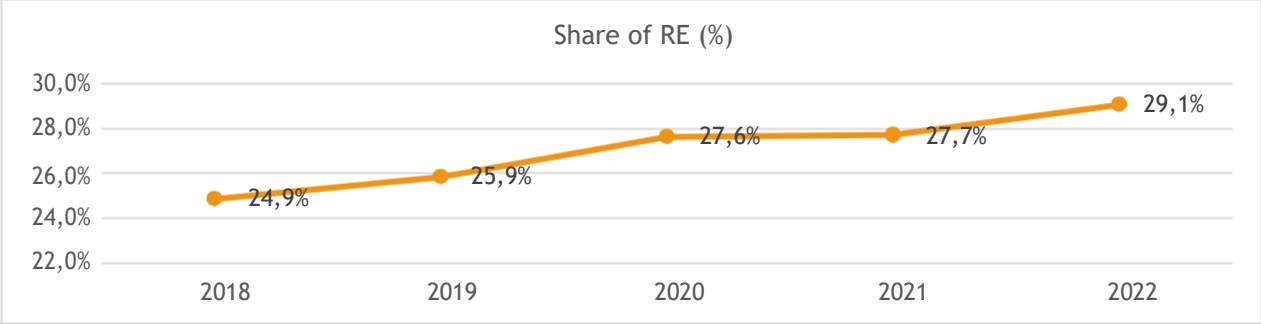
Graph 7: Renewable Electricity Generation GWh -World Level



Source: www. Irena.com

So looking overall we have increased installed renewable technology, and we have increased the capacity of renewables from 33% to 43%, what is 10% increase, but observing effects from its we have noted that generation rose from 25% to 29% what is 5% increase.

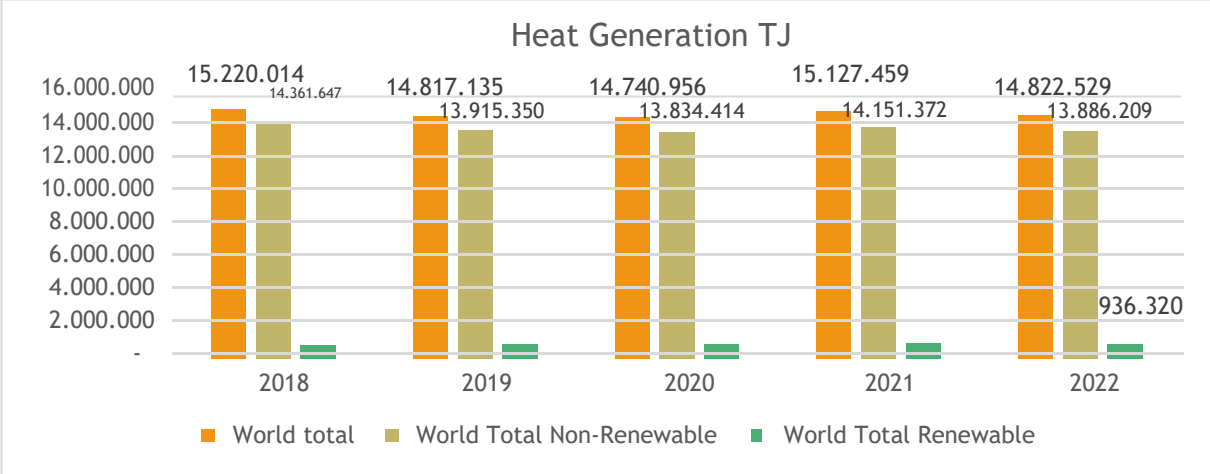
Graph 8: World Electricity Generation -Share of RE %



Source: www. Irena.com

Further to note is that overall heat generation from electricity has a negative slope it has decreased in the last five years, only having heat generation from renewable to rise. Heat generation fell from 15 mil TJ to 14,8 TJ.

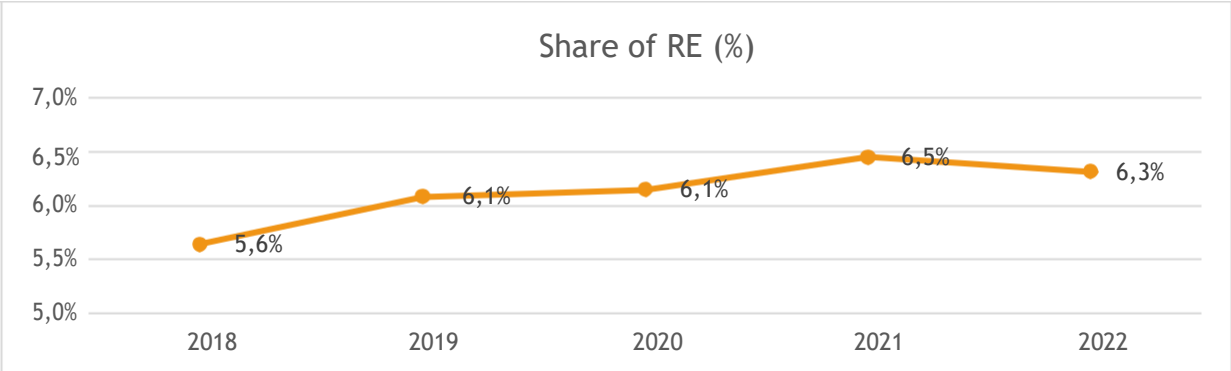
Graph 9: Heat Generation TJ



Source: www. Irena.com

As stated before, only renewables have been risen in heat generation from 5,6 % to 6,3% in overall usage.

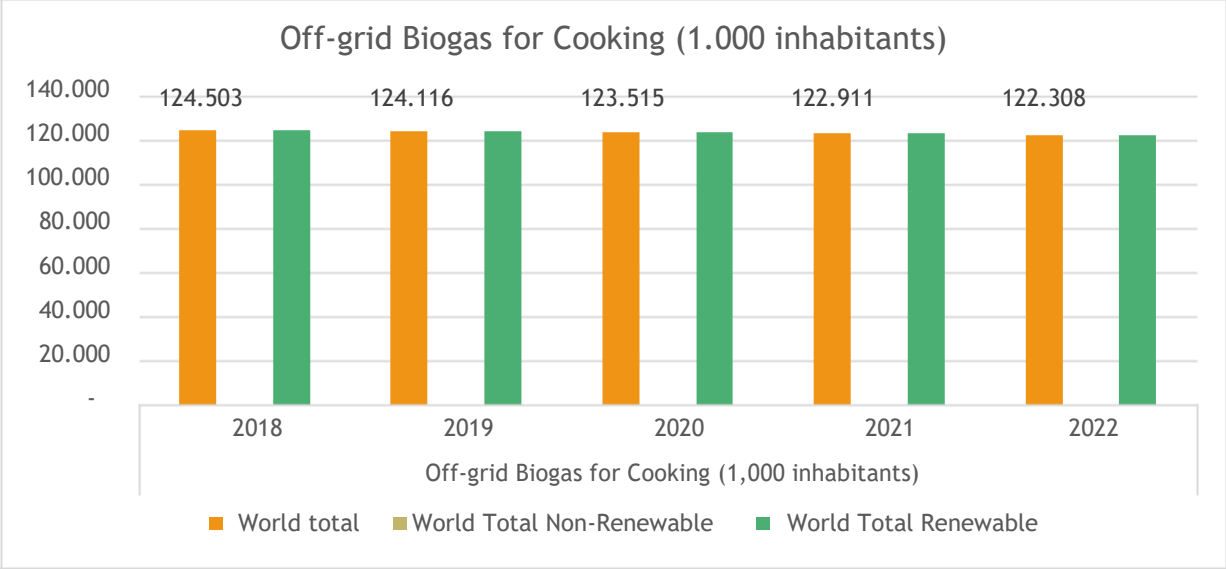
Graph 10: Share of Renewables in Heat Generation TJ



Source: www. Irena.com

Relatively constant results are obtained from off grid biogas quantities for cooking and are around 124 thousand.

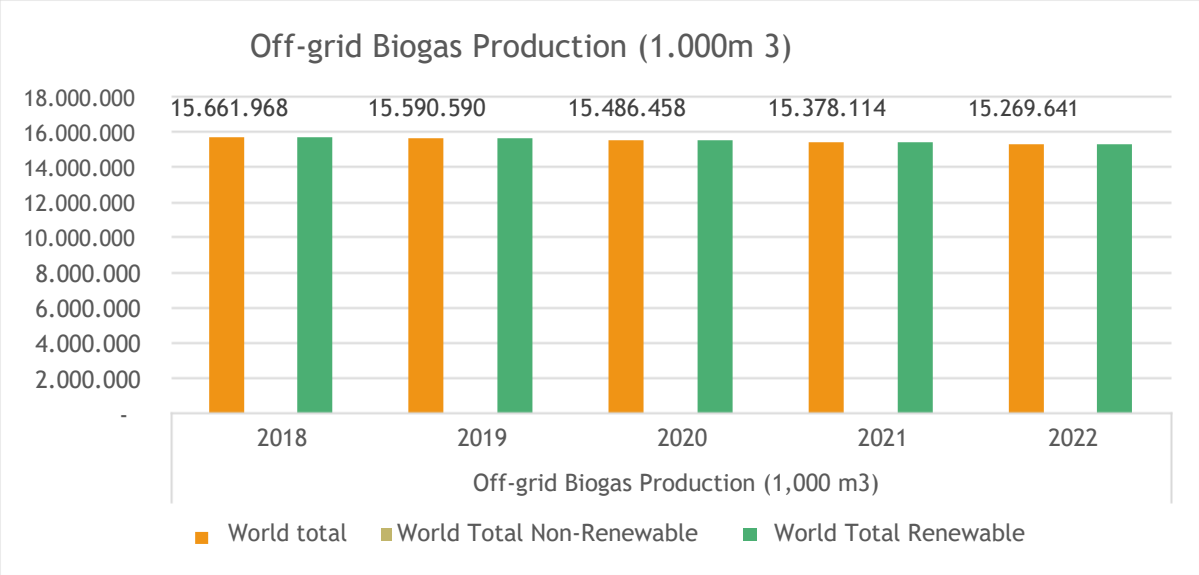
Graph 11: Off grid biogas for cooking



Source: www. Irena.com

Relatively same biogas production is through years and is 15 mil. (1000.m^3)

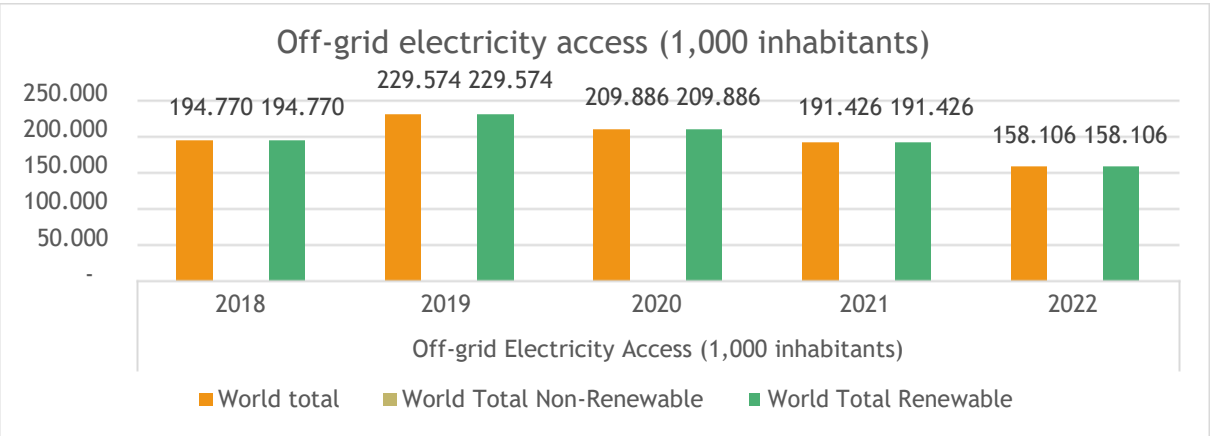
Graph 12: Off grid biogas Production



Source: www. Irena.com

What is surprising is that the lower level off- grid users of electricity fell from 195 th. to 158 th.

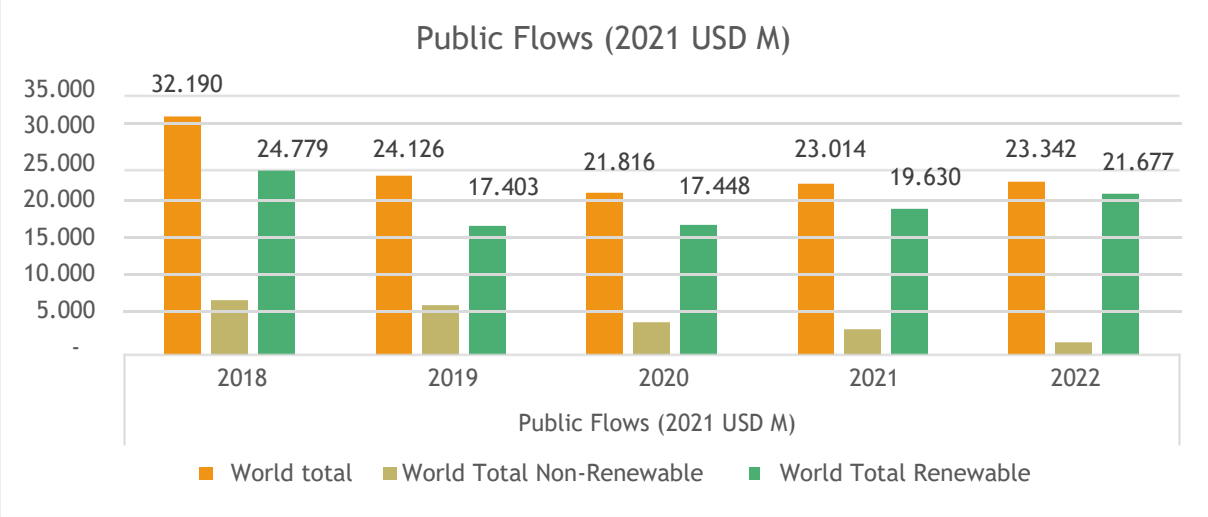
Graph 13: Off grid electricity access



Source: www. Irena.com

Incoming public support is lowered from 2018 to 2022 from 31.190 M. USD to 23.342 M. USD for total and public support and declines for renewables also. In 2018 it was 24.779 M. USD in 2022 21.677 M. USD.

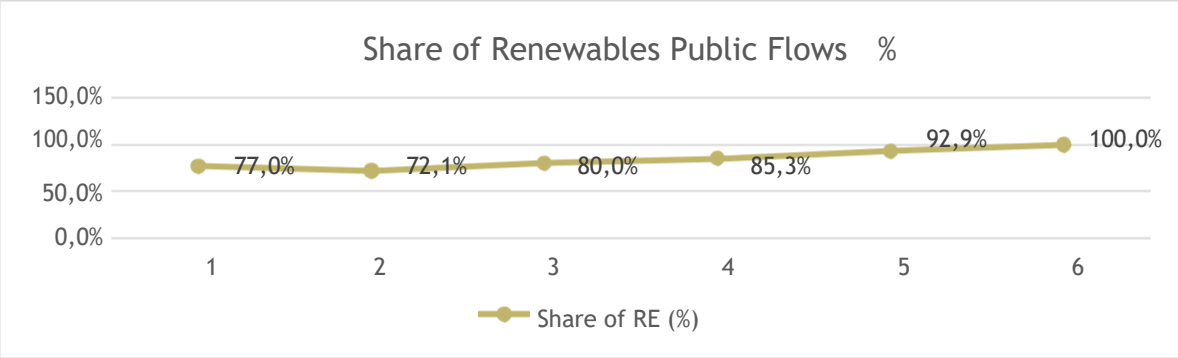
Graph 14: Public Flows (2021 USD M)



Source: www. Irena.com

Public Flow is directed only to renewables in recent years.

Graph 15: Share of Renewables Public Flows %

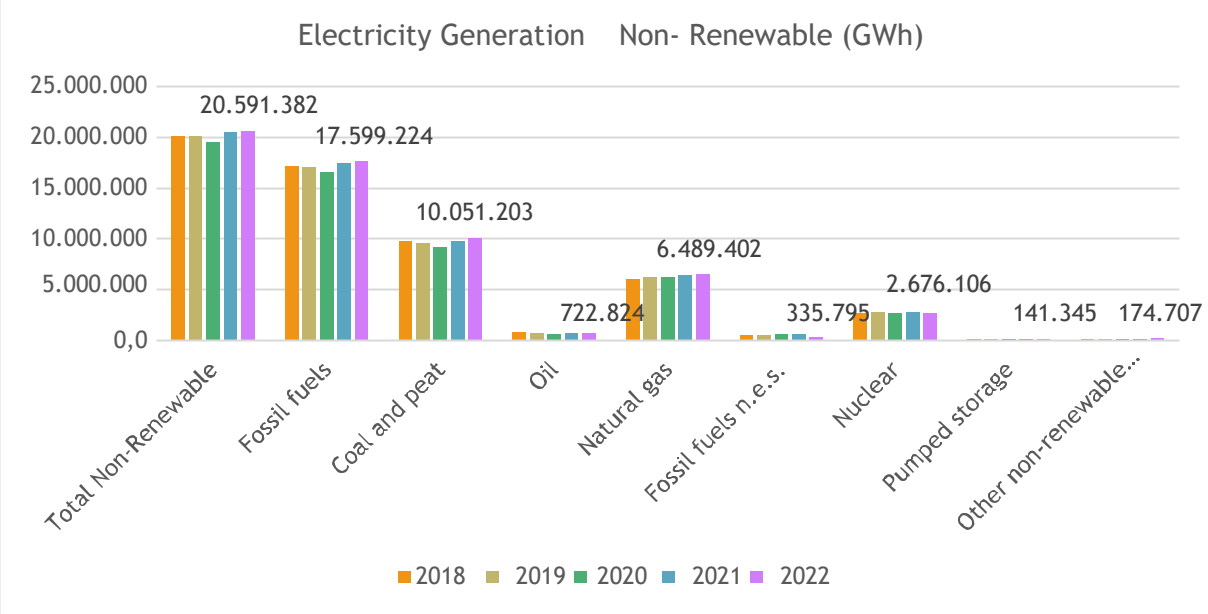


Source: www. Irena.com

At the world scale electricity generation from non-renewables is around the same in the last period of five years where in 2022 amounts 20.591.382 GWh in total.

Out of which the most is produced from fossil fuels 17.599.224 GWh while coal and peat 10.051.203 GWh. Natural gas is seen as further possible input with production of 6.489.402 GWh and nuclear energy is steady with low level of new capacity and production at world scale of 2.676.106 GWh in 2022.

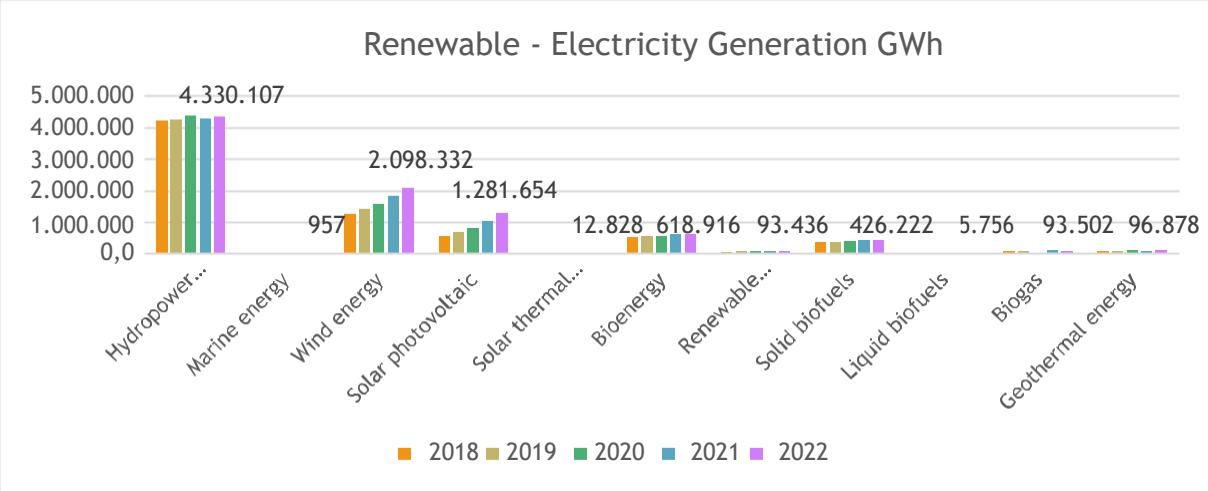
Graph 16: Electricity Generation Non- Renewables GWh



Source: www. Irena.com

Graph 15 brings further comparison where renewable production of hydrogen 4.330.107 GWh and wind 2.098.332 GWh.

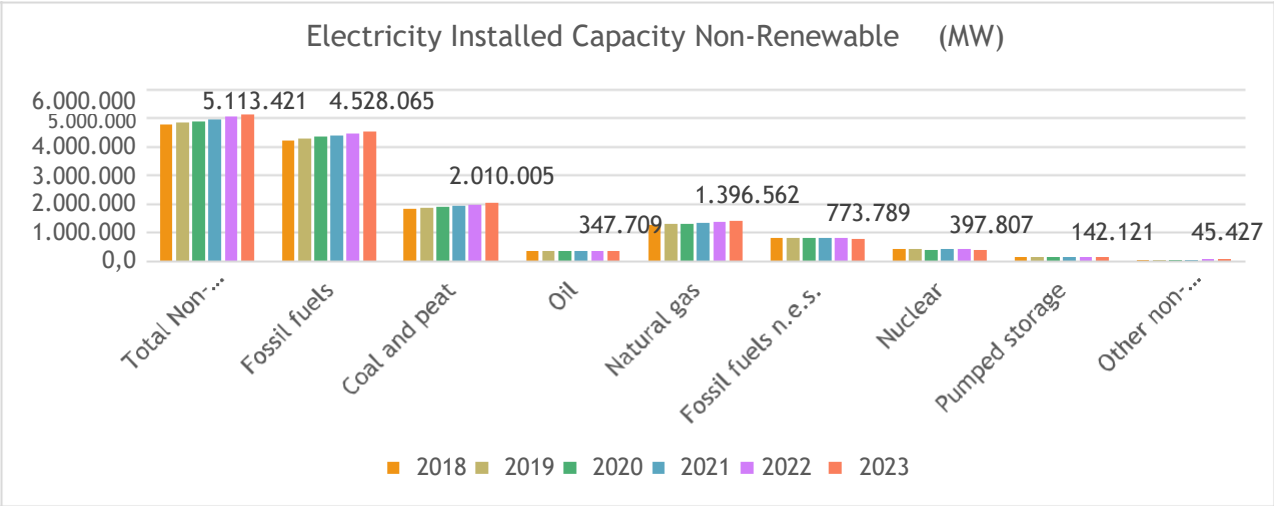
Graph 17: Renewables Electricity Generation GWh



Source: www. Irena.com

This large discrepancy between results points us further to examine renewable capacity installed. With a nonrenewable capacity of 17.5 mil GWh electricity is produced from fossil fuels with 4 mil MW what is much greater efficiency than the solar or wind who produces solar 1,2 mil GWh and wind 2 mil, GWh.

