## Cyprus – an energy island with challenges

The evidence of 'energy dependency' becomes more acute when events, such as what is currently happening in the Ukraine, bring to light both the sensitivity of international trade, as well as the dependency of it, especially toward neighbouring economies such as the EU.

Regarding energy security, of the EU27, we join Luxemburg as *the most dependent on foreign energy imports* (of the EU27, only Norway actually produces more energy than it needs (about 6.2 times more!)). High dependency means high risk, and high costs when prices rise.

Until recently, the EU imported about 40% of its natural gas needs from Russia, while 27% of its oil, and 46% of its coal imports were also from Russia; a value of about €1 Billion per day.

However, one of the responses of such events has resulted in the move to reduce the EU dependency on these 'fossil fuels' from Russia. Germany, for example, aims to half its imports from Russia by the end of the year, and has plans to generate almost all the country's electricity from renewable sources (wind, solar and offshore wind) by 2035 (15 years ahead of schedule).

How does our island fare in the scheme of things?

A great way to review a country's energy needs and uses (balanced in's and out's) is through a Sankey diagram. This diagram depicts the energy flows whereby the width of the arrows represents the flow rate (i.e. the thicker the line, the more there is).

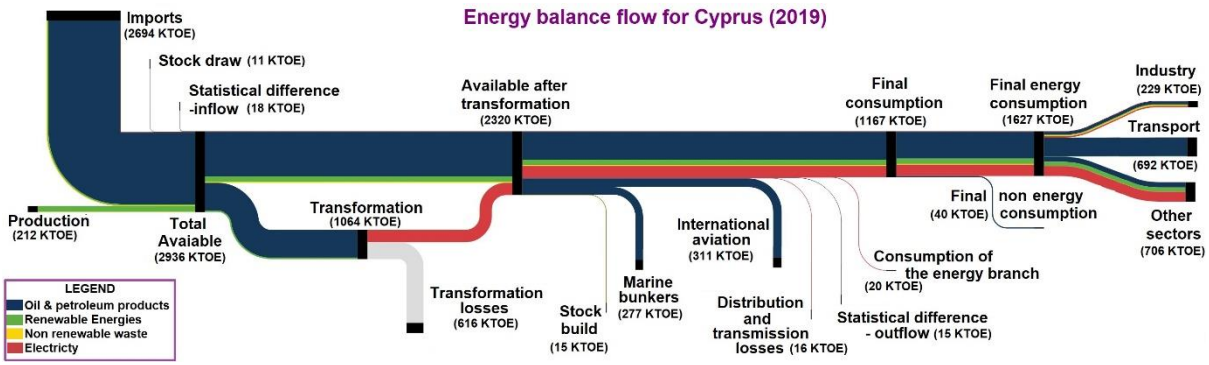


Figure 1 – Energy balance for Cyprus (2019). This data comes from the EuroStat website and represents Cyprus' energy flow in 2019, which should most accurately represent a 'normal' (non COVID-19) year. Sidenote: this type of diagram is named after Irish Captain Matthew Henry Phineas Riall Sankey who, in 1898, showed the energy efficiency of a steam engine using this method.

The Sankey energy diagram indicates that we produce about 8% of our energy needs via renewables (wind, solar, biogas), with the remainder coming from oil and gas (and minimal waste imports).

The end users of all this 'in' energy, are shown where the lines end; either to the right or down. Here we see that a large amount of energy (represented by the 'thickest' lines) is used *in energy production and its associated losses*, *marine bunkers*, *international aviation*, and *transport*.; these are the 'low hanging fruit' for change - sectors where, if we change something, it would have the largest impact to the energy flow.

In principle, we would like to minimise the needs at the 'ends' so that we don't need as much energy to start with.

Of the four identified primary users, mari*ne bunkers* and *international aviation* are dependent primarily on external needs (therefore not much we can do about), and are still at a very early stage of 'decarbonisation' (using a fuel that doesn't contain 'carbon'). What we therefore can tackle is *energy production and its associated losses*, and *transport*.

**Energy production and associated losses**

Our current methodology of producing most of our electricity is very inefficient with huge energy losses (over 50%) as we currently use Mazut (heavy oil) in a conventional generation (a process that is around 38% energy efficient), and some diesel oil with Combined Cycle Units (around 48% energy efficient).

In addition, both technologies are dependent on fuels that are imported, which are susceptible to availability, and market prices (crude oil is currently double of what it was 12 months ago). This is not only costly and risky (due to external influence), but also incurs GHG (greenhouse gases) emission penalties; this year it is estimated Cyprus will pay an estimated €183 mln for GHG emission rights (a rise of 150% over 2021).

According to the Cyprus National Energy and Climate Plan (NECP) report delivered to the EU in 2020, energy production emits about 5 times more GHG than the industrial sector, while Cyprus ranks the 5th highest in GHG emissions per capita in Europe (Eurostat), at 11.6 tonnes per capita.

**Transport**

In *transport*, almost all energy used is used by road transport (as opposed to aviation/marine). GHG emissions from the transport sector contribute around 1/5 (21%) of Cyprus' total emissions.

Most households have their own car while the public transport, though greatly improved, is lacking in efficiency. Cyprus's population has the highest car ownership per capita in Europe, with 40% diesel engines (around 35%-40% efficient), while mostly petrol engines (20%-25% efficient) make up the rest. Add to this that 44% of all vehicles are older than ten years, which means those cars have smaller efficiencies (i.e. they waste more fossil fuels (and pollute more) than newer cars).

To conclude, we can observe that the technologies we are using in both our energy production and the use of the energy, are both very wasteful of energy.

## Additional Current challenges

Current challenges regarding energy are that our electricity grid is outdated.

The TSO (the transmission lines typically seen overhead crossing the countryside) can handle the fluctuations that renewable energy sources (RES) introduce such as wind gusts, sun and clouds.

On the other hand the DSO (distribution grid to homes/industry, etc) can only cope with small variations (up to max 25%-30%), and is urgently in need of an upgrade.  and will only be able to handle the current planned 'renewable energy' projects (around 250MW).

The challenge of the outdated DSO network means that no more significant RES can added to the grid unless Cyprus can;

a) connect via an interconnector to a bigger electricity network, such as Greece/EU (via Crete) or Egypt/Israel). The interconnector between Crete and Cyprus should be moving ahead, thought expected only in 2028 or so.
b) a much quicker solution, is large scale energy storage.

c) Introduce a more flexible energy technology that can quickly adjust to the energy fluctuations of RES and needs (consumers).

The last option would have been the Cyprus LNG terminal and power station which seems to be on hold for various reasons including incompetency of the consortium, rising costs (materials/shipping), and the recent hike in natural gas prices potentially invalidating the cost/benefit equation, plus the construction is only around 5% complete. It seems very unlikely this will go ahead, without serious additional investment.

The good news is that the electricity market is expected to open up this year (October) which will allow for trading of electricity with other electricity producers able to join the market. This system is stated to be top-notch, which is exactly what we need to aid the transition toward a cleaner and greater energy efficient portfolio.

To summarise, the current state of affairs regarding energy security for Cyprus is that we are in a high-risk dependent situation, but also in a perfect position to revaluate our priorities as to energy security, and plan ahead. The EU has prioritised energy independence over the current and coming decades, and therefore we have the opportunity to do the same.

The next article will review possible solutions.

# Cyprus – possible solutions to an energy island

Cyprus, as well as the EU, are currently actively changing how energy is being produced/supplied within the union; primarily with the use of Renewable Energy Sources (RES), and interconnectors, but also in using new fuels such as hydrogen, so as to reduce the impact of climate change caused by 'fossil fuels'. The pace in changing to these technologies has significantly increased due to the reliance of 'fossil fuels' from Russia.

My previous article covered the challenges we have in Cyprus, which covered the energy flow of the island, and how our current technologies of energy production are inefficient and come with huge greenhouse gas (GHG) emission penalties, while our transport sector has the highest per capita of car ownership, all of which use fossil fuels.

Our distribution grid also needs to be upgraded in order to accommodate for RES while our natural gas terminal and power station initiative seems very unlikely to be developed.

While the timing is perfect to develop new energy pathways for the island, it would also be important to review technologies from a holistic and lifecycle perspective.

However, before reviewing energy production three are two ways we can save; by reducing the needs of electricity, and by reducing GHG emissions that also incur costly penalties in the form of emission rights.

**Reducing electricity needs**

Most of the electricity that is produced by the power stations goes towards *households* and *services* (activities, such as construction, tourism, etc., not to be mistaken for the service industry).

Regarding *households*, In comparison to many EU countries, we have been late to adapt energy conservation practices in our construction practices resulting in households requiring more energy to maintain a comfortable environment, however, on the plus side, a 2014 report (by CUT) stated that as much as 91,6% of the energy demand for hot water was provided through solar thermal collectors, which is a significant saving.

Energy efficiency is key, and a lot can be done on existing structures such as wasteful systems (such as old boilers (it's a great idea to decalcify them periodically), and electrical underfloor heating), by using energy efficient technologies, plus significantly reducing the property energy needs by increasing insulation and minimising thermal bridges. New structures could also use Passive House Design principles in the design (e.g. PH Design (passivehouse.cy) is a local company using these principles and the results speak for themselves).