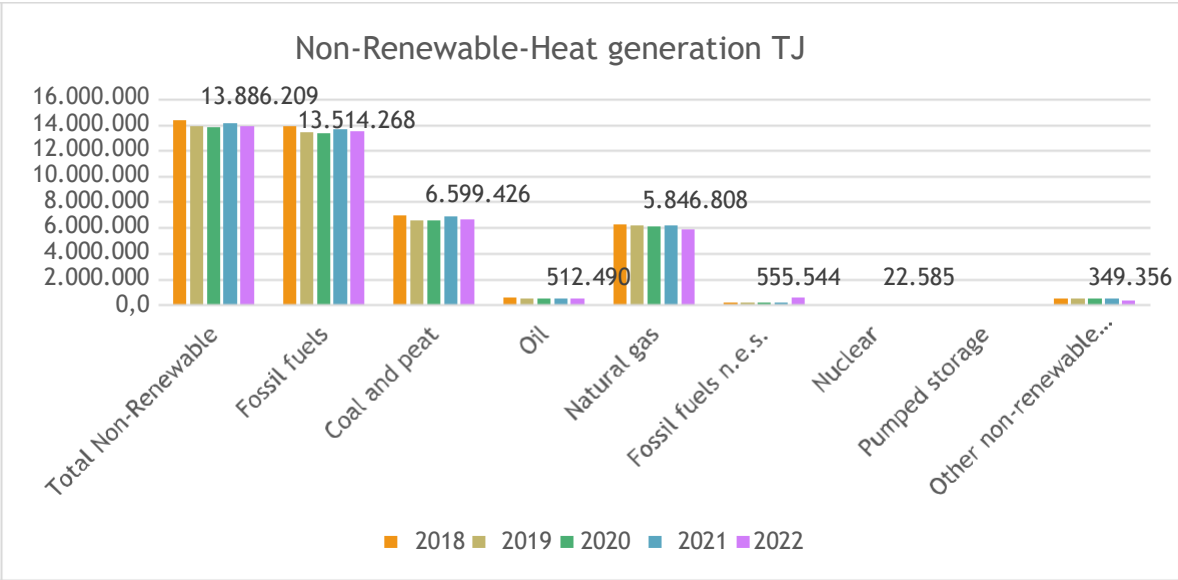
Graph 18: Electricity Installed Capacity Non-Renewables -MW



Source: www. Irena.com

Further to note is that that generation is largely obtained from fossil fuel with 13. 514.268 GWh yearly produced energy from fossil fuel.

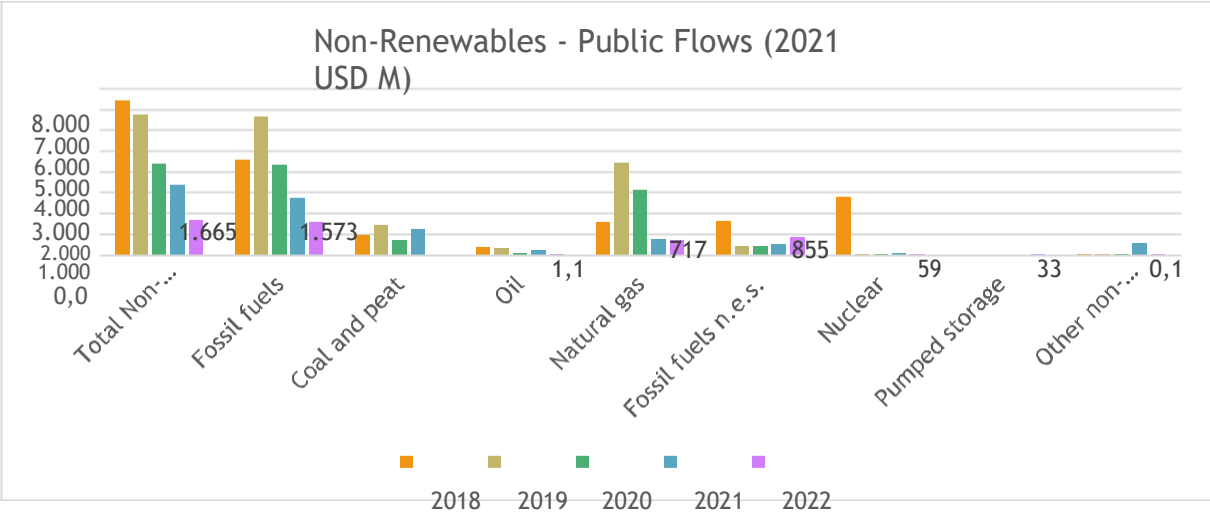
Graph 19: Non-Renewable-Heat Generation TJ



Source: www. Irena.com

Although a significant amount of output of electricity comes from non-renewables steep decrease in public funding is obtained. Means fell in five years from 7.000 M USD to 1.667 M USD.

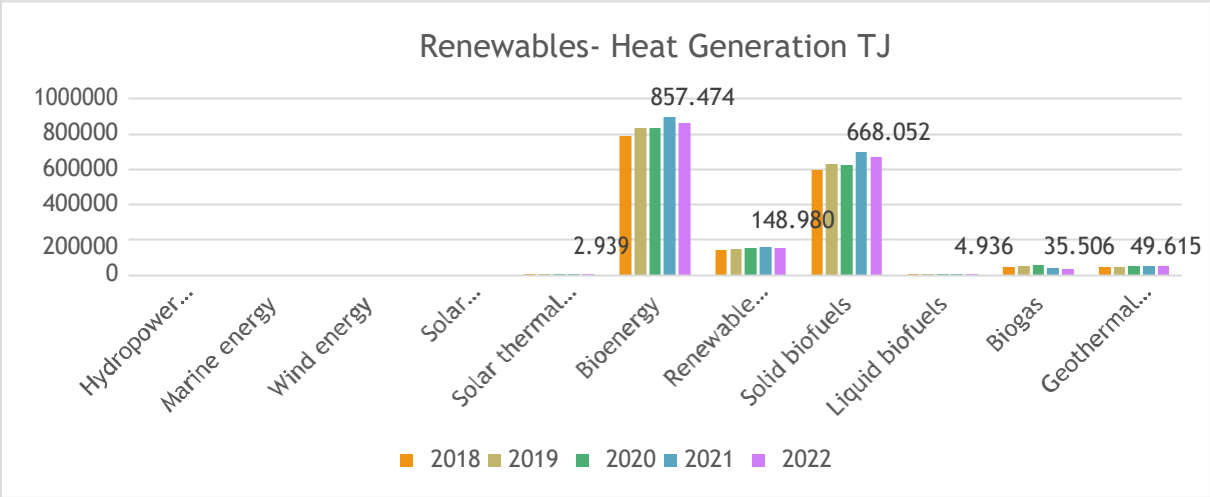
Graph 20: Non-Renewables Public Flows (2021 USD M)



Source: www. Irena.com

This decrease in funding and efficiency measurement further brings us to ask ourselves what is the best alternative? We can find it in solid biofuels, and bioenergy fuels where it has similar characteristics, it is renewable, technology is similar and not big changes to system must occur.

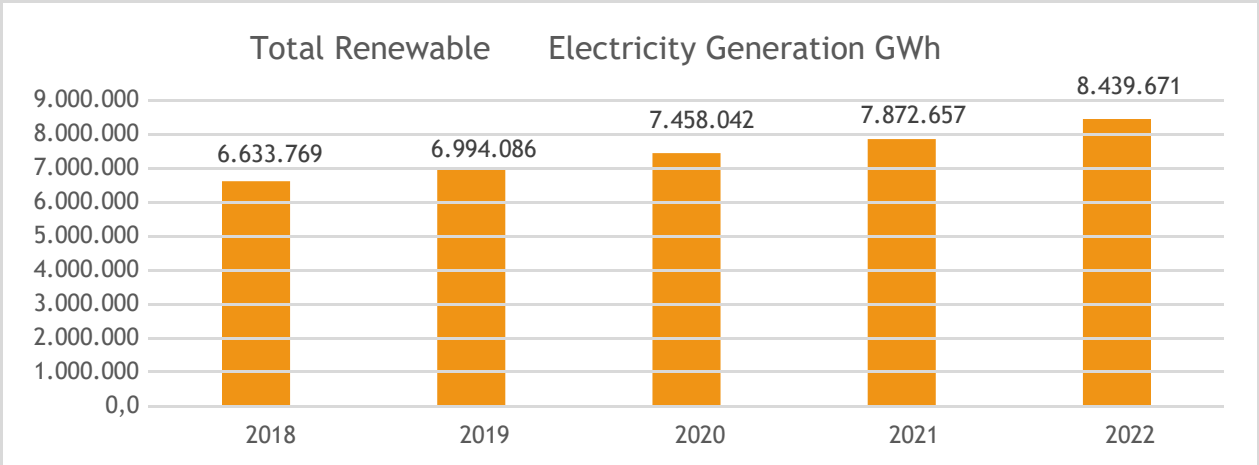
Graph 21: Renewables Heat Generation TJ



Source: www. Irena.com

That future belongs to renewables sources is clear around the world, economic forces and government recognized this fact and it is visible on ground with huge up trend in only 5 years. We have increased electricity production from 6,6 mil GWh in 2028 to 8,43 mil GWh in 2022.

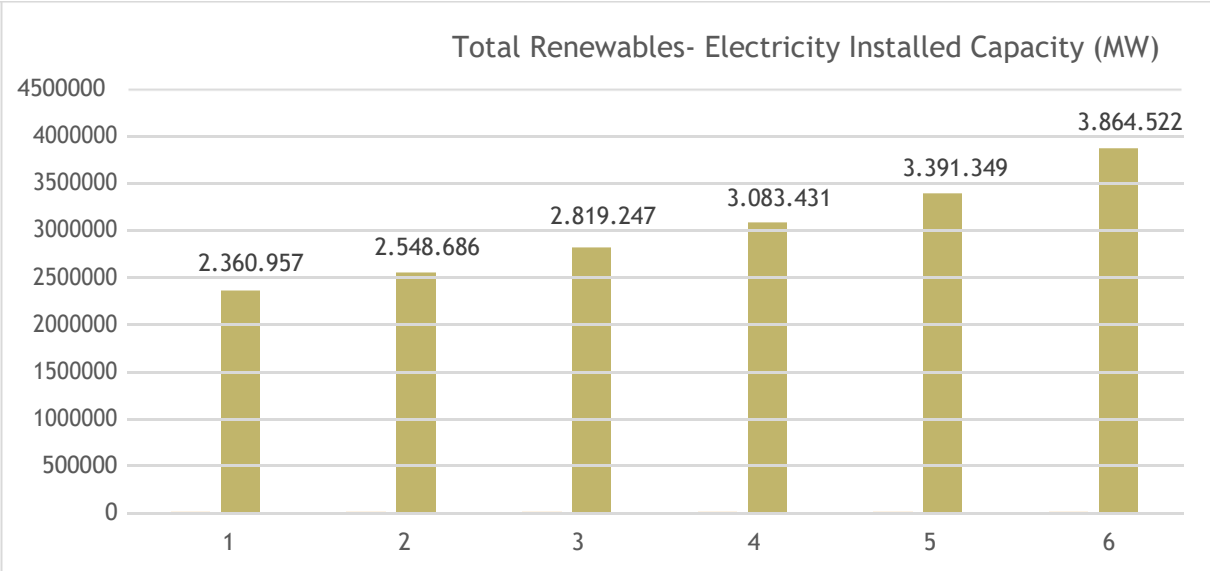
Graph 22: Total Renewable Electricity Generation GWh



Source: www. Irena.com

Installed capacity is increased from 2,3 mil MW to 3,8 mil MW in total renewables what substantiated fact that all states recognized benefits of green revolution as it is called. Although rich countries have taken the first steps and brought world into a new decade, poor economies do not need to be aside or deviate from change. Price competitiveness in equipment and a wide range of possible different strategies is on market today.

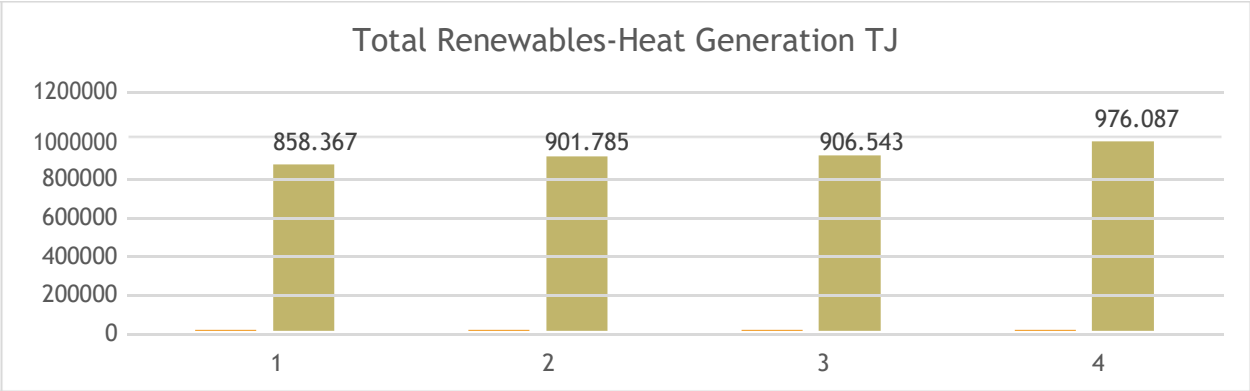
Graph 23: Total Renewables Electricity Installed Capacity MW



Source: www. Irena.com

The most important fact from the numbers above is that renewables can change fossil fuels in heat generation and that is slowly taking place.

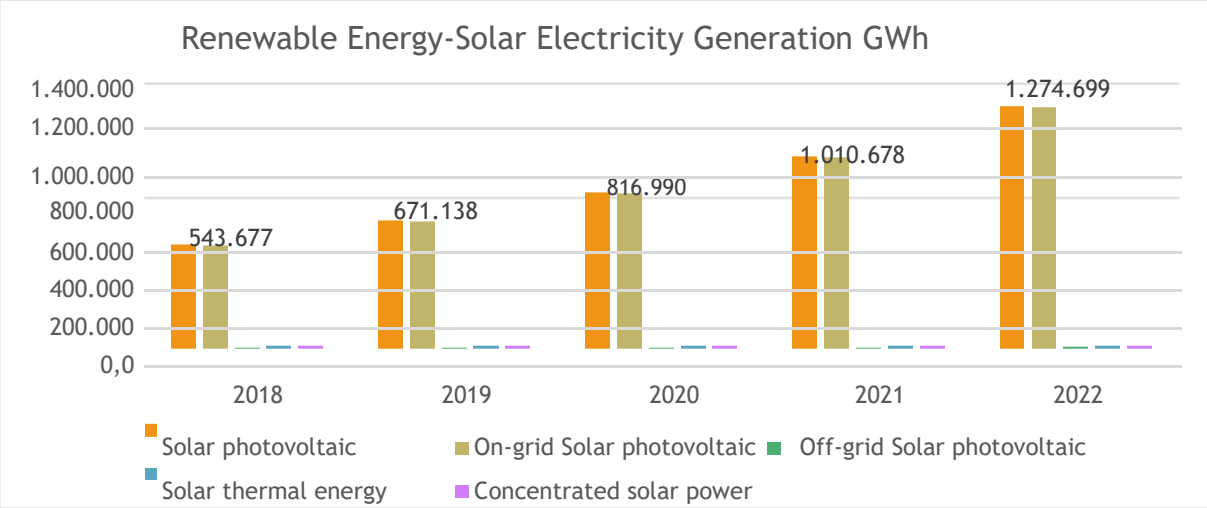
Graph 24: Total Renewables Heat Generation TJ



Source: www. Irena.com

Further to see solar photelectric energy. Solar is recognized throughout the world at all latitudes as an attractive option to solve all or some electricity issues. Adaptability to weekend homes, homes, buildings, factories, and fields made solar a star of the last 5-year transitional period on renewables.

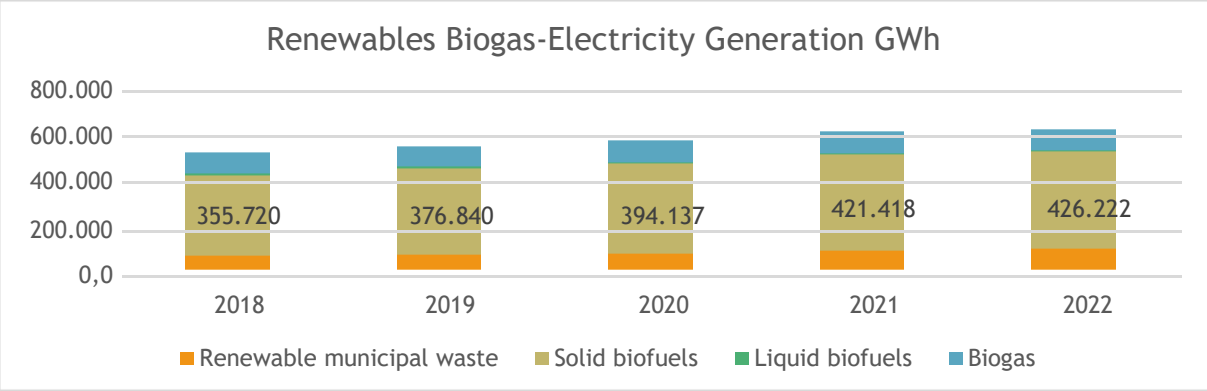
Graph 25: Renewable Energy Solar Electricity Generation GWh



Source: www. Irena.com

Furthermore, next star on renewable horizon is biogas and its usage in obtaining electrical current. Rising possibilities from municipal waste, soldi liquid biofuels and biogas today make real and permanent option for further transfer on green issues.

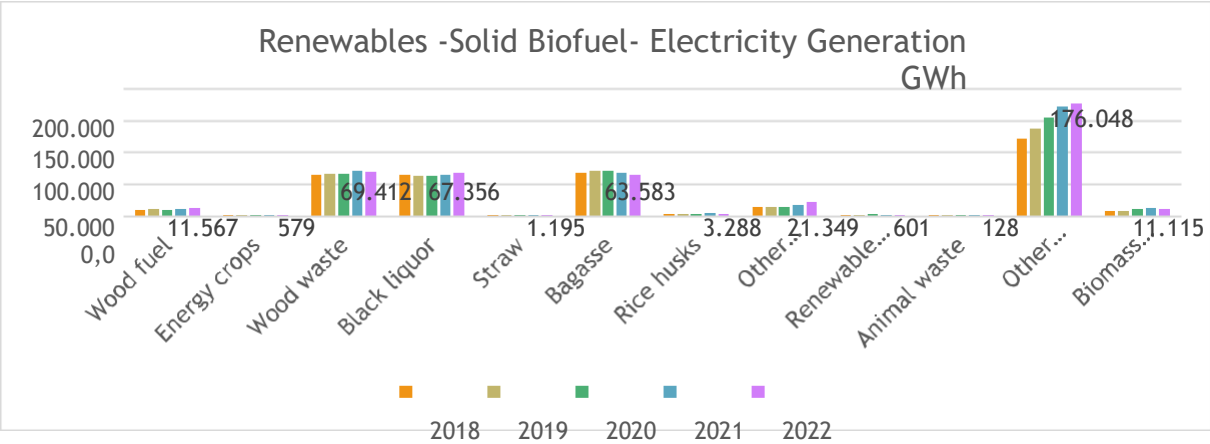
Graph 26: Renewables Biogas Electricity Generation GWh



Source: www. Irena.com

Among solid biofuels input today still we have large amounts of wood waste, but we have increased the notion or possibility to have energy crops, straw, bagasse, rice husk, animal waste etc.

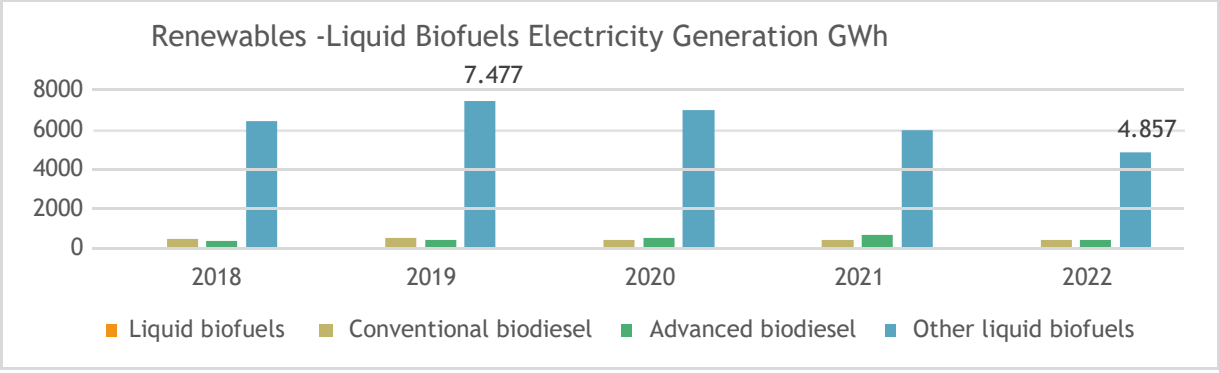
Graph 27: Renewables Solid Biofuel-Electricity Generation GWh



Source: www. Irena.com

What is further important to note is the smaller usage of liquid biofuels in the process of production electricity. In only a few years the quantity halved.

Graph 28: Renewables Liquid Biofuels Electricity Generation GWh

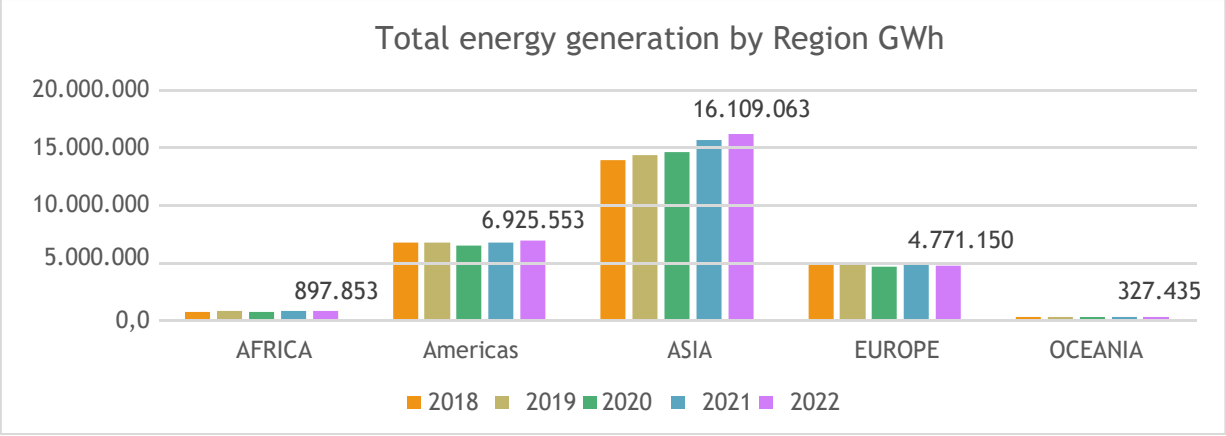


Source: www. Irena.com

1.2. ENERGY DATA FROM DIFFERENT WORLD REGIONS

The continent that produces the most energy is Asia since it has the largest population number and recorded significant GDP growth in the last few decades. China, India, South Korea, Japan are just to mention that are seen as production motor to the world. Since this motor needed energy, Asia contributed significantly with increased installed capacity. Energy produced in 2022 was around 16 mil GWh. Compared with the richest world, America produces only around 7 mil GWh or Europe 4,7 mil GWh. Africa with production of 900.th GWh and tri times less Oceanian with 327 th. GWh have lower electricity production. Both regions need to consider further development strategy in that field not to rely too much on fossil fuels further.

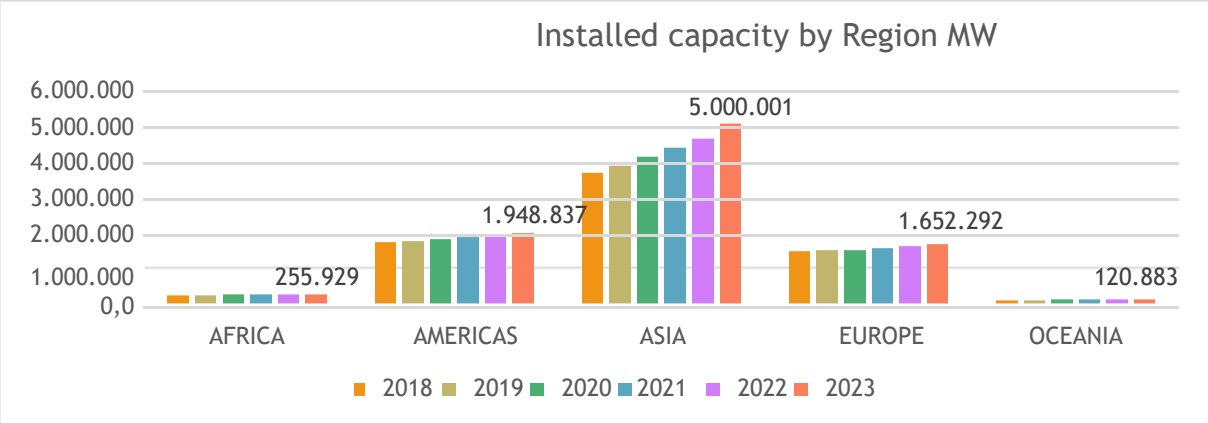
Graph 29: Total Energy Generation by Region GWh



Source: www. Irena.com

Asia has by far the largest capacity increase in the world with now 5 mil MW on disposal. America and Europe are investing continually but do not have such a significant increase in capacity. Europe reaching 1,6 mil MW and America 1,9 mil MW.

Graph 30: Installed Capacity Continents, MW



Source: www. Irena.com

Not all continents managed to have an increase in capacity and generation equally. Europe has continued with capacity increase but lacks generation rise equal to rise in installed capacity.

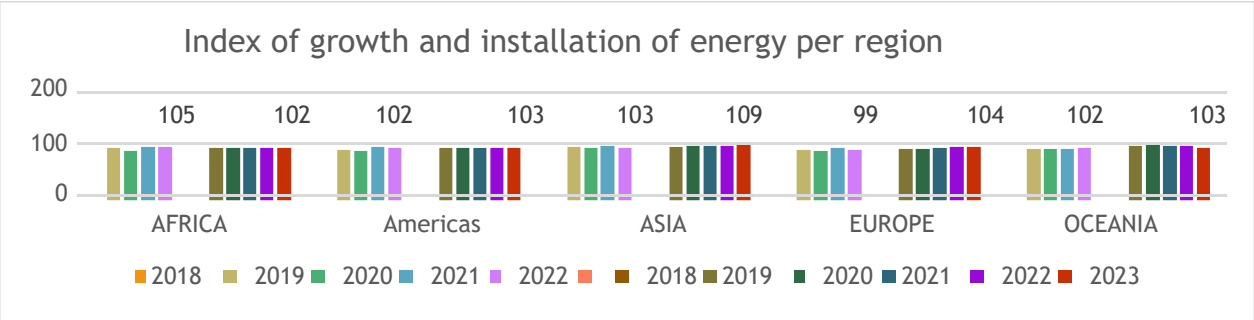
Table 5: Electricity Generation GWh and Installed Capacity MW -Continents

	Electricity Generation				Installed Capacity				
	2019	2020	2021	2022	2019	2020	2021	2022	2023
AFRICA	**103**	**98**	**104**	**105**	**103**	**103**	**102**	**102**	**102**
Americas	**99**	**97**	**104**	**102**	**102**	**102**	**103**	**103**	**103**
ASIA	**103**	**102**	**107**	**103**	**105**	**107**	**106**	**106**	**109**
EUROPE	**99**	**97**	**103**	**99**	**102**	**102**	**102**	**104**	**104**
OCEANIA	**101**	**100**	**100**	**102**	**106**	**108**	**105**	**106**	**103**

www. Irena.com

What is visible on graph China has two-way increase in capacity and generation following latest innovative designs and taking care of reginal characteristics and market opportunities much better than Europe.

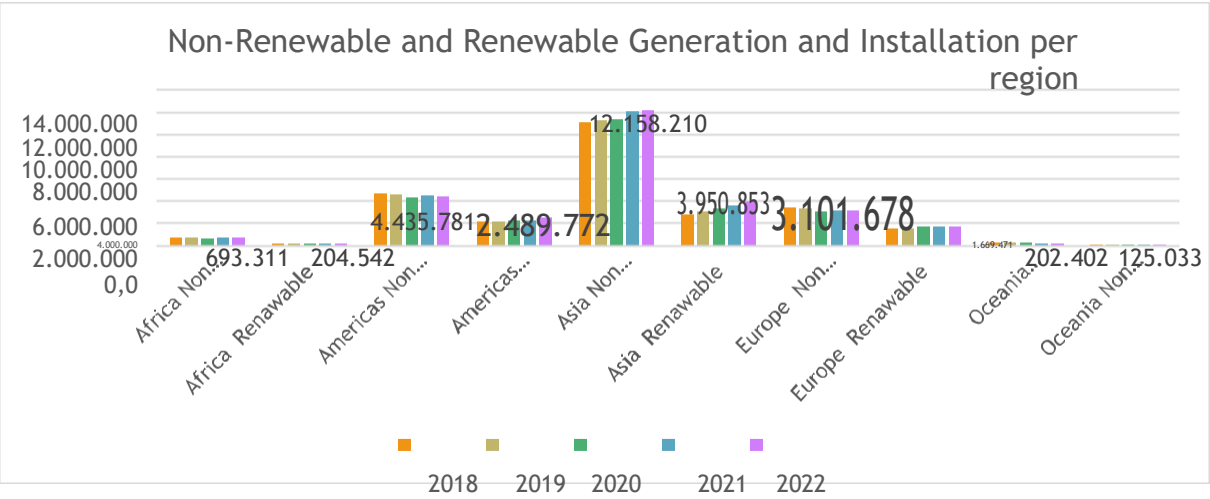
Graph 31: Index of growth and installation of energy per region



Source: www. Irena.com

What goes on benefit side to America is that more than half of production comes from renewables but in only third of ¼ I obtained from renewables. In that's respect Asia increased significantly production but kept or continued with fossil fuel strategy at a greater percentage than developed worked in Europe America.

Graph 32: Non-Renewables and Renewable Generation per Region



Source: www. Irena.com

From table it is visible direction and trend rise in each region and what efficiency they have from different types of electricity input.

In Oceania a similar amount of capacity is installed in renewable and non-renewable.

In Europe there was a large increase in renewable capacity in recent years 1,4 times with efficiency in generation from renewables only 1,9 times and non-renewables 3,8.

In Asia non-renewables have an efficiency of 4,1 and renewables 1,9. America has efficiency in non-renewable 3,9 and renewable 2,9. And Africa has much greater capacity in non-renewables with an efficiency of 3,5 and at renewable 3,2.

Table 6: Electricity Generation GWh and Installed Capacity MW

	Electricity Generation (GWh)					Electricity Installed Capacity (MW)					
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2023
Africa Non Renawable	655.049	668.708	638.691	658.426	693.311	177.658	182.575	186.967	190.146	191.945	193.863
Africa Renawable	161.983	173.792	184.970	197.613	204.542	48.187	50.310	53.715	55.611	59.342	62.066
Americas Non Renawable	4.686.655	4.585.058	4.327.175	4.504.714	4.435.781	1.118.446	1.111.969	1.107.179	1.110.339	1.114.210	1.113.648
Americas Renawable	2.105.510	2.135.365	2.219.058	2.271.366	2.489.772	596.352	632.417	674.032	726.443	777.014	835.189
Asia Non Renawable	11.044.990	11.252.867	11.299.300	12.006.573	12.158.210	2.553.641	2.626.974	2.704.051	2.775.494	2.852.948	2.938.886
Asia Renawable	2.791.170	3.065.418	3.287.987	3.603.395	3.950.853	1.092.191	1.197.256	1.380.539	1.541.644	1.724.315	2.061.115
Europe Non Renawable	3.415.040	3.322.646	3.031.964	3.137.251	3.101.678	859.419	842.831	829.506	821.050	815.861	810.540
Europe Renawable	1.490.801	1.528.128	1.667.898	1.690.706	1.669.471	589.839	628.435	663.954	707.420	771.934	841.752
Oceania Renawable	232.515	228.492	222.181	210.898	202.402	56.387	56.196	57.632	58.037	58.257	56.483
Oceania Non Renawable	84.305	91.382	98.130	109.576	125.033	34.389	40.267	47.008	52.314	58.744	64.400

Source: www. Irena.com

Using statistical calculation relation between two variables with and without intercept are as follows:

This strongly suggests a need for greater efficiency between installed capacity and end result- where Africa has a comparative advantage in installing renewables due to the number of sun days.

			coef b*x	coef b*x
	Africa non renewable	Africa Renewable	no intercept non renewable	no intercept renewable
2021Gwh	658.426,00	197.613,00	3,53	11,76
2022 Gwh	693.311,00	204.542,00	non renewable intercept+b*x	renewable c+b*x
2021MW	191.146,00	55.611,00	-7687168+43,66*x	94335+1,86*x
2022MW	191.945,00	59.342,00		
calculation				

			coef b*x	coef b*x
	Oceania non renewable	Oceania Renewable	no intercept non renewable	no intercept renewable
2021Gwh	109.576,00	210.898,00	1,91	2,04
2022 Gwh	125.033,00	202.402,00	non renewable intercept+b*x	renewable c+b*x
2021MW	58.744,00	58.257,00	-50962+2,73*x	-68105+4,79*x
2022MW	64.400,00	56.483,00		
calculation				

			coef b*x	coef b*x
	Asia non renewable	Asia Renewable	no intercept non renewable	no intercept renewable
2021Gwh	12.006.573,00	3.603.395,00	4,17	6,34
2022 Gwh	12.158.210,00	3.950.853,00	non renewable intercept+b*x	renewable c+b*x
2021MW	2.852.948,00	1.724.315,00	6972566+1,76*x	1924514+1,03*x
2022MW	2.938.886,00	2.061.115,00		
calculation				

	Europe non renewable	Europe Renewable	no intercept non renewable	no intercept renewable
2021Gwh	3.137.251,00	1.690.706,00	3,84	3,86
2022 Gwh	3.101.678,00	1.669.471,00	non renewable intercept+b*x	renewable c+b*x
2021MW	815.861,00	771.934,00	-2317104+6,69*x	1925488+0,3*x
2022MW	810.540,00	841.752,00		
calculation				

			coef b*x	coef b*x
	America non renewable	America Renewable	no intercept non renewable	no intercept renewable
2021Gwh	4.504.714,00	2.271.366,00	4,01	5,54
2022 Gwh	4.435.781,00	2.489.772,00	non renewable intercept+b*x	renewable c+b*x
2021MW	1.114.210,00	777.014,00	-132160478+122,66*x	-645772+3,75*x
2022MW	1.113.648,00	835.189,00		
calculation				

1.2. INDIJA

India installed 500 th. MW capacity and produce 1.735.318 GWh electrical energy what is efficiency of 3,4. The largest part is electricity that is in on grid system. From Total on grid electricity installed in nonrenewable source is 324 th MW what is 65% of grid system. The largest part comes from the fossil fuel of 311 th. MW what is 95% of installed capacity.

India has invested largely in renewable sources having increase in wind capacity, solar and hydro. Solar energy is 70 th. MW and is 40% of total renewable capacity invested. Wind and hydropower are around 45 th MW. Efficiency is 1,1 at solar investment, wind 1,5 and hydro 3,4.

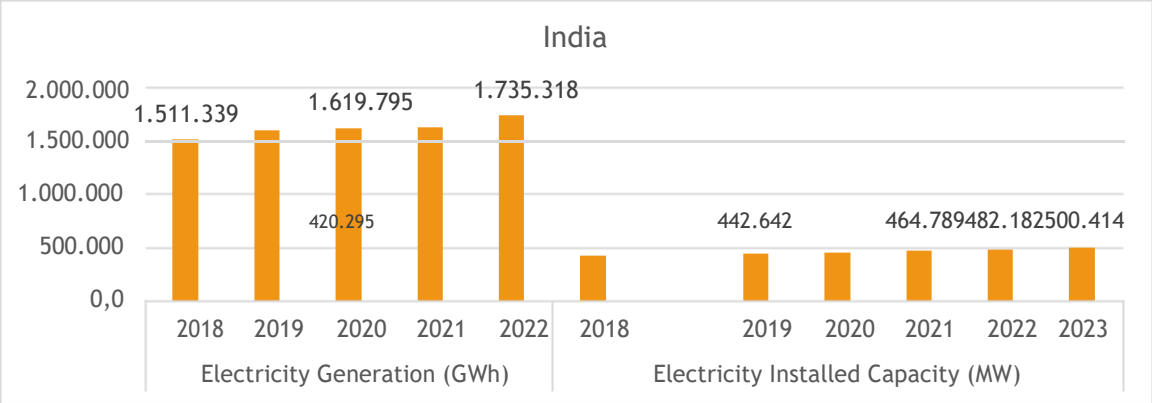
Table 7: India Electricity Generation GWh and Electricity Installed Capacity MW

	Electricity Generation (GWh)					Electricity Installed Capacity (MW)					
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2023
India	1.511.339	1.597.655	1.619.795	1.624.593	1.735.318	420.295	442.642	450.539	464.789	482.182	500.414
On-grid electricity	1.506.792	1.591.161	1.611.758	1.616.532	1.725.807	418.184	440.513	447.980	462.107	479.162	497.112
Total Non-Renewable	1.274.802	1.325.526	1.320.785	1.317.229	1.397.129	302.068	314.167	315.765	317.400	318.969	324.480
Fossil fuels	1.231.223	1.280.020	1.269.295	1.266.694	1.343.465	290.344	302.436	304.012	305.617	307.143	311.923
Coal and peat	1.149.473	1.204.822	1.193.454	1.195.394	1.287.112	241.425	255.831	254.830	255.726	256.971	261.396
Oil	7.729	4.692	2.270	2.625	2.394	15.602	13.983	16.876	18.887	19.651	19.789
Natural gas	74.022	70.506	73.571	68.675	53.959	33.317	32.621	32.306	31.004	30.521	30.738
Nuclear	38.213	39.978	45.612	44.050	46.799	6.780	6.780	6.780	6.780	6.780	7.480
Pumped storage	4.949	4.949	4.949	4.949	4.949	4.786	4.786	4.786	4.786	4.786	4.786
Other non-renewable e	417	579	929	1.536	1.916	159	165	188	217	260	291
Total Renewable	231.989	265.635	290.973	299.303	328.678	116.116	126.346	132.215	144.708	160.193	172.632
Hydropower (excl. Pum	131.462	144.343	159.451	156.335	160.304	45.232	45.409	45.893	46.696	47.139	47.251
Renewable hydropowe	131.462	144.343	159.451	156.335	160.304	45.232	45.409	45.893	46.696	47.139	47.251
Wind energy	55.009	62.689	63.522	62.272	69.434	35.288	37.505	38.559	40.067	41.930	44.736
Onshore wind energy	55.009	62.689	63.522	62.272	69.434	35.288	37.505	38.559	40.067	41.930	44.736
Solar energy	29.581	42.344	53.059	64.033	80.977	26.354	34.073	38.195	48.317	61.424	70.913
Solar photovoltaic	29.220	41.984	52.699	63.673	80.617	26.026	33.731	37.852	47.974	61.081	70.570
Solar thermal energy	360	360	360	360	360	329	343	343	343	343	343
Bioenergy	15.938	16.260	14.940	16.662	17.964	9.241	9.359	9.569	9.628	9.701	9.732
Renewable municipal w	417	579	929	1.536	1.916	159	165	188	217	260	291
Solid biofuels	15.505	15.665	13.995	15.111	16.033	9.076	9.187	9.374	9.404	9.434	9.434
Biogas	15	15	15	15	15	7,0	7,0	7,0	7,0	7,0	7,0
Off-grid electricity	4.548	6.494	8.037	8.061	9.511	2.111	2.128	2.560	2.682	3.019	3.302
Total Renewable	4.548	6.494	8.037	8.061	9.511	2.111	2.128	2.560	2.682	3.019	3.302
Hydropower (excl. Pum	231	252	275	265	269	85	85	85	85	85	85
Solar energy	1.526	1.589	2.039	2.205	2.655	1.130	1.177	1.511	1.633	1.966	2.197
Solar photovoltaic	1.526	1.589	2.039	2.205	2.655	1.130	1.177	1.511	1.633	1.966	2.197
Bioenergy	2.791	4.653	5.723	5.591	6.587	896	867	964	964	968	1.020
Solid biofuels	2.775	4.637	5.705	5.574	6.570	890	860	957	957	961	1.013
Biogas	16	16	17	17	17	6,7	6,9	7,2	7,2	7,2	7,2

www. Irena.com

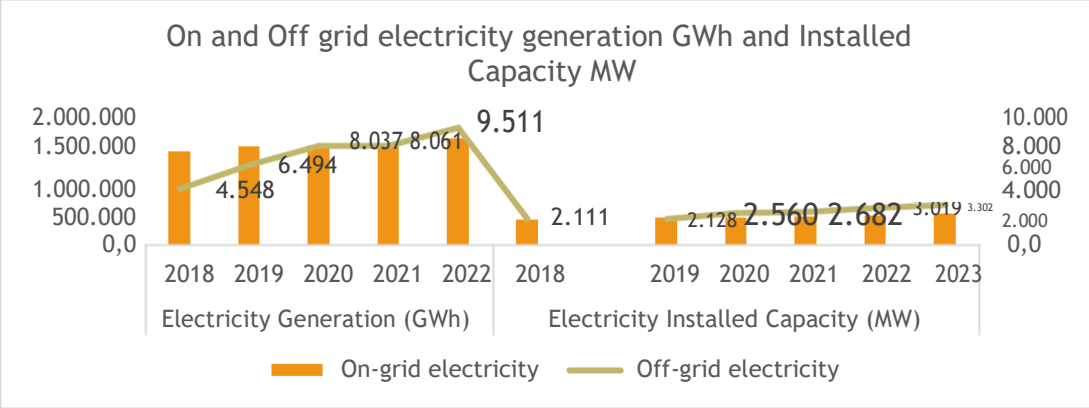
In the period from 2018 to 2022 generated energy has risen 1,13 times. Installed capacity rose 1,19. So although the significant rise in capacity installed was incurred it was not linearly followed by electricity generated from new technology.

Graph 33: India- Electricity Generation GWh and Installed capacity MW



Source: www. Irena.com

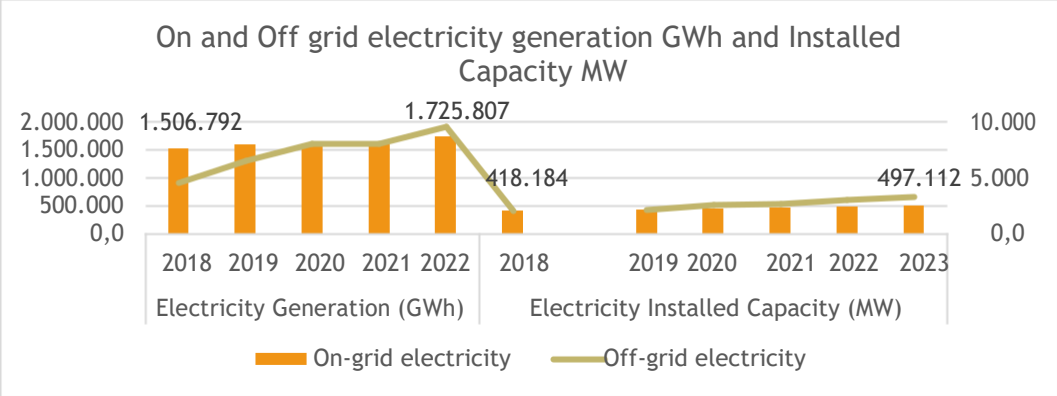
Produced energy average was on grid around 1,6 mil. GWh and off grid 9.511 GWh. The installed capacity is 500.414 MW and off grid 3.019 MW. Graph 34: India On and Off grid electricity generation and capacity



Source: www. Irena.com

Such a large populus country has off grid technology 1% of total installed technology. This implies that people do not invest since they do not have money, knowledge, opportunity or enough goodwill to meet all demand and still look to grid technology who at the end can be cheaper and more reliable for technology needed.