Regarding the *services*, this would need to be considered on a case-by-case basis depending on the industry, however the same PH design principles apply for the properties.

**Greenhouse Gases (GHG) emissions**

The current narrative of 'climate change' is that it is being primarily caused by greenhouse gas (GHG) emissions, which is resulting in a projected 1.5ºC – 4ºC (or more) increase of average planetary temperature (currently at around 1.1 ºC), the impact of which is catastrophic climatic events including heatwaves, superstorms, droughts, floods, dust storms, change in seasonal climate, etc. The Paris Agreement sets out a global framework to limit global warming to well below 2°C and pursuing efforts to limit it to 1.5°C.

The EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions (meaning whatever GHG emissions we emit, these are somehow absorbed). This

objective is at the heart of the European Green Deal and in line with the Paris Agreement. As am interim plan, the EU has developed the 'Fit for 55' plan which aims to reduce GHG emissions by 55% by 2030.

Electricity generation and transport are the biggest emitters of GHG's in Cyprus (we account for about 0.02% of global emissions), of which we are already paying penalties as emission credits. Our approach to reducing these was through the construction of a natural gas based power station, however, in light of the complications within the project and global rise in prices, this now seems very unlikely.

There is another GHG emission that seems to be the elephant in the room; a massive GHG emission footprint from the current construction of 4 major highways, costing the public around €1.2 billion, with an untold environmental footprint, emissions from mining, material importation/transportation, and waste generated, all to serve the use of the personal vehicle.

The needs for better roads to these destination would have been better served by adding in certain sections, overtaking lanes, slow lanes, off ramps, and turning lanes; a cost possibly of about 1/10$^{th}$ of the current projected costs at a minimal GHG emission footprint.

**Are Renewable Energy Sources the answer?**

Renewable Energy Sources are the hot item being pushed globally as the moment, and pertain primarily to solar, wind generation (on shore and offshore) and hydrogen.

The EU taxonomy on what is considered 'green investments' (a green investment rulebook) currently include Natural Gas and Nuclear.

**Are electric vehicles the answer?**

Electric cars hold the promise of 'emission free vehicles' which is great for populated areas. However, aside from the new infrastructure costs of home and public charging, the important question is where did the electricity come from? In Cyprus, currently it is mostly from fossil fuel generation, meaning we have just moved our emissions down the road.

Until power generation comes form emission free (or near zero), we only have a slight environmental benefit by using electric vehicles.


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Secondly, the bill for these highways would have been better spent on an efficient public transport solution, such as a train (Larnaca to Nicosia) and tram (Nicosia – 3 routes), all of which have shown to be profitable investment.

Lastly, electric cars

One Russian company releases more sulphur dioxide into the air than the whole of the U.S. Nornickel Became the Arctic's Biggest Polluter. The Nornickel mining and metallurgical company supplies metals to 37 countries, where they are used in the production of electric cars, electricity stations and solar panels. Sulphur dioxide makes up 98% of all the company's emissions. Emissions amount to around 2 million tons per year — that is, more than half of all sulphur dioxide emissions in Russia (3.6 million tons in 2018, according to a state report by the Ministry of Natural Resources), or twice the total amount of emissions from the United States, (according to 2018 data from Greenpeace).The factories in Norilsk are the world's largest stationary source of man-made sulphur dioxide, according to Greenpeace data.

Norilsk Nickel is a key supplier of nickel and palladium, two metals that are key for electric-vehicle batteries and semiconductors

These represent only the systemic pollution we know about, but there are also accidents and violations which are not reflected in the statistics. A good example of this is an unscheduled check carried out by Russian environmental watchdog Rosprirodnadzor after the spill of 21,000 tons of diesel fuel from a tank owned by the Norilsk-Taimyr Energy Company (NTEK) in May 2020, which was the largest man-made disaster in the Arctic to date.

According to forecasts by McKinsey & Co., demand for high-quality Class 1 nickel — precisely the type produced by Nornickel – is set to grow. By 2030 it will rise from the current 2.2 million tons to 3.5–4 million tons, primarily due to the growth of electric car production. The question is, what will be the cost of this growth to the environment?

Emissions don’t only apply to the vehicle. If you are charging the car with electricity produced by burning fossil fuels, then al that has happened is that the emissions have moved to Limassol – cleaner cities maybe, but with a questionable environmental impact.

PLANT TREES TO OFFSET

With only about 1 per cent of the global hydrogen production being green, the challenge for production at this scale will be land availability to deploy renewables and abundant solar/wind renewable resources.