Graph 35: On and Off grid generation and capacity



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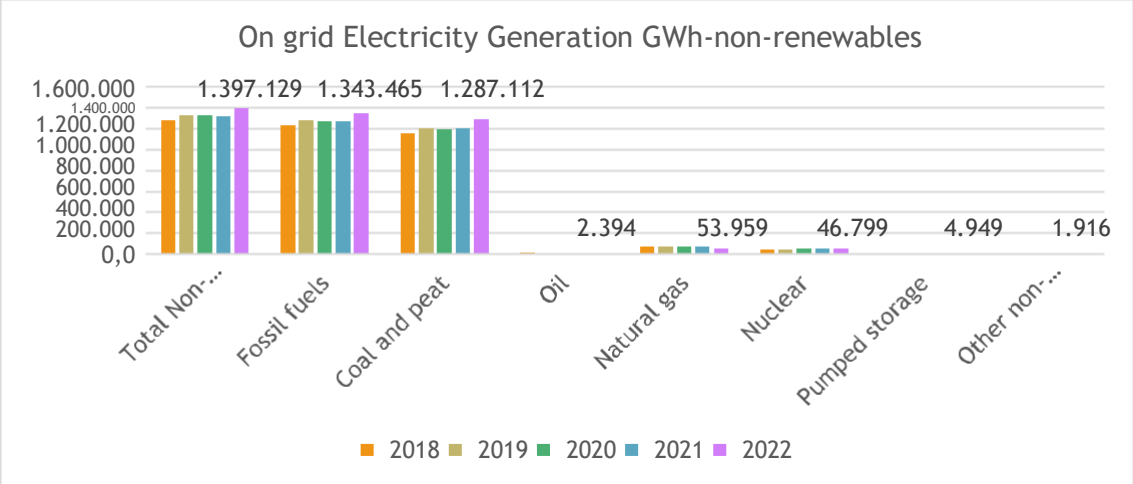
Beside fossil fuel as the largest input to electricity production India has almost the same number of outputs from coal and peat 1,2 mil GWh. It also has some nuclear industry output.

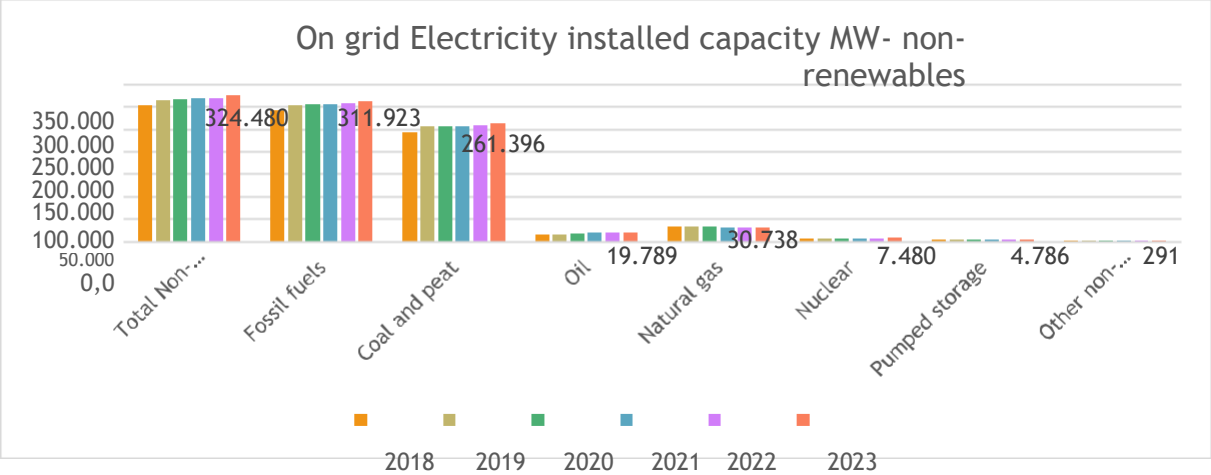
Graph: 36 On grid Electricity Generation GWh non-renewables



Source: www. Irena.com

Installed capacity from nonrenewable has slowly increased bit not at any significant rate as production trade would suggest.

Graph 37: On grid Electricity installed capacity MW non renewables



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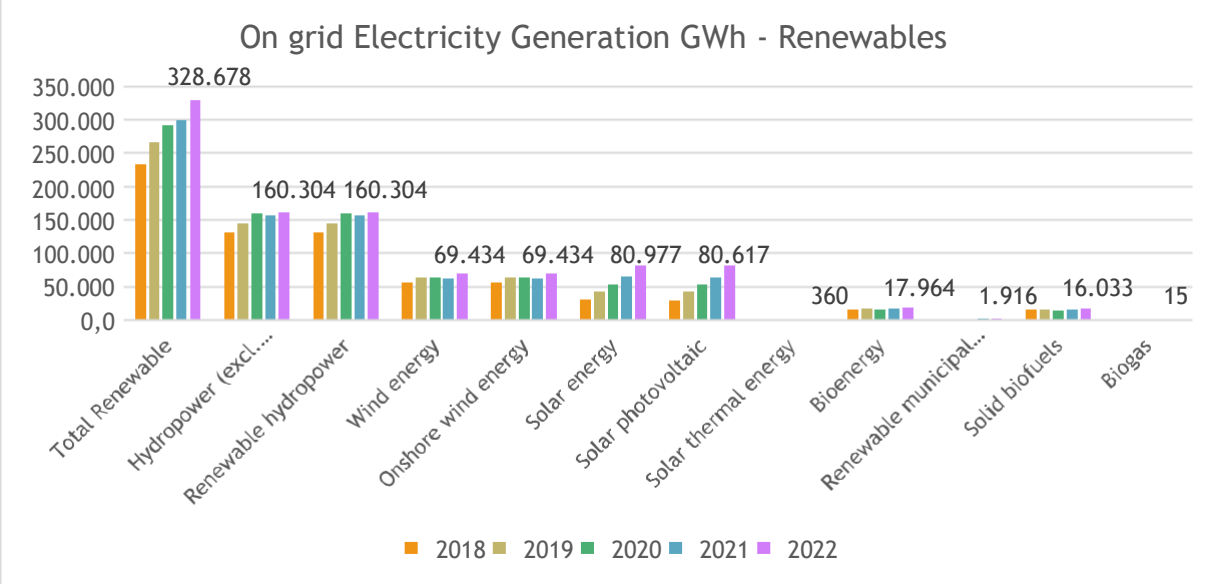
Half of production that comes from renewables, the largest source of renewable input is from hydro energy. Hydro energy from Tibet or other river flows are gradually substituted by solar panels.

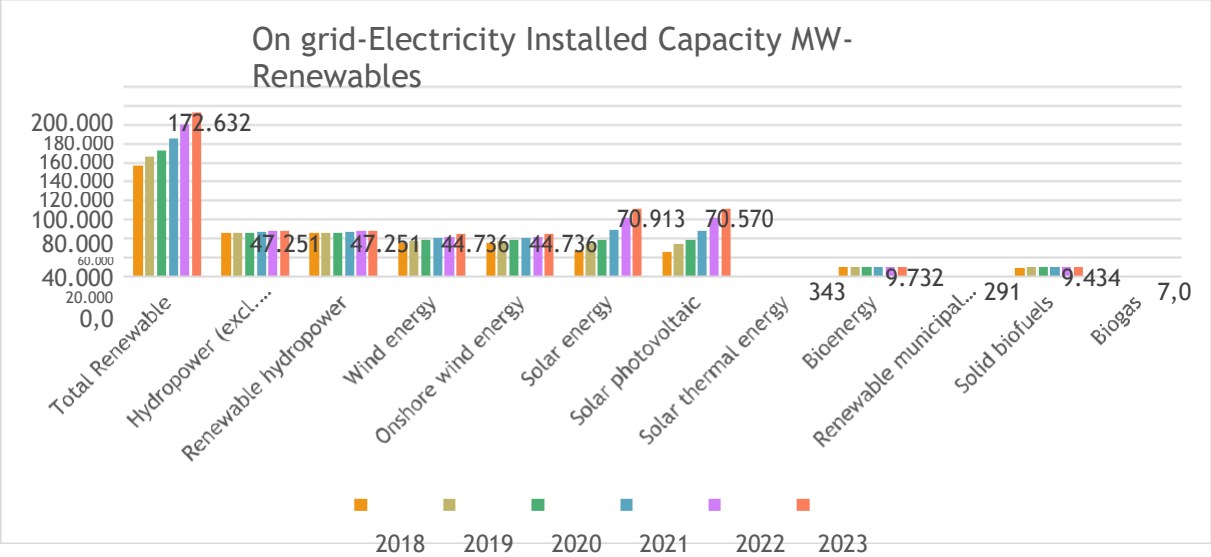
Graph 38: On grid Electricity Generation GWh -Renewables



Source: www. Irena.com

Solar photovoltaic is important and we can expect further growth in production and implementation since it marks the largest increase in capacity from 20 to 70 th. MW.

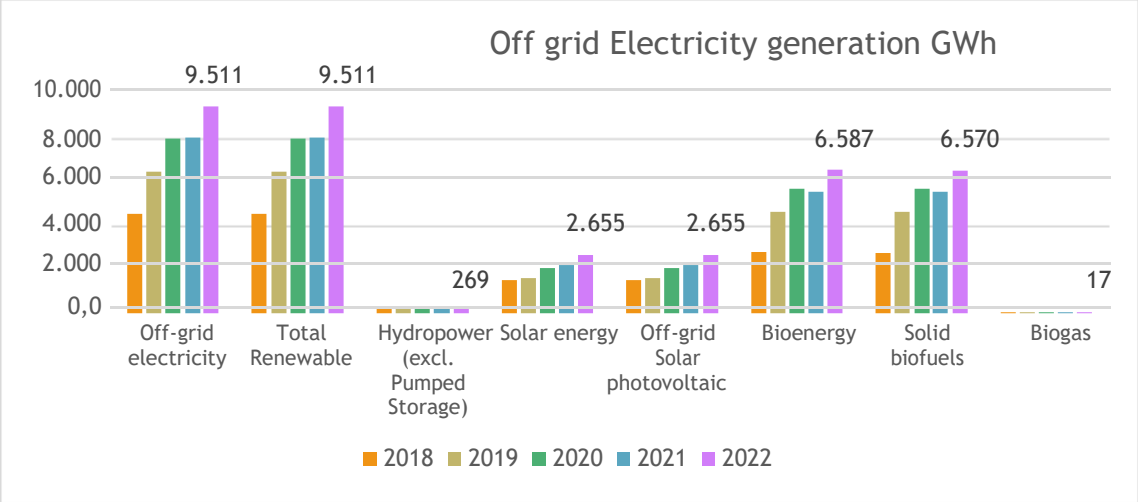
Graph 39: On grid Electricity installed capacity Renewables



Source: www. Irena.com

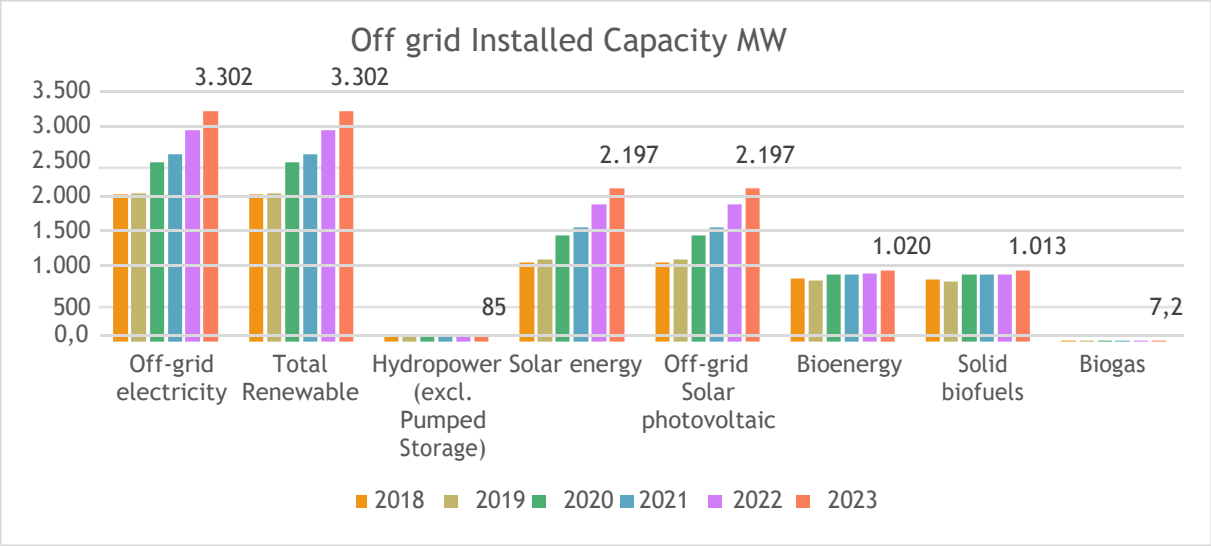
When we turn to an off-grid source, we can conclude that solid biofuels are the most significant resource.

Graph 40: Off grid Electricity generation GWh



Source: www. Irena.com

Installed capacity present off grid is solar energy that rose from 500 to 2.197 MW and bioenergy that is not changed significantly in the last period. Graph 41: India Off grid Installed capacity MW



Source: www. Irena.com

1.3. Madagascar

Madagascar has not invested largely in the last five years in electricity. Constant amount of installed capacity of 866 MW with output of 2051 GWh is present what makes efficiency (generation/1000*capacity) of 2,3.

Table 8: Madagascar Electricity Generation GWh and Installed Capacity MW

	Electricity Generation (GWh)					Electricity Installed Capacity (MW)					
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2023
	1.866	1.933	1.910	1.984	2.051	808	810	811	811	865	866
On-grid electricity	1.830	1.893	1.869	1.944	2.009	800	800	800	800	854	854
Total Non-Renewabl	828	974	1.018	1.143	1.111	622	622	622	622	622	622
Fossil fuels	828	974	1.018	1.143	1.111	622	622	622	622	622	622
Coal and peat	117	117	117	117	117	120	120	120	120	120	120
Oil	711	856	901	1.026	994	502	502	502	502	502	502
Total Renewable	1.001	919	851	800	898	178	178	178	178	232	232
Hydropower (excl. P	968	886	818	767	822	158	158	158	158	186	186
Renewable hydropo	968	886	818	767	822	158	158	158	158	186	186
Solar energy	33	33	33	33	75	20	20	20	20	46	46
Solar photovoltaic	33	33	33	33	75	20	20	20	20	46	46
On-grid Solar photovo	33	33	33	33	75	20	20	20	20	46	46
Off-grid electricity	36	40	41	41	42	7,9	9,2	10	10	11	11
Total Renewable	36	40	41	41	42	7,9	9,2	10	10	11	11
Hydropower (excl. P	32	34	33	33	33	5,5	5,8	5,6	5,6	5,6	6,1
Renewable hydropo	32	34	33	33	33	5,5	5,8	5,6	5,6	5,6	6,1
Wind energy	0,5	0,5	0,5	0,5	0,5	0,2	0,2	0,2	0,2	0,2	0,2
Onshore wind energ	0,5	0,5	0,5	0,5	0,5	0,2	0,2	0,2	0,2	0,2	0,2
Solar energy	3,5	5,2	7,4	7,2	8,5	2,0	3,0	4,3	4,2	4,9	4,9
Solar photovoltaic	3,5	5,2	7,4	7,2	8,5	2,0	3,0	4,3	4,2	4,9	4,9
Off-grid Solar photovo	3,5	5,2	7,4	7,2	8,5	2,0	3,0	4,3	4,2	4,9	4,9
Bioenergy	0,6	0,6	0,6	0,6	0,6	0,2	0,2	0,2	0,2	0,2	0,2
Solid biofuels	0,6	0,6	0,6	0,6	0,6	0,2	0,2	0,2	0,2	0,2	0,2
Rice husks	0,6	0,6	0,6	0,6	0,6	0,2	0,2	0,2	0,2	0,2	0,2

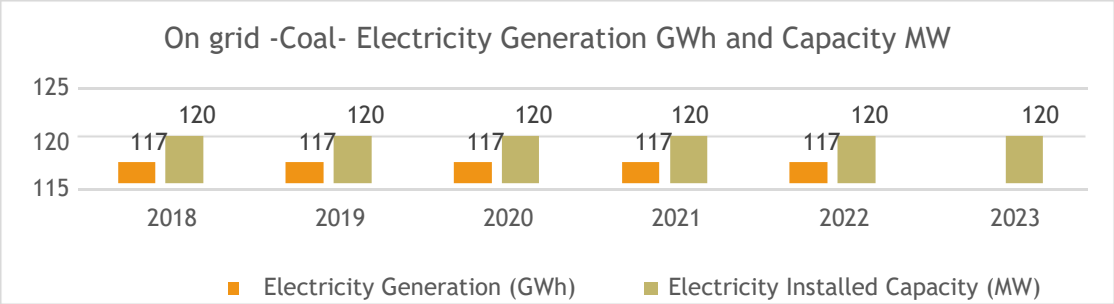
Source: www. Irena.com

On grid electricity makes 98,6% of total installed capacity. On grid electricity nonrenewable input is fossil fuel -oil that makes 72% of total grid input. Coal is present in much else amount and makes only 14% of total on grid capacity.

Madagascar has 11 MW renewable capacities that makes 42 GWh. Half comes from hydro energy and 36% from solar energy.

Graph shows little change in the last five years where on grid coal installed and produced it is only 1,02 efficient and does not make much since using it considering CO_2 output.

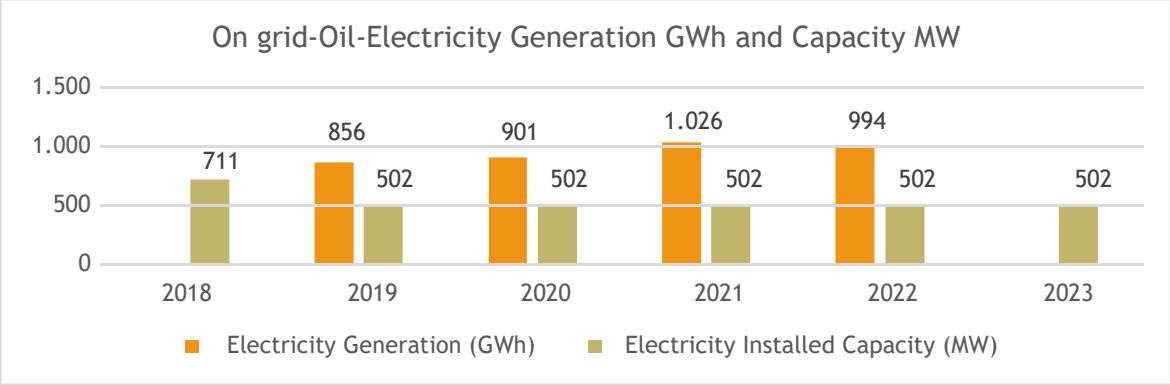
Graph 42: Madagascar On grid Electricity generation and Capacity Coal



Source: www. Irena.com

The majority input on the grid comes from oil and is also steady capacity. Oil is having an efficiency of 2 or lower what also does not generate much comfort considering CO_2.

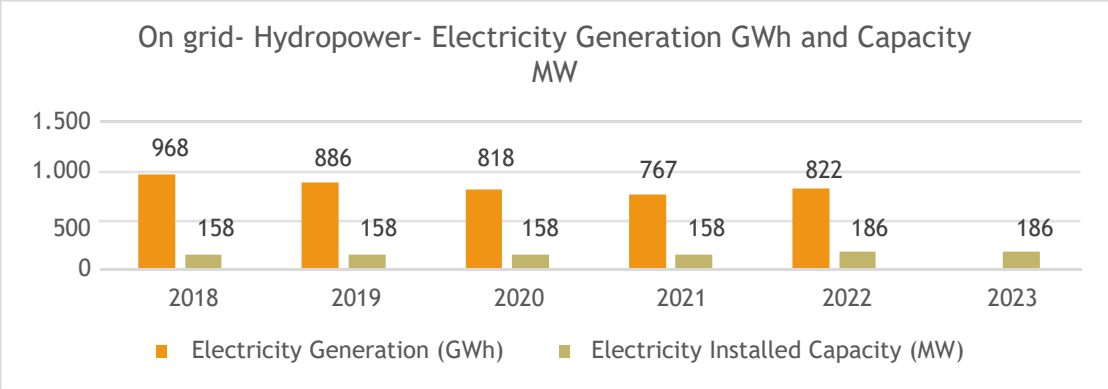
Graph 43: Madagascar On grid Oil Electricity Generation Installed Capacity



Source: www. Irena.com

The largest source of renewable power and for Madagascar is Hydro energy. Large efficiency is present where with installed capacity of 186 MW obtains 822 GWh output making 4,65 efficient productions.

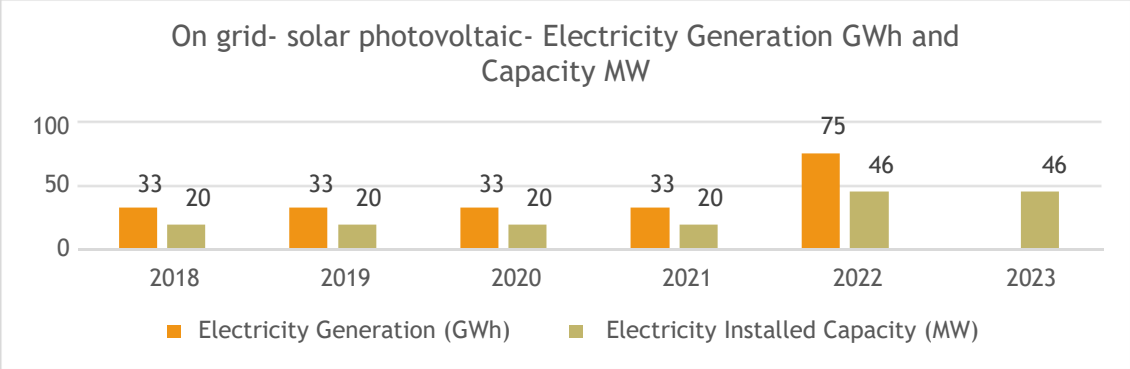
Graph 44: Madagascar On Grid-Hydropower Electricity Generation Installed Capacity



Source: www. Irena.com

On grid photovoltaics grew by half in installed capacity and produced quantity of energy. With 46 MW makes 75 GWH electricity that is 1,6 efficiencies.

Graph 45: Madagascar On grid Photovoltaic

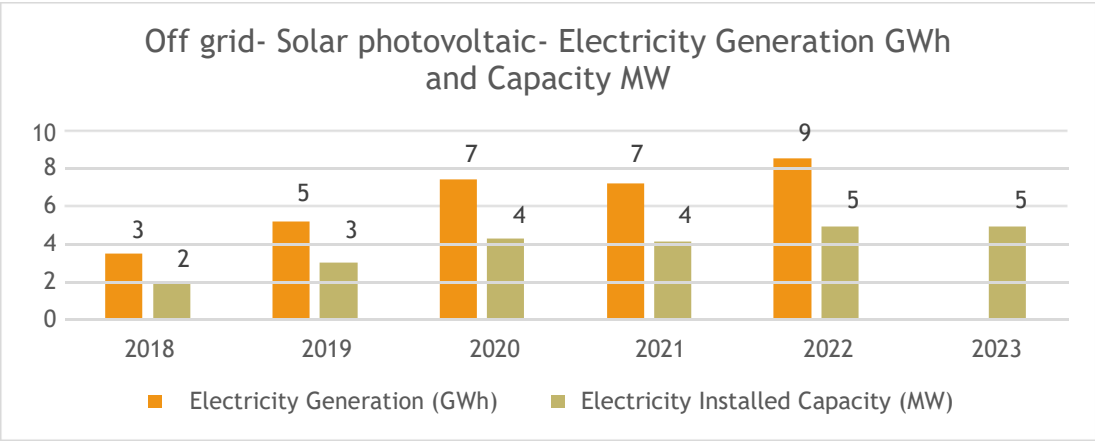


www. Irena.com

A much smaller amount of off grid solar technology is present, and this also grew by double in recent five years. With 5 MW installed off grid it makes 9 GWh output.

Off grid solar is 10% of those on grid.

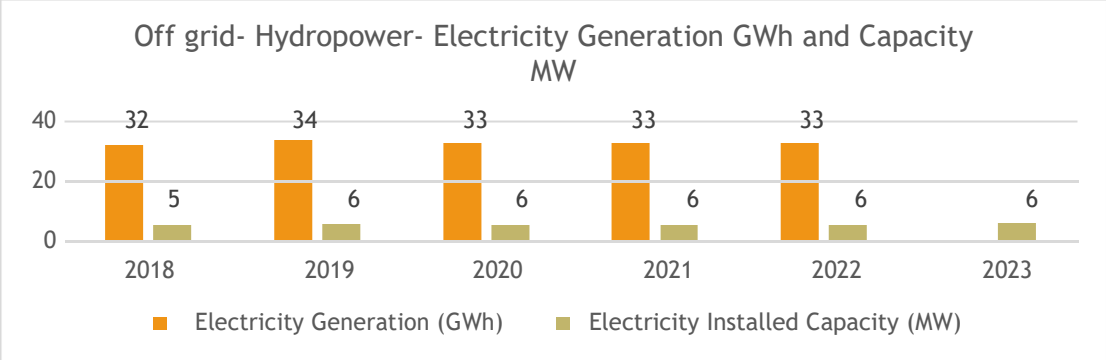
Graph 46: Off grid Photovoltaic



Source: www. Irena.com

There is also off grid hydro production where country produces with 6MW 33 GWh of output what is 5,5 efficiencies in production.

Graph 47: Off grid hydropower



Source: www. Irena.com

1.4. AUSTRALIA

Australia has invested much in recent years in new capacity. From the base in 2018 of 77 th. MW they are having in 2023 106 th. MW what is 1,37 increases. Onside of electricity generated they grew from 260 th. GWh to 271 th. GWh that is 1,04 increases in production.

Majority of electricity is on grid installation and production.

What is significant to note is that Australia has half of installed capacity in renewable sources. Where 47% are on nonrenewable source and 53% on renewable source.

Nonrenewable has capacity installed of 51 th. MW and produces 188 th GWh what is 3,6 efficiency rate.

Renewable capacity is 54,8MW that produces 83 th GWh what is efficiency rate of 1,5.

Table 9: Australia Electricity Generation GWh Capacity Installed Mw

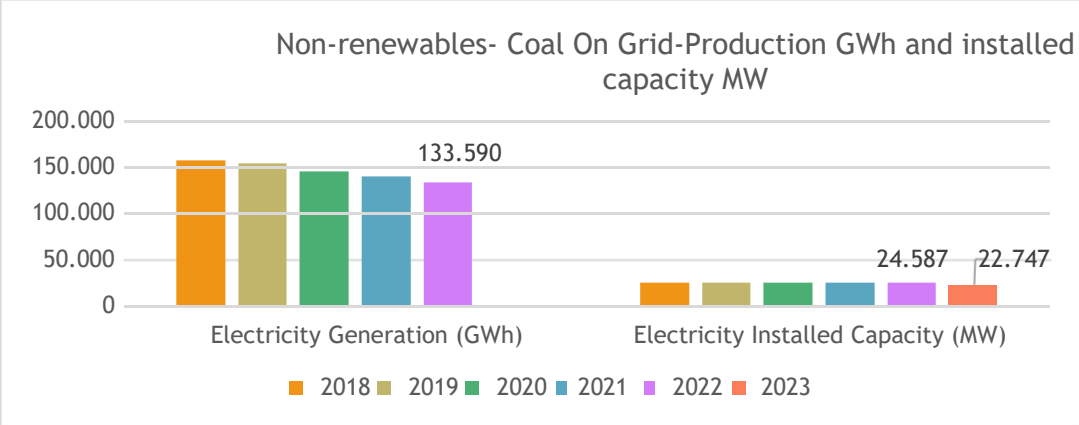
	Electricity Generation (GWh)					Electricity Installed Capacity (MW)					
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2023
	260.999	264.025	265.178	265.555	271.531	77.760	83.397	91.328	96.697	102.847	106.464
On-grid electric	260.999	264.025	265.178	265.555	271.531	77.760	83.397	91.328	96.697	102.847	106.464
Total Non-Rene	216.583	212.367	205.633	195.195	188.249	51.646	51.486	52.765	53.162	53.410	51.630
Fossil fuels	216.366	212.002	205.247	194.756	187.535	50.836	50.676	51.955	52.352	52.600	50.820
Coal and peat	157.711	154.304	145.522	140.311	133.590	24.954	24.954	24.986	24.986	24.587	22.747
Oil	4.838	4.923	4.509	4.662	4.665	2.441	2.399	2.307	2.434	2.397	2.397
Natural gas	53.817	52.775	55.216	49.783	49.280	22.846	22.722	24.060	24.330	25.014	25.074
Fossil fuels n.e.s.						595	601	602	602	602	602
Pumped storag	217	365	386	439	714	810	810	810	810	810	810
Total Renewabl	44.416	51.658	59.545	70.360	83.282	26.114	31.911	38.563	43.535	49.437	54.834
Hydropower (e	15.804	15.602	14.764	14.761	16.297	7.713	7.713	7.713	7.713	7.713	8.440
Renewable hyd	15.804	15.602	14.764	14.761	16.297	5.913	5.913	5.913	5.913	5.913	6.640
Mixed Hydro Plants						1.800	1.800	1.800	1.800	1.800	1.800
Marine energy	0,0	0,0	0,0								
Wind energy	15.164	17.712	20.396	24.535	29.108	6.409	7.881	10.207	10.555	11.966	12.911
Onshore wind	15.164	17.712	20.396	24.535	29.108	6.409	7.881	10.207	10.555	11.966	12.911
Solar energy	9.930	14.848	21.034	27.717	34.687	11.128	15.453	19.772	24.396	28.887	32.612
Solar photovolt	9.925	14.842	21.028	27.712	34.682	11.125	15.450	19.769	24.393	28.884	32.609
On-grid Solar ph	9.925	14.842	21.028	27.712	34.682	11.125	15.450	19.769	24.393	28.884	32.609
Solar thermal e	5,0	6,0	6,0	5,0	5,0	3,0	3,0	3,0	3,0	3,0	3,0
Concentrated s	5,0	6,0	6,0	5,0	5,0	3,0	3,0	3,0	3,0	3,0	3,0
Bioenergy	3.518	3.496	3.351	3.347	3.190	864	864	871	871	871	871
Renewable municipal waste											0,4
Solid biofuels	2.264	2.164	1.998	1.993	1.817	674	674	674	674	674	674
Wood waste	614	635	611	515	450						
Black liquor	207	217	168	228	226	174	174	174	174	174	174
Bagasse	1.443	1.312	1.219	1.250	1.141	500	500	500	500	500	500
Biogas	1.254	1.332	1.353	1.354	1.373	190	190	197	197	197	197
Landfill gas	966	1.002	1.007	1.013	943	150	150	150	150	150	150
Sewage sludge g	216	248	221	218	274	30	30	30	30	30	30
Other biogases	72	82	125	123	156	10	10	17	17	17	17
Geothermal energy						0,1	0,1	0,1	0,1	0,1	0,1

Source: www. Irena.com

The largest installed capacity is in the form of solar where 32 th. MW gives 34 th. GWh what is efficiency of 1,06. The second important thing is wind energy installed capacity of 12 th. MW that gives 29 th. GWh what is 2,41 efficiency rates. They have hydro energy production with an efficiency of 2,6.

There is still large coal on grid capacity that has 22 th MW production of 133 th GWh what ask efficiency of 6,04.

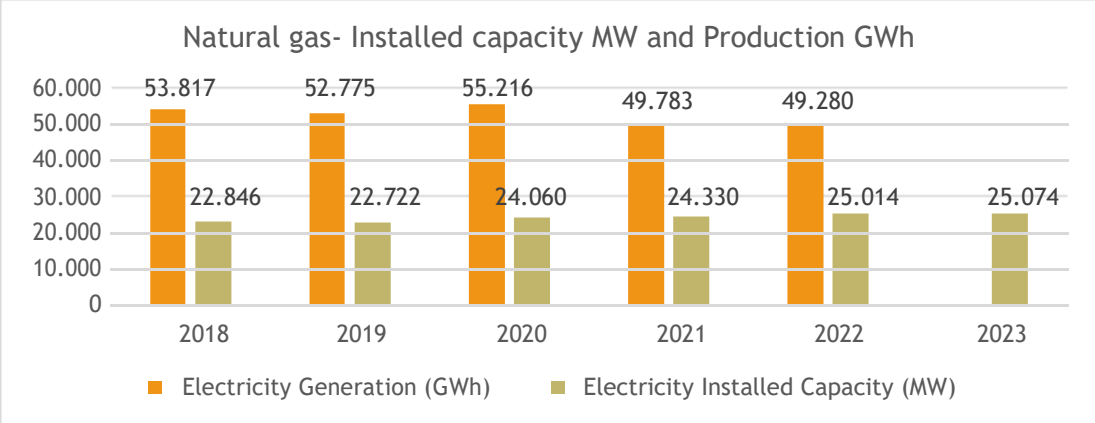
Graph 48: Australia -Coal on grid- Electricity Production and Capacity



Source: www. Irena.com

Another nonrenewable important source of energy is gas. Where country uses 25 th. MW of gas capacity to produce around 50 th. GWh output. So has doubled in efficiency.

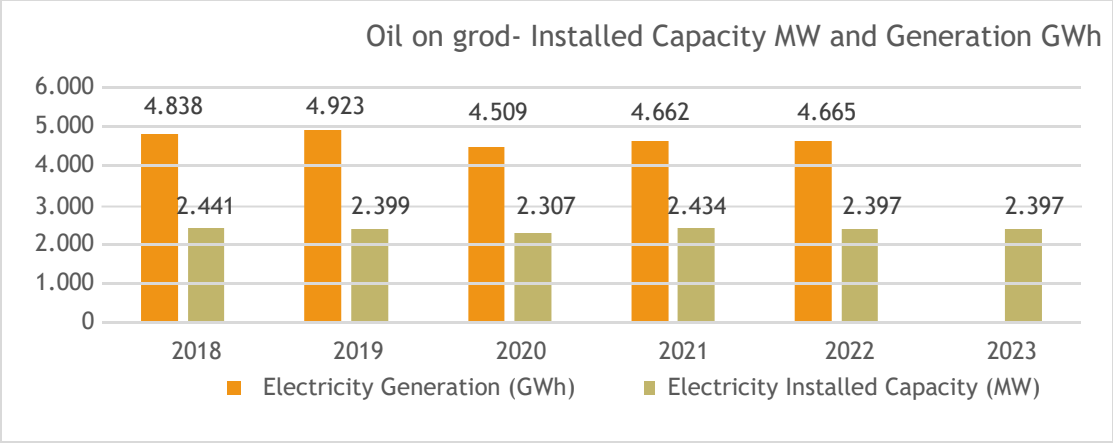
Graph 49: Australia -Natural gas – Installed Capacity and Production



Source: www. Irena.com

There is some oil capacity installed 2 th. MW with production of 4,6 th GWh output. What is considered bad is due to high CO_2 level and low level of efficiency.

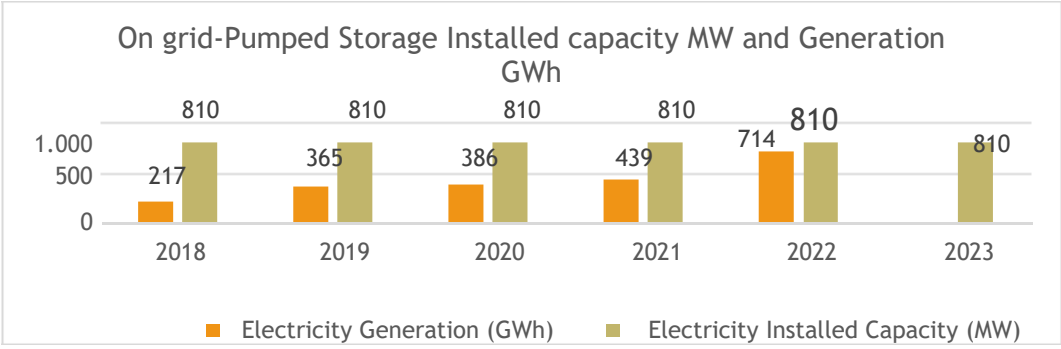
Graph 50: Australia- Oil on grid -installed Capacity and Production



Source: www. Irena.com

On grid pumped storage installed capacity is 810 MW and energy has risen several times in the last five years equaling 714 GWh.

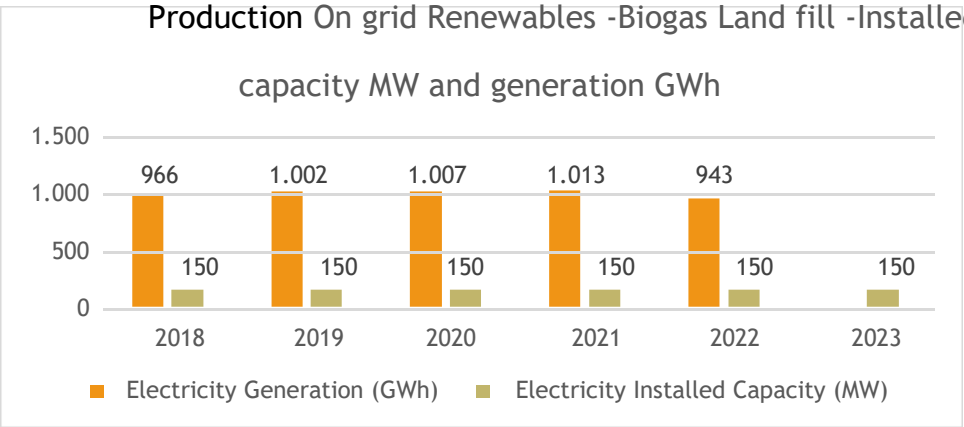
Graph 51: Australia- Oil on grid pumped storage- installed Capacity and Production



Source: www. Irena.com

Landfilled gas capacity is 150 MW and energy produced around 950 GWh.

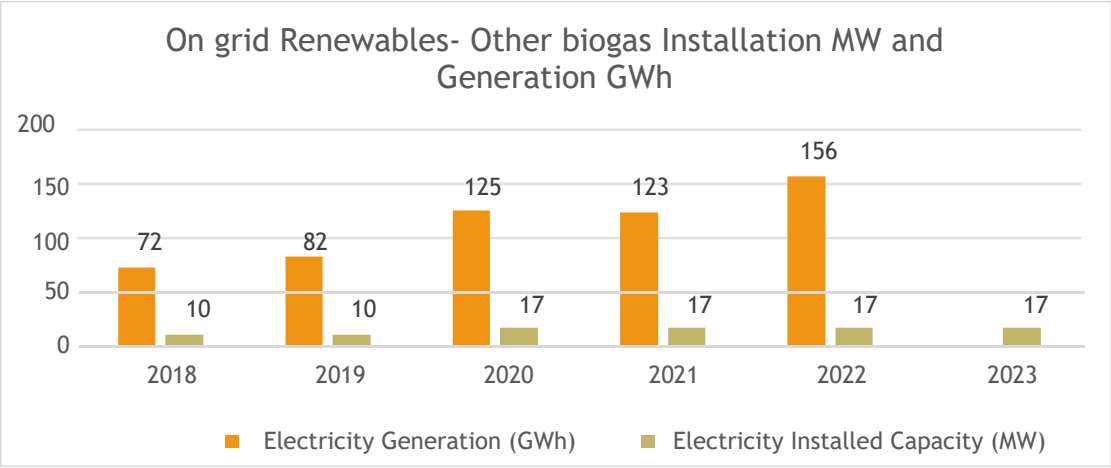
Graph 52: Australia- biogas landfill-Installed Capacity and Production



Source: www. Irena.com

The other biogas installation on the grid is 17 MW and produces energy is 156 GWh.

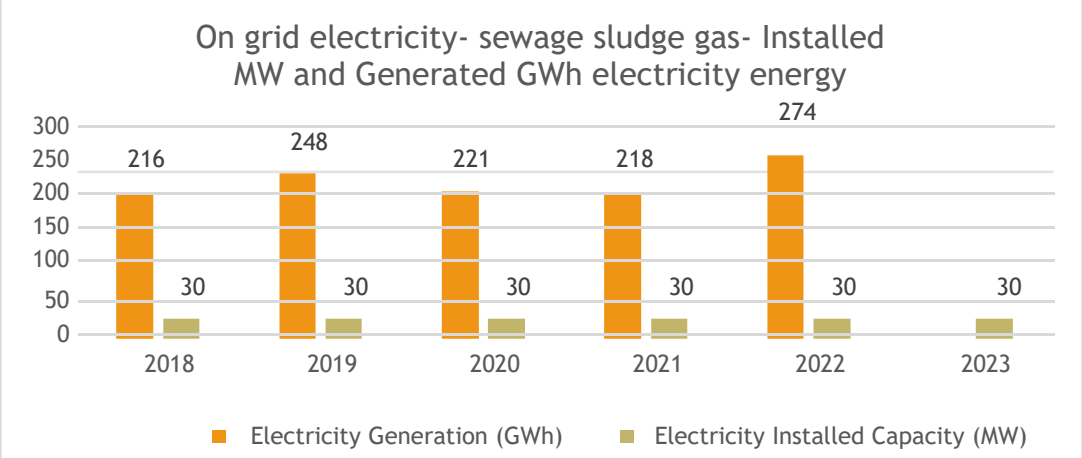
Graph 53: Other biogas – installation and generation



Source: www. Irena.com

What is interesting especially about efficacy is that Australia has significant quantities of electricity on grid from sewage sludge gas. They installed 30 MW, and that number is constant and have at end 274 GWH power what is efficacy production/capacity 9 times.

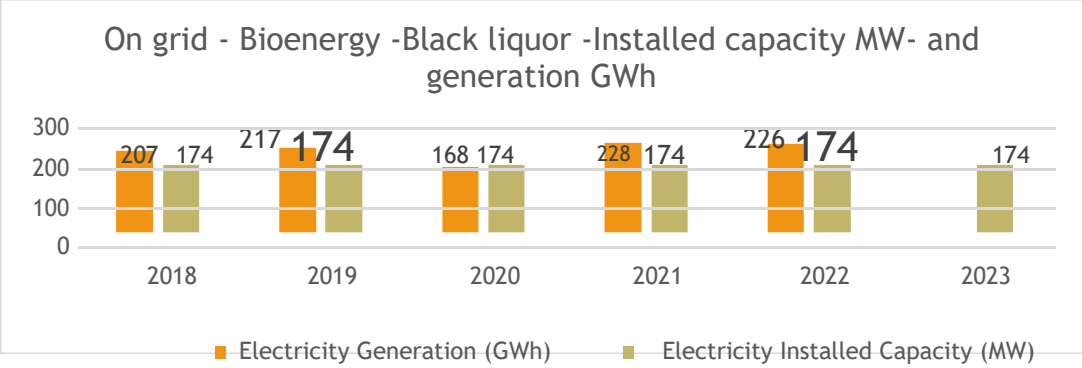
Graph 54: Sewage sludge gas- generated and installed capacity



Source: www. Irena.com

Australia has some capacity reserved for bioenergy where with installed 174 MW black liquor produces around 200 GWh electricity.

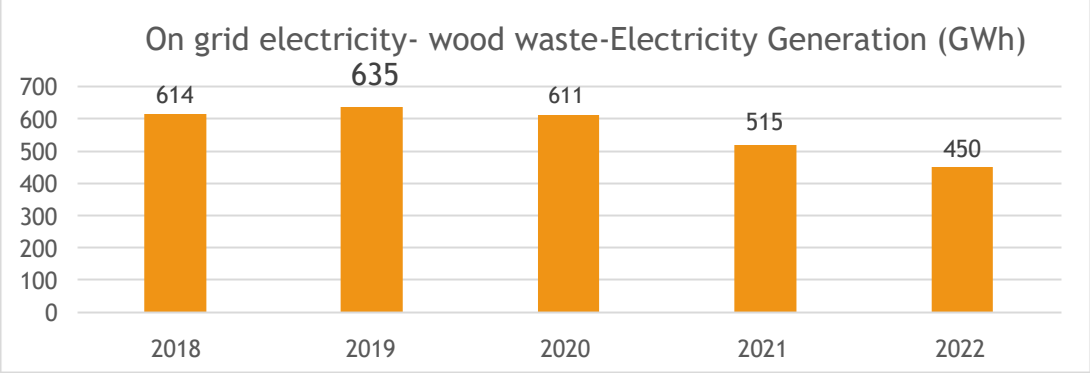
Graph 55: Bioenergy black liquor capacity and generation



Source: www. Irena.com

There is a large capacity of grid that comes from wood waste and produces around 500 GWh electricity yearly.