The cheapest way to transport green hydrogen from the East Med to Europe is by subsea pipeline. Why transfer hydrogen, when you can transfer electrons, with minimal losses, and risks?

The Egyptian Government is expected to announce a $40 billion hydrogen strategy this year, which will include a production capacity of 1,400 Mega Watts by 2030. With at least five known active green hydrogen projects under development, it is already on the way.

With its expanding renewable energy capacity – targeting 42 per cent by 2035 – Egypt considers this to be an opportunity to become a leader in the region for the production, use and export of hydrogen.

EU and Japan plan to agree this year a Memorandum of Cooperation on Hydrogen

The UK's Oil and Gas Authority is now called the North Sea Transition Authority

Regarding ‘decarbonisation’, currently in most nations around the world, there is a concentrated push in all sectors to ‘decarbonise’; meaning they need to find alternate ways of reducing their emissions of greenhouse gases (GHG’s), and of producing energy without using a fuel that contains carbon (e.g. fossil fuels). This is being done proactively, including at government level, to find ways of capturing these emissions, and by both funding alternate fuel research (such as green hydrogen), while also introducing additional penalties (e.g. these are already being discussed in both the aviation sector and the maritime sectors) so as to switch toward a cleaner fuel.

It is important to note that GHG emissions are ‘a’ factor in ‘climate change’ however, some scientists believe that these emissions are most likely not the biggest factor toward changing climate patterns. The biggest contributor to ‘climate change’ is believed to simply be how we live on this blue planet; the building of ‘hydrophobic’ urban sprawls, clearing of large areas of forest, increasing of desertification, loss of biodiversity, chemical release into nature (industry, modern agriculture, etc.), pollution, interruption and contamination or riverways, waste, and so much more. These have all had a detrimental effect on *ecosystem function* and the *destruction of the water cycle*; both key in the function of the biosphere (that thin layer between the upper atmosphere and the rock below).

The key challenge regarding energy itself is in a more delicate situation as it is an energy island; there are no interconnectors of electricity to other land Aside from energy, basic needs such as water security (dependency on desalination), food security (heavy dependence on imports), and the lack of energy security (92% dependent foreign petrochemical imports) make Cyprus very sensitive to external shocks, like what we see in the Ukraine, or the extraordinary cold weather that has taken its toll in the agricultural sector.

From Cystat (Republic of Cyprus Statistical Service) the latest figures (2018) of energy consumed from our total electricity demand is:

| Total Consumption (000’ kWh) | Unbilled Consumption (occupied territories) | Billed Consumption | Domestic | Commercial | Industrial | Agriculture | Public Lighting |
|---|---|---|---|---|---|---|---|
| 4.572.478 | 3.814 | 4.568.664 | 1.622.544 | 1.816.143 | 883.962 | 154.878 | 91.137 |

Here we find that commerce and domestic users account for around 75% of the electricity demanded island wide; a good indicator of where to start reducing energy needs.

Oil & gas are known as fossil fuels. Coal was formed from trees in the high-oxygen Carboniferous, before bacteria found a way to break down lignin. Yet much of the earth's hydrocarbon is 'abiotic' & produced naturally in the mantle rather than from fossils. They are renewable.

Nuclear

all nuclear reactors that have begun construction outside China after 2019 have a Russian supplier including Akkuyu Nuclear Power Plant (south coast of Turkey, 50nm directly north of Cyprus – (2023)), and El Dabaa Nuclear Power Plant (Egypt’s Med coastline about 300nm SW of Cyprus (2026)).

The majority of nuclear power plants are located in the northern hemisphere, with concentrations in Europe, US (central to east coast), eastern Russia, southern China and South Korea / Taiwan / Japan.. all industrialised countries significant in the world stage.

Therefore, if we, as an island nation, are looking toward building a healthy, clean, and cooler (pun intended!), future, then we ought to be looking at a holistic 'ecosystem' viewpoint of the island, and to understand our biome in the context of the greater biosphere.

A brief holistic overview of Cyprus tells us more of the challenges, and potentially how we can go about solving them. For us to be resilient, the basic needs of the island should go beyond sufficient, towards abundant, so that in the event of an external shock (e.g. hail, extended cold spell, heat wave) there would be a buffer.

EUROSTAT LINK:
https://ec.europa.eu/eurostat/cache/sankey/energy/sankey.html?geos=CY&year=2019&unit=KTOE&fuels=TOTAL&highlight=_&nodeDisagg=0101000000000&flowDisagg=true&translateX=-62.22039999999993&translateY=-202.7750000000001&scale=1.4400000000000002&language=EN#0