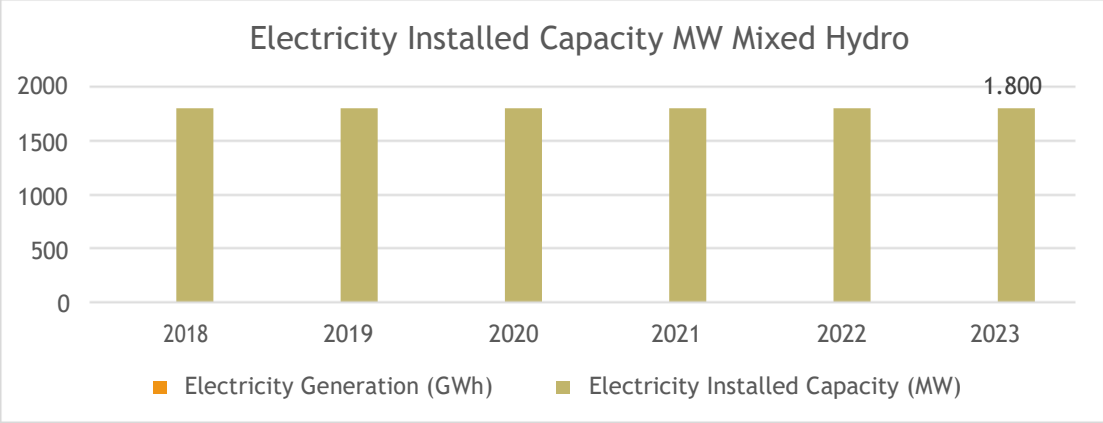
Graph 56: Wood waste generation GWh



Source: www. Irena.com

Installed capacity in hydro is 1.800 MW and is fixed last five years.

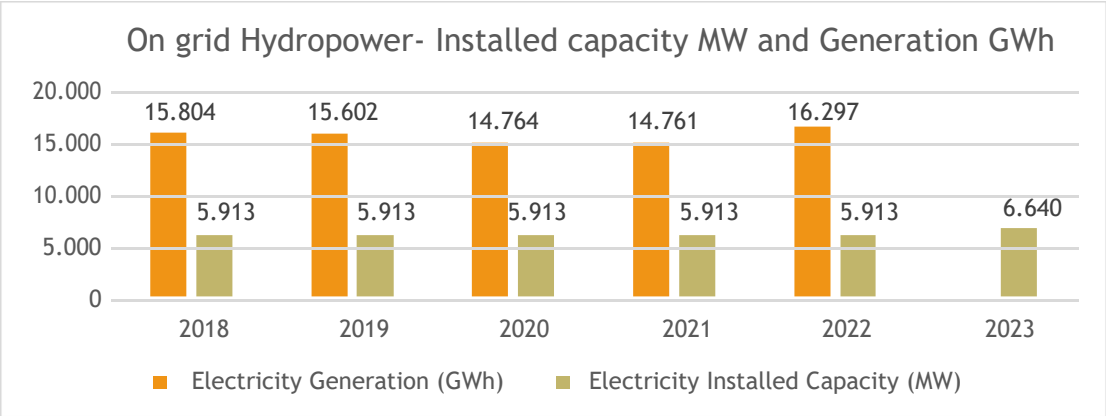
Graph 57: Mixed Hydro



Source: www. Irena.com

Although it is not possible to examine and predict hydro production since it fluctuates significantly depending upon water rain it is around 15.000 GWh.

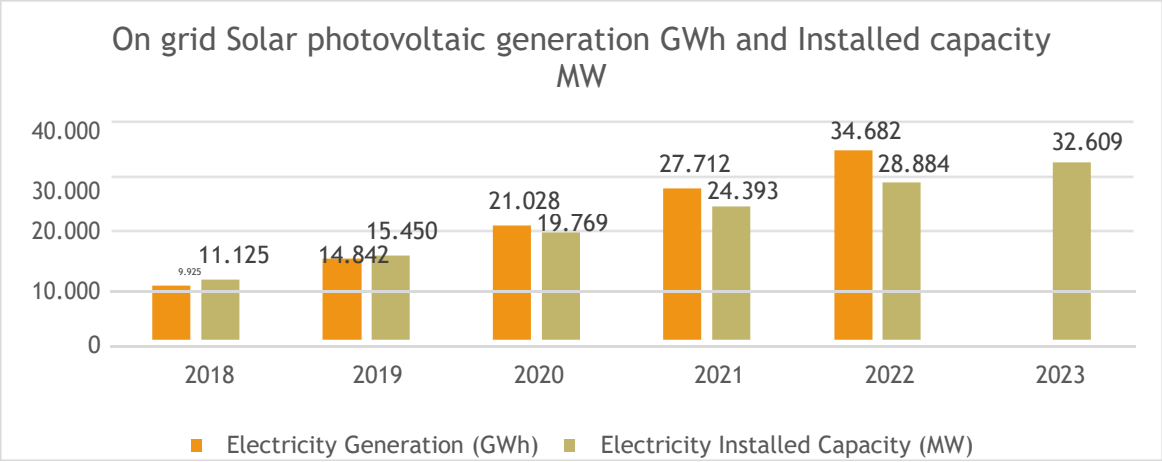
Graph 58: On grid Hydropower -Capacity and generation



Source: www. Irena.com

What Australia as done in the last period of five ten years is to examine and increase significantly its stand on solar photovoltaic generation with 32.600 MW it produces more than 34.000 GWh electricity yearly what makes production /capacity ratio of 1,06 and more.

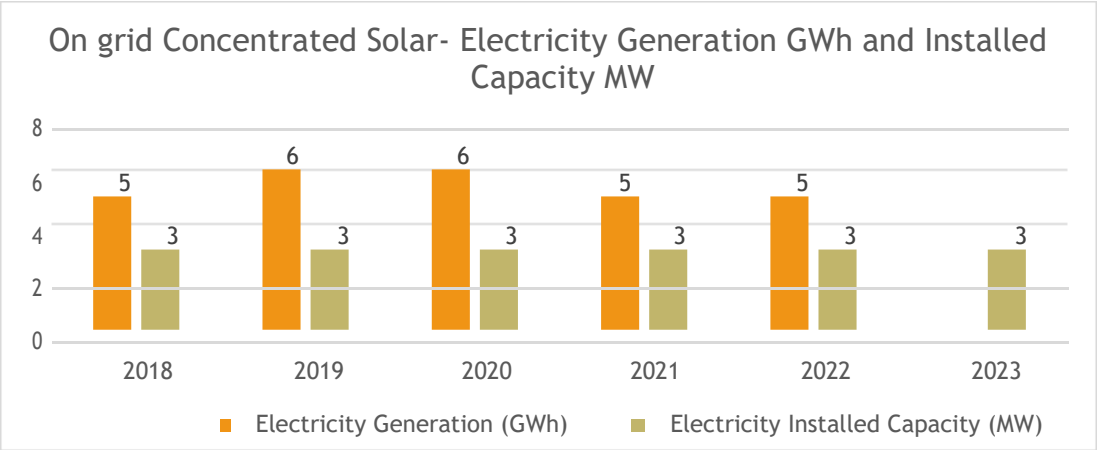
Graph 59: On grid solar Photovoltaic Generation and Capacity



Source: www. Irena.com

Much lower numbers are in concentrated solar technology that is present on grid. With 3 MW capacity produces 5 GWh energy.

Graph 60: On grid Concentrated Solar -Installed and Generation

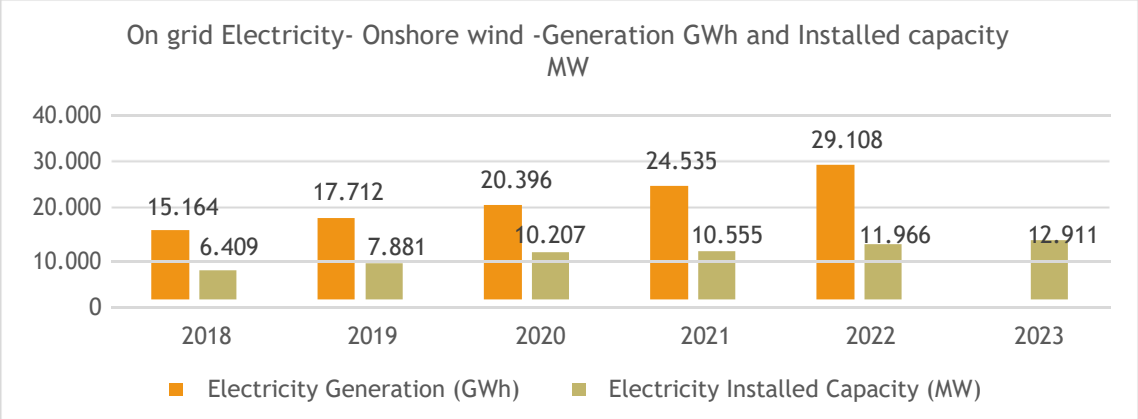


Source: www. Irena.com

Producing electricity from wind onshore is also on the rise in Australia.

Installed capacity rose from 6 th. to 12.911 MW and produced 29.100 GWh or have 2,25 ratio Production/1.000 Capacity Installed.

Graph 61: On grid Electricity onshore wind Capacity and Generation



Source: www. Irena.com

1.5. South Africa

South Africa increased is energy capacity from 56 th. MW to 62 th. MW in the last five years. This 10% capacity increase has resulted in an outcome of 226 th GWh. On the grid electricity is 99% of the total. Out of which nonrenewable source makes 82% of on grid installed capacity. Fossil fuels inputs are increased from 43 to 47 th MW. Coal and peat increased from 40 th MW to 43 th MW. Nuclear energy is constant at 1.9 th. MW installed capacity. Pumped storage gained significance in total 2,7 th MW.

From many renewable sources the main source is solar energy around 6 MW that produce

8,3 GWh than wind energy 3,4.

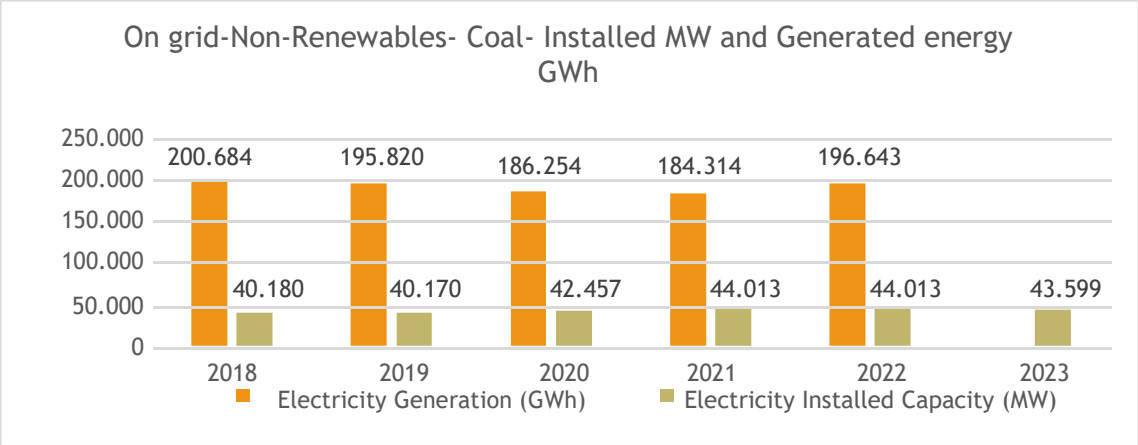
Table 10: South Africa

	Electricity Generation (GWh)					Electricity Installed Capacity (MW)					
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022	2023
	226.366	223.267	212.966	213.723	226.897	56.194	56.295	60.097	61.952	62.636	62.333
On-grid electricity	226.323	223.162	212.858	213.637	226.889	56.182	56.274	60.070	61.924	62.608	62.306
Off-grid electricity	43	105	108	86	7,6	13	21	27	27	27	27
Total Non-Renewable	218.411	214.893	203.280	202.546	214.628	48.283	48.273	50.560	52.110	52.116	51.696
Fossil fuels	201.615	197.117	187.679	186.048	199.363	43.611	43.601	45.888	47.444	47.444	47.030
Coal and peat	200.684	195.820	186.254	184.314	196.643	40.180	40.170	42.457	44.013	44.013	43.599
Oil	931	1.297	1.425	1.734	2.720	3.431	3.431	3.431	3.431	3.431	3.431
Nuclear	12.233	12.834	10.740	11.742	10.594	1.940	1.940	1.940	1.934	1.940	1.934
Pumped storage	4.562	4.943	4.861	4.756	4.672	2.732	2.732	2.732	2.732	2.732	2.732
Total Renewable	7.913	8.269	9.578	11.091	12.261	7.899	8.001	9.510	9.814	10.492	10.610
Hydropower (excl. Pun	949	773	1.212	1.804	3.303	740	740	740	744	744	744
Renewable hydropowe	949	773	1.212	1.804	3.303	740	740	740	744	744	744
Wind energy	329	294	300	266	224	2.094	2.094	2.516	2.495	3.163	3.442
Onshore wind energy	329	294	300	266	224	2.094	2.094	2.516	2.495	3.163	3.442
Solar energy	6.203	6.771	7.656	8.615	8.329	4.800	4.903	5.989	6.311	6.321	6.159
Solar photovoltaic	5.174	5.217	6.033	6.963	6.739	4.400	4.403	5.489	5.811	5.821	5.659
On-grid Solar photovoltaic	5.174	5.217	6.033	6.963	6.739	4.400	4.403	5.489	5.811	5.821	5.659
Solar thermal energy	1.029	1.554	1.623	1.652	1.589	400	500	500	500	500	500
Concentrated solar power	1.029	1.554	1.623	1.652	1.589	400	500	500	500	500	500
Bioenergy	431	430	410	405	405	265	265	265	265	265	265
Solid biofuels	386	385	364	360	360	242	242	242	242	242	242
Bagasse	386	385	364	360	360	242	242	242	242	242	242
Biogas	45	45	45	45	45	23	23	23	23	23	23
Landfill gas	26	26	26	26	26	14	14	14	14	14	14
Other biogases from anaer	19	19	19	19	19	9,0	9,0	9,0	9,0	9,0	9,0

Source: www. Irena.com

South Africa increased capacity from 40 th MW to 43 th MW in 2023. This means production of electricity in amount of 196.643 GWh what is efficiency of 4,5 times.

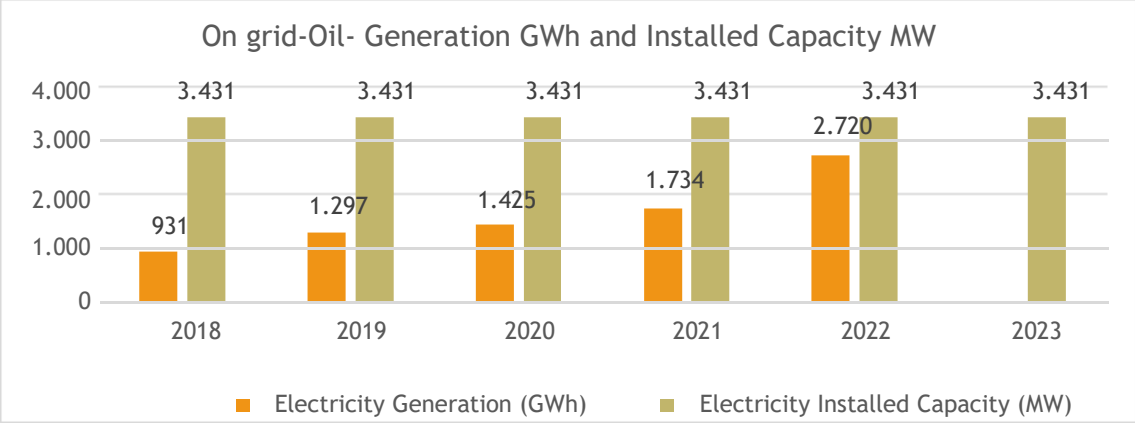
Graph 62: Coal on grid Installed and generated energy



Source: www. Irena.com

Oil capacity is 3.431 MW and produced energy is 2.700 GWh what is much lower level than expected 0,79 efficacy rate.

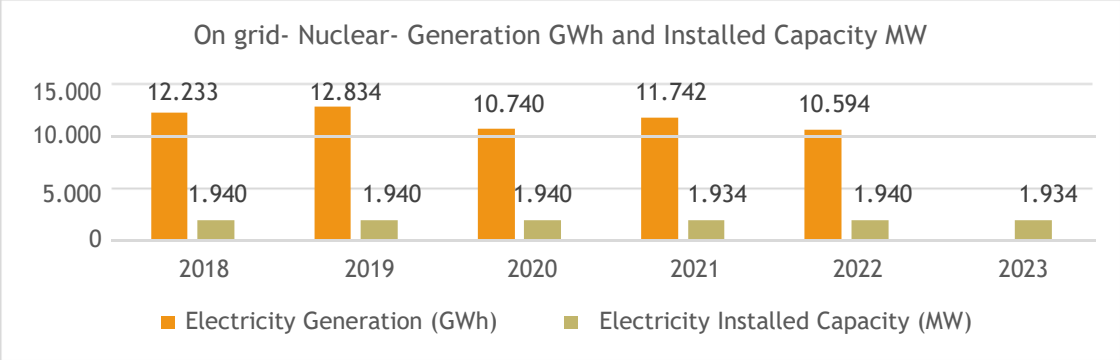
Graph 63: On grid-oil- Generated and installed energy



Source: www. Irena.com

Nuclear energy proved to be much more reliable in terms of efficiency so with 1.934 MW installed capacity South Africa produces 10.559 GWh energy. What seems to be a problem is the age and trend of production that goes downturn, along with danger of radiation in case of large accident and waste disposal that can radiate many years after usage.

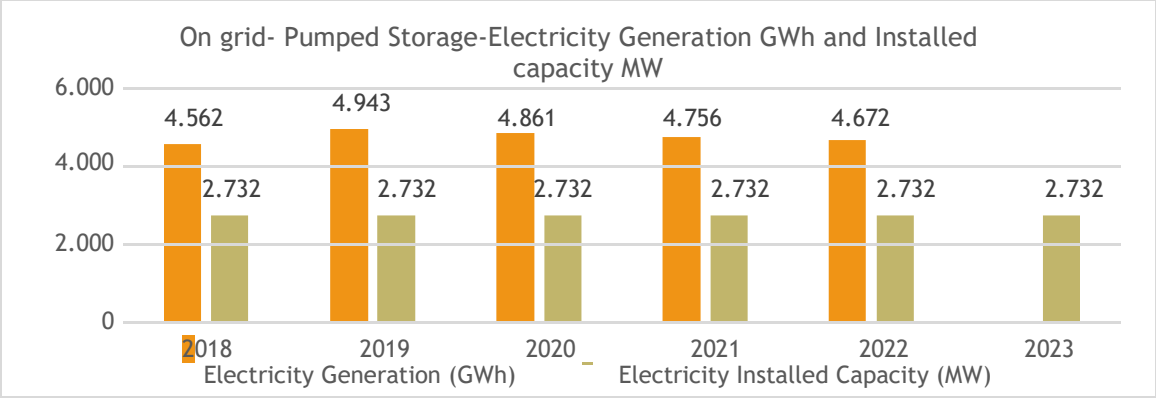
Graph 64: On grid -nuclear-Generation and installed Capacity



Source: www. Irena.com

With pumped storage capacity of 2.732 MW South Africa makes around 4.600 GWh electricity output

Graph 65: On grid- pumped storage – installed and generated

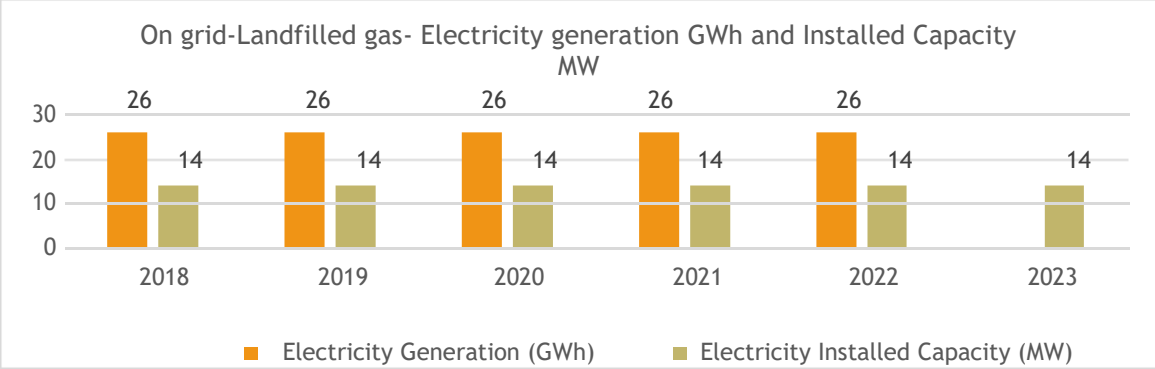


Source: www. Irena.com

The installed capacity of landfilled gas is constant and is around 14 MW also constant output is to be expected is 26 GWh. This gives us the message that

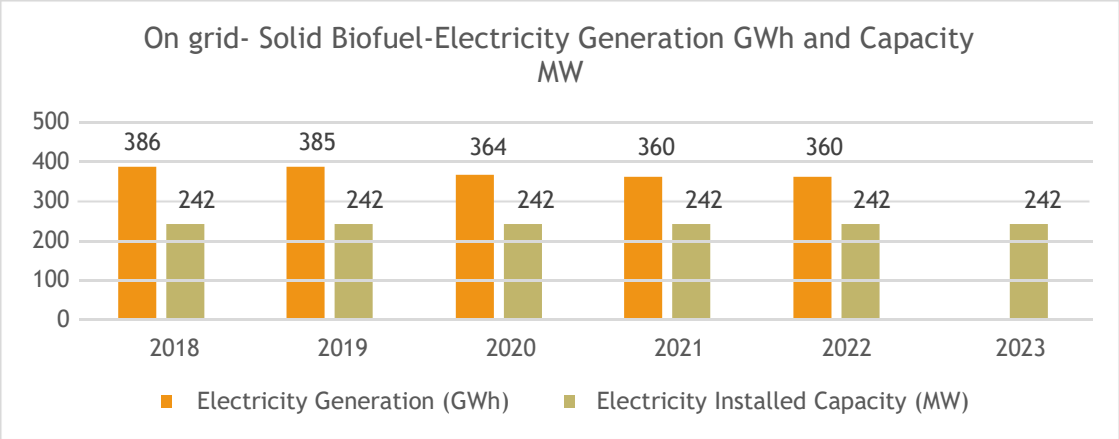
with landfilled gas we can expect a stable amount of output so the system will not deviate much. Efficiency is 1,8.

Graph 66: On grid landfilled gas- generation and capacity



Source: www. Irena.com

Solid biofuel is present in the form of 242 MW capacity and the output that is produced fluctuates around 360 GWh. Efficiency is 1,4. Graph 67: On grid solid biofuel – generation and capacity

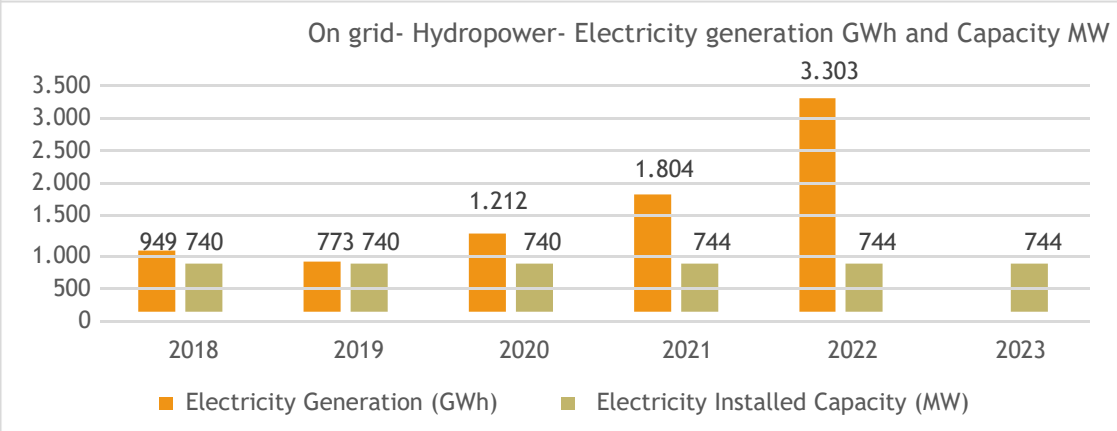


Source: www. Irena.com

The real difference in installed capacity and output is present with hydropower

With same installed capacity we reach different outputs from 3.300 GWh to 949 GWh.

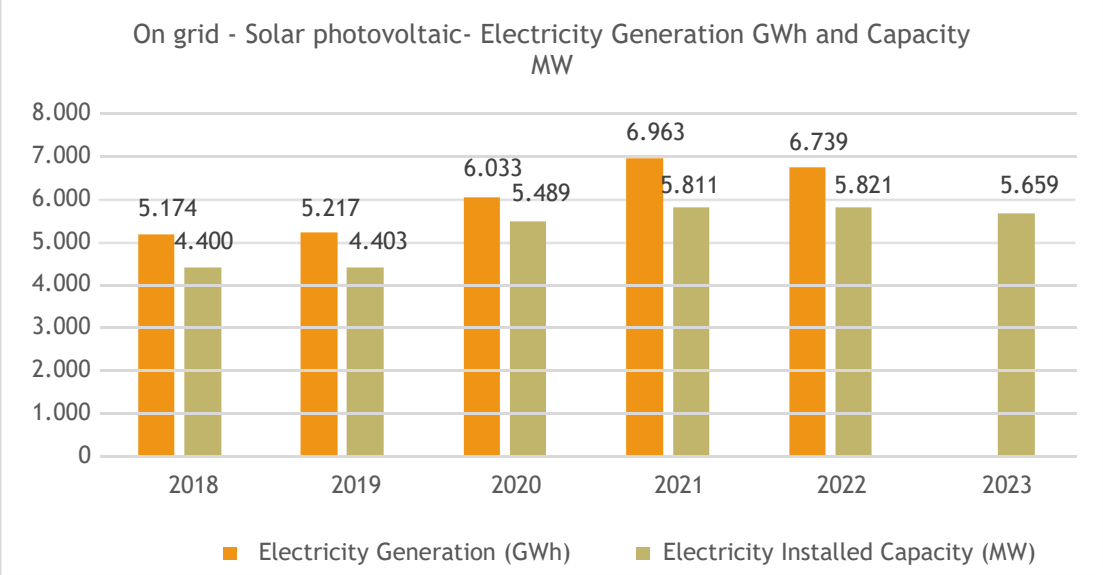
Graph 68: On grid-hydropower- generation and capacity



Source: www. Irena.com

Country increased capacity in solar photovoltaic from 4.400 MW to 5.659 MW what is 28% increase. Constant output but with less efficiency than expected compared to other renewable sources is around 6700 GWh. Efficiency is 1,18.

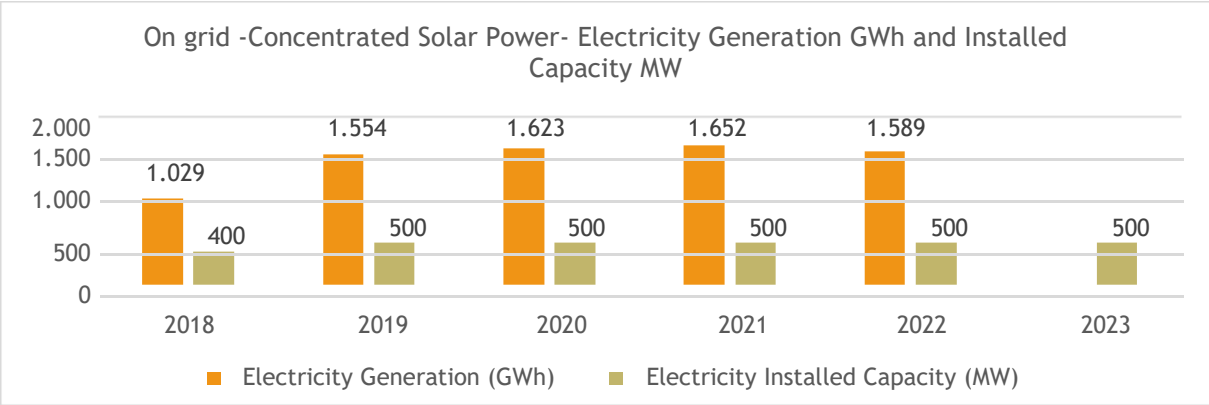
Graph 69: On grid-solar photovoltaic-installed capacity and generation



Source: www. Irena.com

On grid solar concentrated solar is constant and is 500 MW and output is much greater than in classical solar photovoltaic and is 1589 GWh or efficiency of 3.

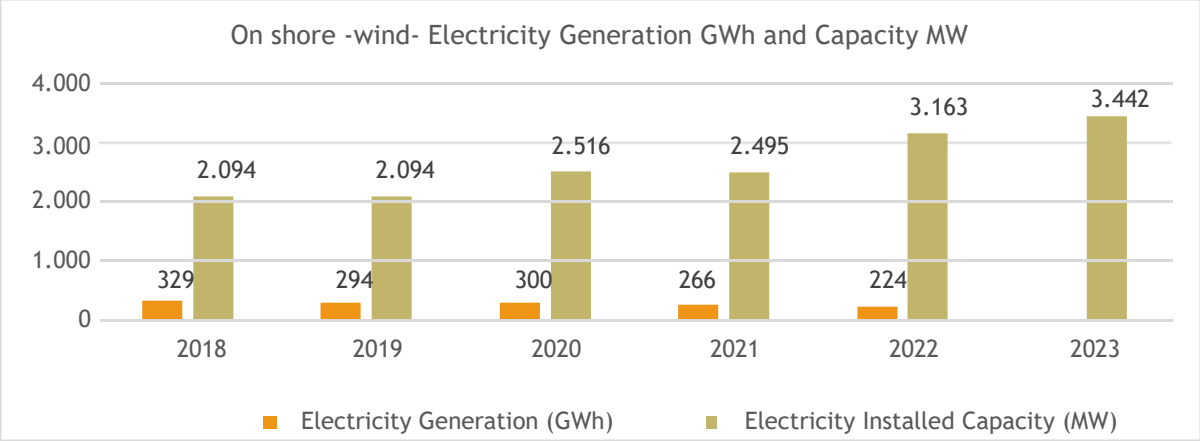
Graph 70: On grid Concentrated solar -generation and capacity



Source: www. Irena.com

On shore wind installed capacity is 3.442 MW and output is 224 GWh. It is highly dependent upon wind strength and weather conditions so the history of output shows.

Graph 71: On shore wind -generation and installed capacity

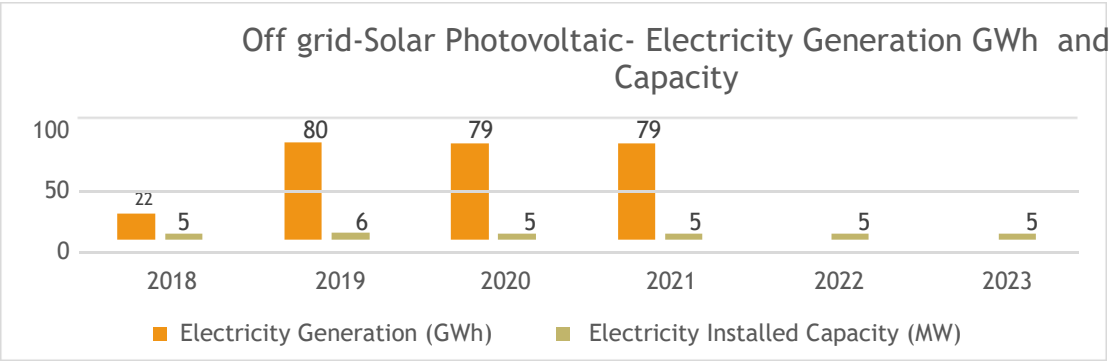


Source: www. Irena.com

Off grid solar photovoltaic is 5MW and output is 80 GWh.

Graph 72: Of grid photovoltaic -generation and installed capacity

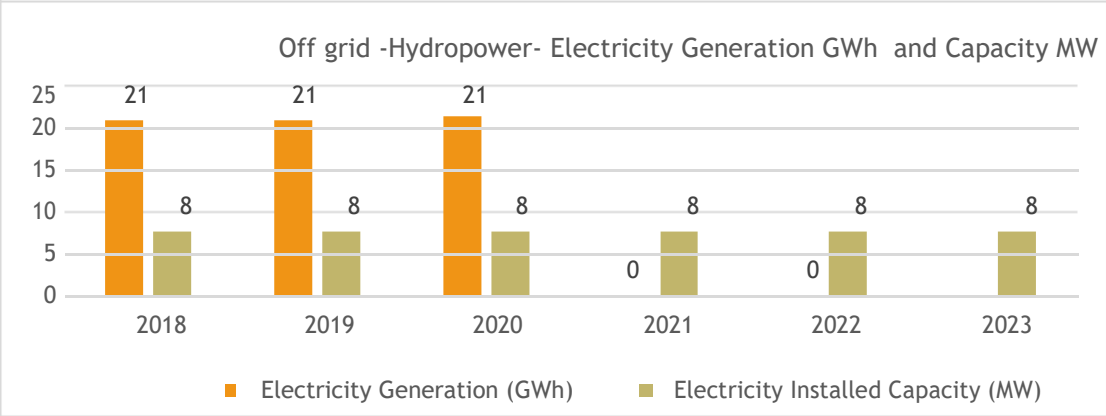
MW



Source: www. Irena.com

Off grid power hydropower installed capacity is 8 MW and produced energy is 21 GWH.

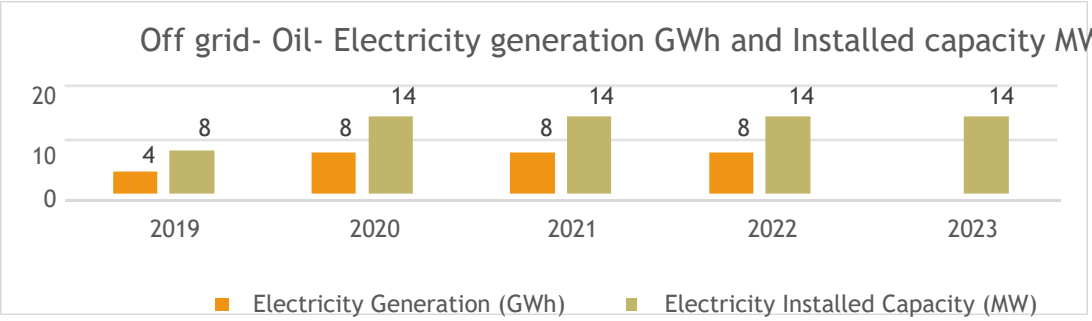
Graph 73: Off grid hydropower generation and capacity



Source: www. Irena.com

Off grid electricity production with oil technology is 14 MW and generation is 8 GWh.

Graph 74: Off grid- oil- generation and installed capacity



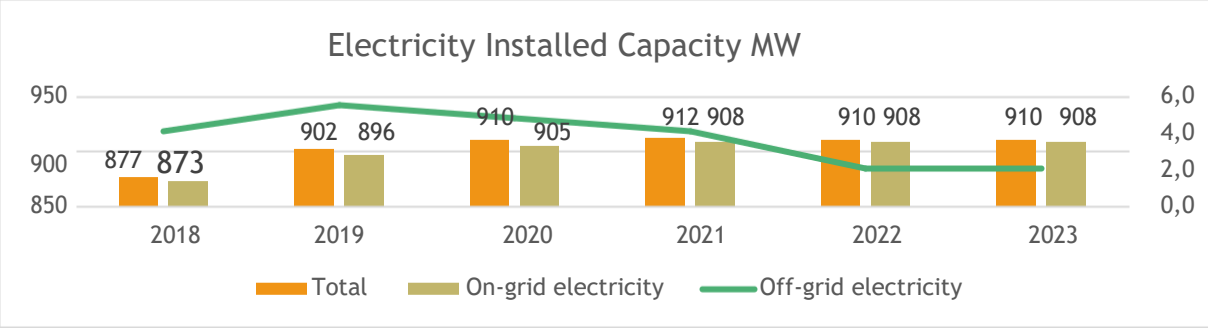
Source: www. Irena.com

2. COUNTRY DATA

Collecting all data and analyzing how different countries cope with diversification in electricity generation is the basis for further discussion.

In the Mauritius country we see that installed capacity is 908 MW and with that capacity 910 GWh electricity is produced. Efficiency is very low compared with other countries at 1,002.

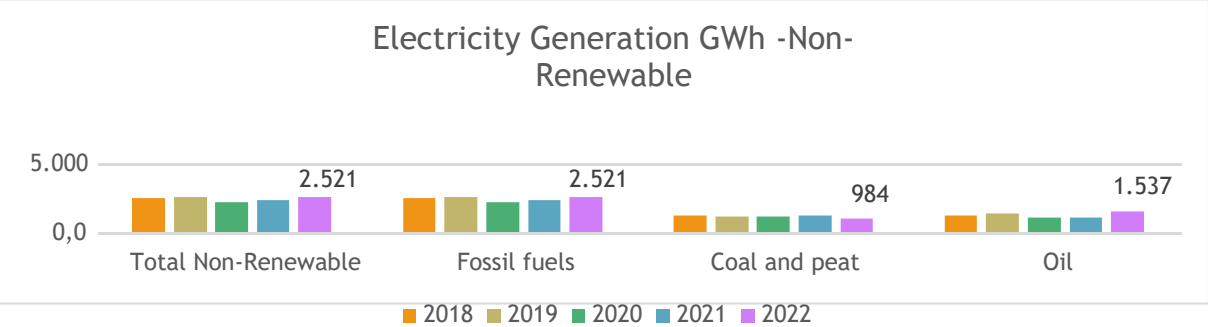
Graph 75: Electricity Installed MW - On and off grid



Source: www. Irena.com

Production electricity from nonrenewable is steady around 2.521 GWh and the largest part comes from fossil fuels out of which oil 1.537 GWh and then coal and peat 984 GWh.

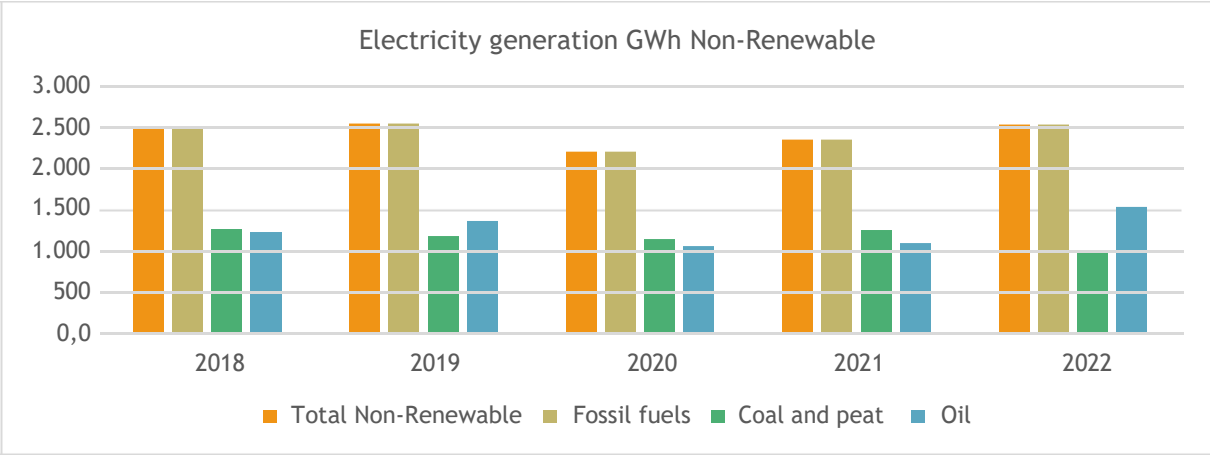
Graph 76: Electricity generation from non-renewables GWh



Source: www. Irena.com

From Graph 77 is visible that investment in oil capacity and increasing efficiency is what they expect. So rose from 1.361 GWh to 1.537 GWh. Looking at historical values is decreasing for coal mad peat and goes from 1.223 GWh to 984 GWh.

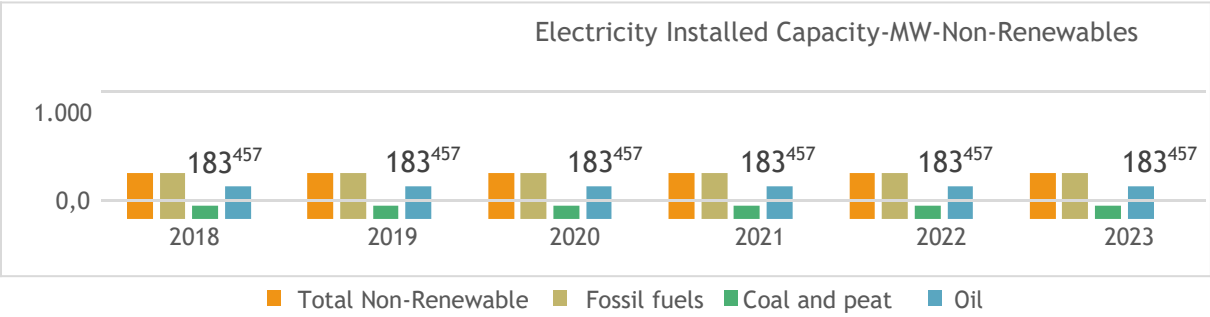
Graph 77: Electricity generation GWh non-renewables



Source: www. Irena.com

Installed capacity in oil is constant 457 MW and constant capacity in coal and peat in the last five years. No improvement or capacity increase is visible on graph 78.

Graph 78: Electricity Installed Non renewables MW

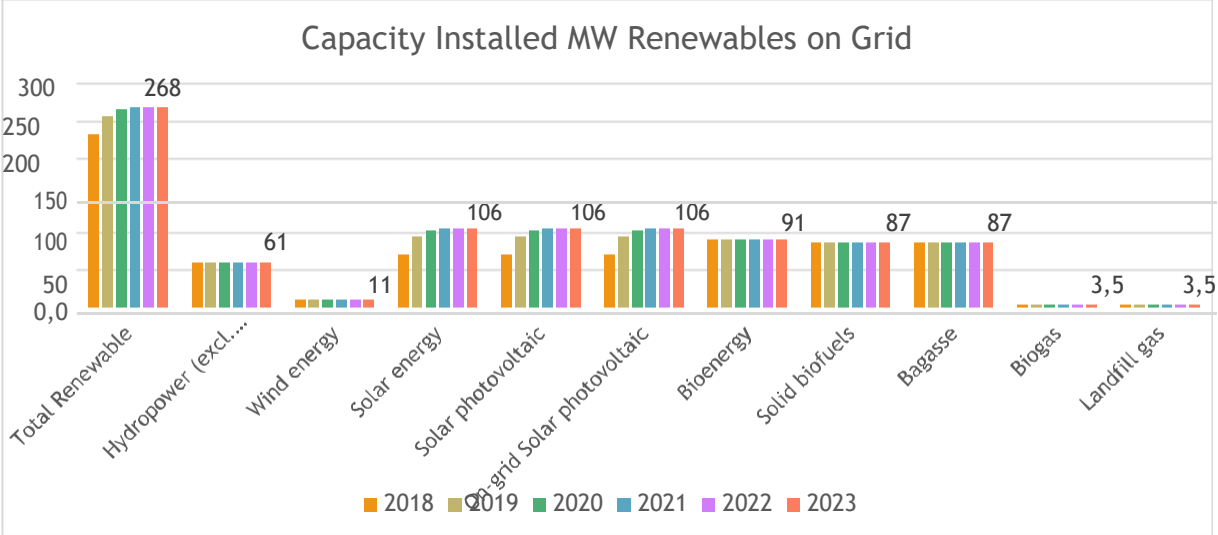


Source: www. Irena.com

What especially worries are on the side of renewables. The same capacity has been present in the last five years. Country has chosen diversification on side of renewables is present, but Hydropower capacity is 61 MW, solar energy capacity is

106 MW, bioenergy capacity 91MW, solid biofuels 87 MW (bagasse) and some landfilled gas 3,5MW.

Graph 79: Capacity installed Renewables on grid MW

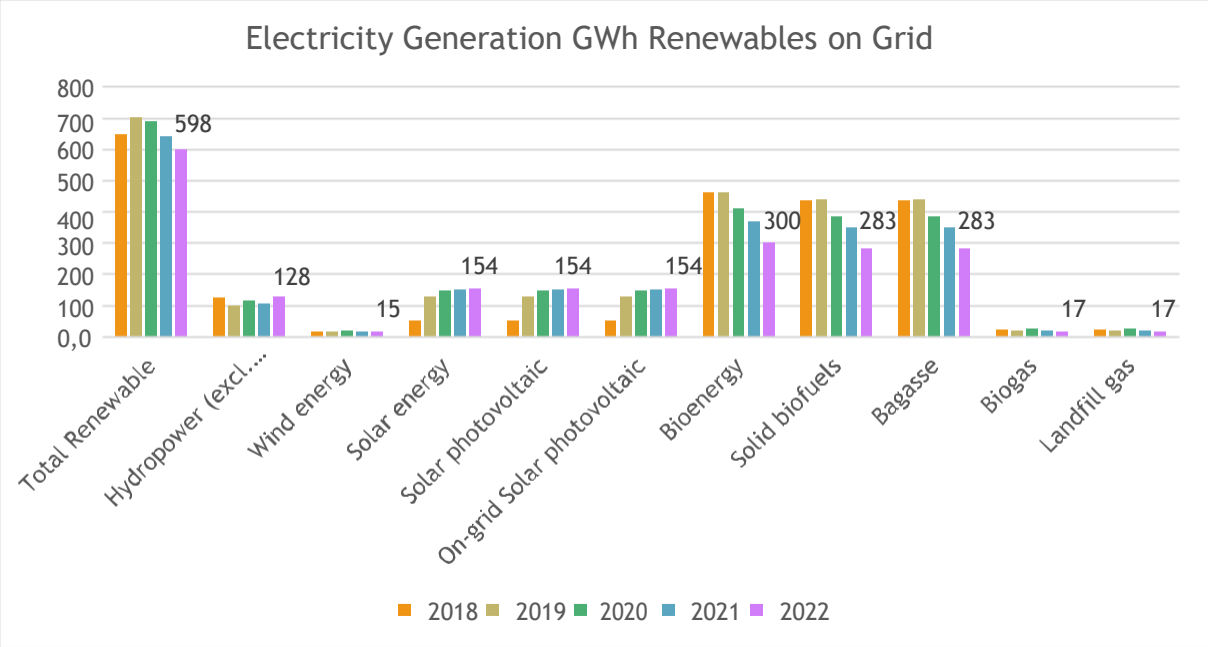


Source: www. Irena.com

Different output came from hydropower is 128 GWh, solar energy 154 GWh and bioenergy 283 GWH landfilled gas 17GWh. Further points examine the efficiency of single source and examine that: hydropower is 2,09; solar efficiency 1,45; and bagasse 3,25. Landfilled gas 4,85.

On this data, the country needs to further build policy and energy production increase strategies.

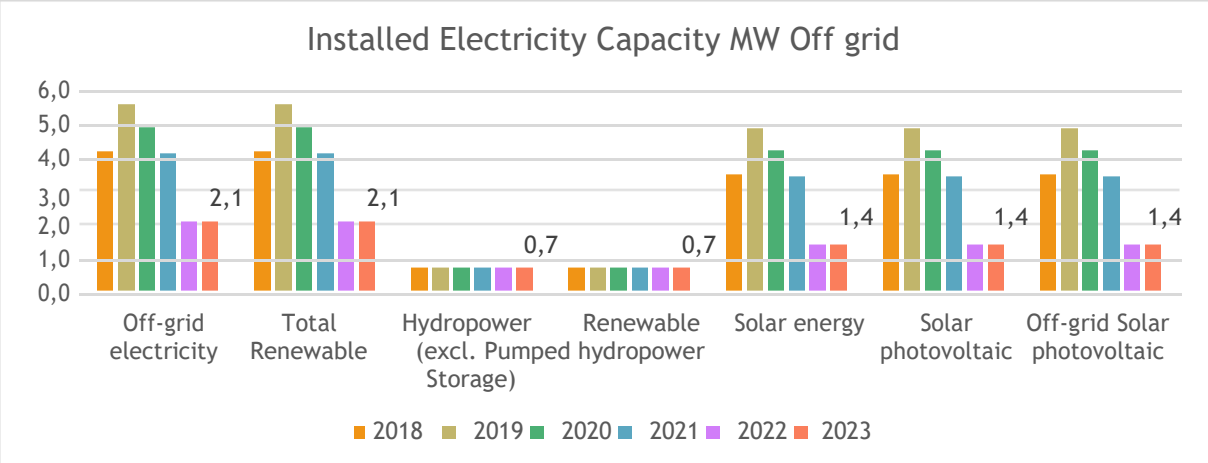
Graph 80: Electricity generation Renewables on grid in GWh



Source: www. Irena.com

Off grid capacity is decreasing and is present in the form of solar photovoltaic and pumped hydro storage.

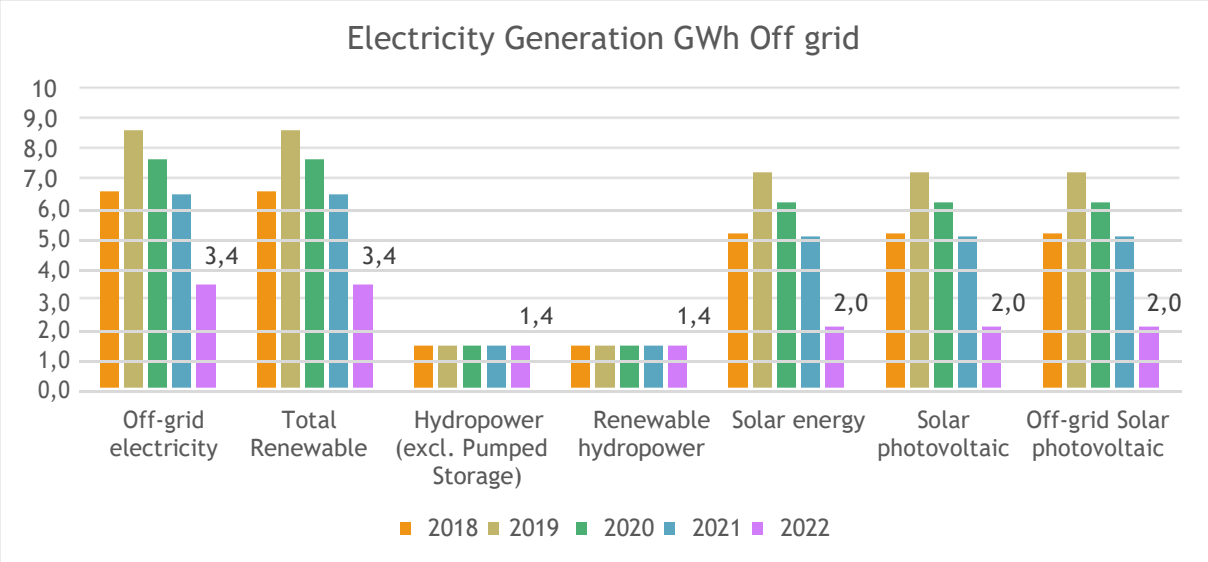
Graph 81: Installed electricity off grid



Source: www. Irena.com

From 1,4 MW off grid production is 2 so efficiency is 1,4.

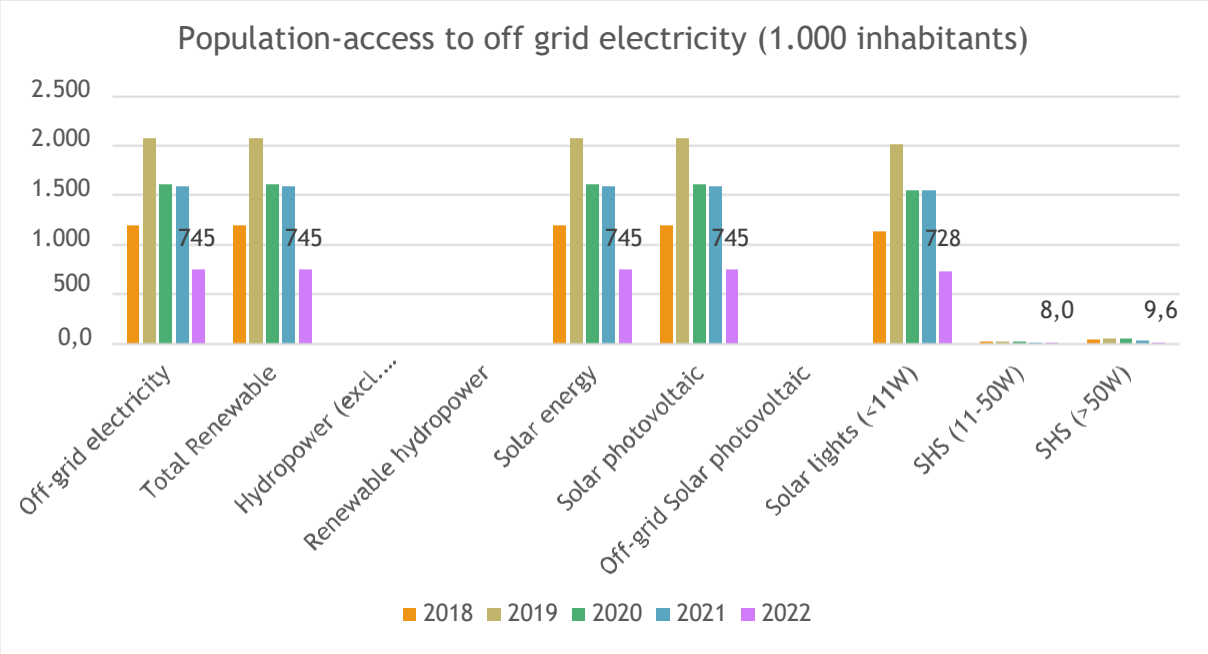
Graph 82: Electricity generation GWh off grid



Source: www. Irena.com

The number of people that have access to off grid technology is 745 people.

Graph 83: Population access to off grid electricity



Source: www. Irena.com

3. PROJECTS PRE CALCULATIONS

3.1 Costs of technology

Before starting the best possibility for new technology, increase existing technology, replace nonrenewable with renewable, introduce energy efficient measure that we need to see prices of technology and output price of electricity to consumers.

Table 11: Costs of installation and capacity factor

	Cost of installation USD kW			Capacity factor	Levelized cost of electricity (USD/kWh)		
	2010	2022	Change		2010	2022	Change
Bioenergy	2904	2162	-26%	72	0,082	0,061	-25%
Geothermal	2904	3478	20%	85	0,053	0,056	6%
Hydropower	1407	2881	105%	46	0,042	0,061	47%
Solar PV	5124	876	-83%	17	0,445	0,049	-89%
CSV	10082	4274	-58%	36	0,380	0,118	-69%
Wind - onshore	2179	1274	-42%	37	0,107	0,033	-69%
Win- offshore	5217	3461	-34%	42	0,197	0,081	-59%

Besides having off and on grid usage of electricity we have several possibilities for the market. That is the wholesale market or local market. Wholesale market is in Europe where you can buy electricity on spot market or forward market – market with different derivatives. Europe wholesale price for electricity is between 0,15 and based on packet o,20 USD/MWh while for cash 0,05 USD/MWh.

1. Offshore wind

   In the period from 2018-2022 the following cost reductions were possible to reach market throughout world.

So, we have offshore wind installation costs that decreased from 5.124 to 3.461 USD/KW capacity factor is from 38% to 42% and levelized cost of electricity fell from 0,197 to 0,081.

2. On shore wind

   On shore investment costs fell from 2186 to 1274, capacity factors rose 27% to 37%. Price decreased 0,107 to 0,033.

3. Solar photovoltaic

   Solar photovoltaic costs fell from 5124 to 876, capacity increased from 14% to 17%, and price fell from 0,445 to 0,049.

4.Concentated Solar Parabolic

Costs of installation and technology fell from 11.879 to 4.272, capacity factor rose from 30% to 36%-40%, and levelized costs of electricity fell from 0,38 to 0,118.

There is different price between countries who insect in CSP and solar tower. End price on average is in Australia 0,030 USD/kwh Marocco 0,014, USD/kwh so investing in technology depends upon country willingness to support certain technology.

5.Hydro Power

Hydropower Total installed cost of hydropower rose from 1.407 to 2.881. Capacity factor is from 44% 46%. Levelized cost of electricity rose from 0,042 USD/KWh to 0,061 USD/KWh.

6.Geo energy

Total installed costs in geothermal energy rose from 2905 USD to 3.478 capacity factor fell from 87% to 85%. Levelized costs of electricity rose from 0,053 USD/kWh is 0,056 USD/kWh.

7.Bioenergy

Bioenergy total installed costs fell from 2905 USD to 2162. Capacity factor is around 72%. levelized costs of electricity fell from 0,082 USD/kWh to 0,061 USD/kWh.

The very significant role of electricity can come from biomass materials. Biomass is the organic material of recently living plants trees grasses agricultural crops. Biomass can be very heterogenous with chemical composition highly dependent on the plant species. The costs of feedstock vary. Due to different factors land values storage on site, logistics land use, different feedstock. Examples of low costs residues that are used for

3.2. RESULTS OF PRESENTED

Based on data shown, some further important conclusions need to be considered and stressed before we start with real projects and numbers.

3.2.1. Pre event considerations

1.

Paris Agreement is not only Legal Obligation- it is real life scenario of real possible threats. If we are using overload of carbon fuel and allocating it into atmosphere statistics say CO_2 rise. There is a need to reduce harmful gases to ensure a clean environment is proved.

2.

Threat is known to all countries even the richest like USA and China have problems with climate change in respect of tornado, sea level rise.

This possible situation is more stressful for a small country that is surrounded by sea, faced with possible threats of sea level rise. In that respect the fight against climate change is not abstract but a real-life situation where it keeps lives and property essential for tomorrow. Fight for that needs to be considered.

3.

The slow pace of implementing renewables brings additional dangers to all, but what we put there is somewhere in local atmosphere or land also so local and global need to be respected.

4.

We need to consider scenarios of different technologies what is best suited in the first place, then compare investment costs of wanted scenarios and take world benchmarks with local characteristics into account when putting operation costs to work into pre-feasibility studies.

Electricity prices vary according to wholesale or retail price and different technologies offer different end price results to customers.

For small vulnerable economy decreased opportunity in market input put additional stress of choosing, and putting to work new technology,

5.

Comparing prices and combining different technologies are essential in reaching the most efficient result.

6.

After choosing the right strategy be aware of imported goods prices and transport costs.

Goods imported is maybe in use for 30 years and after need to be changed recycled. In that time, you need to have an additional contract with the seller in respect of further trade agreement like. If I buy your goods on a wholesale basis. You provide tourist numbers for 30 years.

In that respect, ensuring businesses develop further.

7.

States are expected to have an active role in ensuring policies, legislation, trade agreements, standard, discount, possibility to sell electricity into network on calculated price. Price needs to be incorporated into some social values such as: public lights, hospital feed in, emergency tariffs etc.

3.3. Data Gathering

When making a project you need to be aware of facts like:

How to allocate problems, distribute to proper economic and energy analysis further.

1.

Where is the Location of a Project

What characteristics Location has:

Classical data include temperature, wind speed, solar daily radiation, cooling degree days, heating degree days, atmospheric pressure, relative humidity, precipitation etc.

2.

What kind of facility is needed and will be considered:

-Power plant (fuels cells, wind turbine, gas turbine, geothermal power, hydro turbine, solar thermal power, steam turbine, tidal power, wave power, photovoltaic, ocean current, multiple technologies implemented etc.)

-Combined Cooling, heating and power, or only cooling, only heating, only power system.

Allocating combined power heating or cooling we have greater efficiency that can reach from 40 % in divided case or combined 85% efficiency in end results.

3.

-For Whom is the Project?

Is it a Project - Industrial, commercial, institutional, residential, Agricultural, Individual measures taken, other

4.

-What transportation is about to be implemented or needed?

Ship, boat, car, Air carrier, off road vehicles, train, etc. Cost of transport and import duties, emissions in transport etc.

5.

-What are Local characteristics?

6.

Comparison between Base and Proposed Case need to be stated clearly

When choosing different kinds of end project, we need to define old type of behavior with proposed measures, compare results, induce efficiency measures or calculate new prices obtained on market.

In the case of power plants:

- We need to know base case and propose case in respect to fuel type (oil gas, biomass, hydrogen, wood mass, different biomass material, propane, gasoline, diesel, etc.)

7.

Technology involved

- What proposed KW of technology will be bought, and how much kWh is estimated to result. What quantity will be put in use, at what price, what is for own usage what for electricity network.

-Technology in power industry has many producers, what is name, type, price, technological parts, possible agreements, about certain technology used or planned to be implemented anew.

In the case of combined or separate power, cooling, and heating system we need to know the following:

-What is system efficiency in combined cycle and how much, what is base case scenario, what is heating load, what is fuel consumption at annual base, what are end efficiency measures need to be taken and by what percentage saving we expect system to work, what is per month or day power load for each system power load, heating load, cooling load

What is the base and proposed case monthly or annual electricity rate.

What equipment is used for cooling (compressor, absorption, desiccant, free cooling, heat pump).

What is the coefficient of performance, and end cooling delivered.

What technology is needed to power system in combine resources and what is power capacity, base load, initial cost, operating costs, kWh expected to produce, manufacture and model of each product is expected to be recognized on market so to be able to send spare parts or make afterwards repair if needed in granted time.

Clear aim and definition between installed capacity and generated energy

So, in short, each system has its own capacity and end-of-expected energy delivered.

8.

-We need to know the following costs to calculate feasibility study

-Initial costs of putting technology to work

-Operating costs

-Annual saving costs if introduce new measures.

9.

Emissions

-Before calculating feasibility, we compare old and new types of technology and calculate CO_2 emission of both cases. We need to know how much we have contributed to the environment with our proposed project.

For that we have calculated GHG credit rate in euro per ton of CO_2 Emissions.

10.

Important Financial parameters are as follows:

- (Inflation rate, project life, debt ratio, debt interest rate, debt term, total initial costs, possible incentives and grants obtained, annual costs and payments, annual savings in form of GHG reduction revenue,

Results obtained need to show- NTP Net Present value, IRR internal rate of return, IRR on EQUIPTY, IRR on assets, simple payback, and equity payback.

11.

-We need to calculate risks of project

If we increase/decrease costs what is the project like? Profit /Revenue rise fall for how much? What is IRR in each case of variable change? If we raise or decrease certain parameters what results at the end?

12.

Reporting

-When report we need to show main points, be brief and concise, so decision makers can be aware of the main points, and possible strategy outcome of purpose projects but not overburdened with unnecessary data.

4. PROJECTS EXAMPLE

The following chapter examines examples suggestions of projects that will fit into surroundings. Firstly, we shall compare countries and their populations. See that Australia leads in terms of capacity and production per man in country. Indija and Madagascar lags in that respect. Country is fighting but also lagging g behind develop world – this is more scented if certain number of tourists come, and energy become scarce resource below standard minimum.

These are all marks that new technology and projects need to be considered and implemented.

Table 12: Population over Capacity Generation

Country	Population	Capacity MW	Generation GWh	Capacity/ Population	Generation /Population
Australia	27.500.000	106.464	271.531	4	9.874
Madagascar	31.960.000	866	2.051	0,027	64
Indija	1.430.000.000	500.400	420.295	0,350	294
South Africa	62.027.000	62.333	226.897	1	3.658
Mauritius	1.300.000	910	3.119	0,7	2.399

Table 13: Increased number of people, number of tourists

Tourist Number	Capacity/ Population	Generation/ Population
1.300.003	0,35	1.200

4.1 Solar

Since solar technology has decreased its price and rise in the world overall and country has geographical advantage of usage 1st proposed project is solar photovoltaic. It means that we look at projects and think about data facts.

1. Weather

   On image below we can see great potential to implement solar technology

2. Price

The price per 1 kw is 800 USD and we are thinking about covering all roofs

3. Phase quantity

With long run-in mind, we can install 300 MW capacity over

Next 20 to 30 years. We can install 50 MW each 7-15 years so 50x7= 350 MW

Following data

Capacity 300 MW

Price 800 USD /KW

Total cost = 240.000 000 USD

Cost of 50MW x800x1000=40.000.000 USD

With efficiency of 1,6

Price 0,07 kwhx60GWhx12month=4.800.000 USD /month

60 GWh=60.000.000 kWh

Return up to 6 years.

Advantage	Disadvantage
Lower and lower cost of technology and installation	Need a lot of space on roofs
Use maximum solar energy	Have lower efficiency
Can be used for social and energy needs	Must be divided into price for social public and market base occupation
Can be used for electric cars pump further develop region	Bad days lowers production and income rising years of return
Efficiency rise return	Need to be replaced after 30 years
Contribute tourism	Constant measurement planning
Contribute environment	
Can be recycled long term strategy plan introduced	

4.2. Ethanol plant production storage

The second project is ethanol plant and storage.

Advantages and disadvantages follow:

Advantage	Disadvantage
Usage of existing biomass	Costs and organization
Different types of usage gas and ethanol	Having space with large storage and factories secure from spills, breaks
Efficiency large	Have ships for production or part of island, pipe to island, ship can be expensive
Usage for cooling, cars, energy, storage for years	Contribute to emissions but in smaller amount than oil
Need long term strategy	Contribute to transport meaning safe Planning and safe future

What we need to consider is

1. Location

   Put on small, deserted island, artificial island or on ship

2. Transport with pipes to main island

3. Buying property cheapest price connect with tourist arrival

Price goes from 5.000- 50.000.000 USD

Make the best deal cheapest price connected with expected quantities.

4.Make market for output

Cars, trains, ships, airplanes sell goods to neighboring countries in regions.

4.3. RECYCLING

Recycling of all garbage and material that can be recycled making use of

1. Paper – collect make new paper
2. Plastic-collect smash-make new bottles
3. Bio waste – make gas and fill it in bottles -long term storage place
4. Garbage overall - smash -put in tanks and make bio plant source of electricity
5. Sewage sludge gas- make gas for bottles out of sewage sludge

Advantages and Disadvantages are as follows

Advantages	Disadvantages
Recycling is the future and only solution	Need strategy and discipline
Making profit while reducing illness and spreading disease	Need initial costs
Making long term gas storage	Demand persistent education and work
Making new plastic	Does not solve all energy problems but clears the land
Be attractive to tourist	Demand initiatives and innovation

CONCLUSION:

The world has changed in respect of recognizing a new possibility and having the right technology to achieve goals. Overall standard increased with GDP growth simultaneously increasing demand for energy. This further induced a new relationship between energy, consumption and the environment.

Reducing harmful emissions and decreasing costs of large weather problems is the aim of today. This means new strategies and investment in renewable types of energy.

The most countries still linger in old system contributing to its own problems. If problems are not locally solved the world initiatives will reach the end point.

Although neighboring area and countries were observed Mauritius was central point. Country has constant energy capacity and production observing the last decade. The majority comes from oil.

This system paper sees as inherited and slow in change and needs to be slowly replaced with new technology, increasing renewables. Paper goes into three possibilities: increased number of solar, ethanol production and storage, usage of garbage to make recycled products and biogas for storage and further use.

In that way the long-term process of economic stability, energy independence with the possibility of export will also contribute to environmental standards demanded by UN and by common sense. Security of not having flooding is priority for all.

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