# An Engineer's View



## The Transition to Renewable Energy

*Posted By **Frank Kienhöfer**, Thursday, 18 November 2021*

**The Transition to Renewable Energy**

The global debate on the existence of global warming and the urgency to reduce CO2 emissions has shifted to the best method of transitioning to this new decarbonized world. The European Union has set a target of reducing CO2 emissions to 100% below 1990 levels by 2050. Cynics may question the feasibility of this ambitious target and the timidity of setting targets rather than laws, while optimists may argue, “Aim for the stars – you may reach the moon.”

The UK, notwithstanding Brexit, has arguably taken the lead by passing the net zero target for 2050 into law; while on the other end of the spectrum Poland appears reticent to support CO2 emissions targets. Across the Atlantic, we see a similar mixed approach with California taking the lead in decarbonization and the oil states being less supportive.

Tackling global warming requires worldwide and immediate joint effort in which regional vested interests will need to be negotiated. Europe and the United States have made massive progress in reducing CO2 emissions such that South Africa cannot continue with business-as-usual. Our current technology imported from Europe and America, will become unavailable. As an example, Volvo, DAF, Daimler, Ford, Iveco, MAN, and Scania have all pledged to end diesel truck sales by 2040. These truck brands deliver over 90% of the long-haul road freight in South Africa and are the backbone of our supply chain network.

**New energy source**

Overseas investment in projects which emit CO2 emissions has ceased, and Europe, our biggest export market, appears likely to implement a carbon import tax on products associated with CO2 emissions. The following article will discuss our required transition to a low carbon economy. South Africa needs to focus on poverty alleviation and job creation within the context of positioning itself in this new low carbon world economy.

At the heart of this transition is replacing the burning of fossil fuels with a new energy source. Progress in the 20th century was made possible by burning coal, oil, and gas to power mechanized machines for farming, mining, construction and mobilize goods and people. In 2020, 5 out of the 10 largest companies in the world by revenue were oil and gas industries, which demonstrates that energy is a key economic driver to our global economy.

Through a combination of using a cleaner energy mix of wind turbines, solar power plants, and gas-fired rather than coal-fired power stations, and greater efficiencies in using this energy in industry, businesses, and homes, both the UK and Germany have led the way in reducing emissions by around 50% compared with their 1990 levels: with continued improvements still possible. Further positive developments have been the emergence of electric passenger vehicles as a viable alternative to internal combustion engine vehicles. Battery electric vehicles made up 54% of all new cars sold in Norway in 2020, and a modest 6% but growing in China. Challenges however remain. The cost of energy storage is currently limiting a full penetration of intermittent renewable energy sources to provide high quality uninterrupted power.

**Hydrogen**

Hydrogen fuel (or using hydrogen as an energy carrier) has been proposed as a solution to store surplus renewable energy by electrolyzing water to be used again when the sun stops shining, or the wind stops blowing. Hydrogen has an energy density 2.6 times that of diesel which is extremely positive, but the economic feasibility of a hydrogen powered industry including hydrogen production and distribution needs to be questioned and compared with state-of-the-art alternatives.

The argument that the future glut of cheap renewable energy will power a green hydrogen economy does not hold water. Currently 98% of hydrogen is produced from natural gas using the steam-methane reforming (SMR) process. This cheaper hydrogen production process, as compared to electrolysis, commonly releases CO2 into the atmosphere. The production of electricity directly from methane is cheaper than the production of electricity from hydrogen produced with SMR.

The production, distribution, and utilization of hydrogen requires water purification, compression or liquification, distribution and conversion back to electricity through a fuel cell. In each of these processes, energy is lost to the point that only 35% of the original energy is useful. This is 3 times less compared with the energy stored in a battery. Using a realistic energy grid, which is not 100% decarbonized, each unit of electricity derived from a hydrogen fuel cell is responsible for 3 times the CO2 emissions derived from a Li-ion battery.

**No meaningful penetration**

The freight haulage business is extremely price sensitive, which is why hydrogen fuel cell technology has made no meaningful penetration into the commercial vehicle market for which it is hyped as the solution to the weight of a battery. The flagship hydrogen fuel cell vehicle is the Toyota Mirai, which is a passenger vehicle. Toyota has contributed immensely to the world economy in furthering lean engineering and waste

reduction, but the waste of energy in driving a Toyota Mirai compared with a battery electric vehicle is at loggerheads with Toyota guru, Taiichi Ohno's waste reduction principles.

The VW group, comprising MAN and Scania, which accounts for 1/3 of commercial vehicles sales in South Africa, has ceased further investment in hydrogen technologies in spite it being currently the only heavy-duty vehicle manufacturer with hydrogen vehicles in operations with customers. Scania's Head of Sales and Marketing, Alexander Vlaskamp, "To do what's best for both our customers total operating economy and our planet, we are not closing the door on any possibilities. It is clear that Scania's focus in the here-and-now perspective as well as short- term is a combination of renewable fuels and battery electric vehicles. We see that for basically all segments."

Nuclear energy is also no silver bullet. A nuclear power plant takes 10 years to build, which is how long we have taken to build coal power stations Medupi and Kusile. Realistically South Africa cannot afford the capital investment for a nuclear power plant. Furthermore, it is a challenge to vary the power output of nuclear power stations to track the energy demand variations and dips of energy output from solar and wind. South Africa should continue with plans to extend the life of the 2 GW Koeberg but not plan for new nuclear plants which we cannot afford.

**Energy needs**

South Africa's current electricity mix of 4% from solar and wind provides ample room for expansion with the most potential for overseas and local investment to decarbonize our electricity supply. Other good news is that South Africa has expanded the Lesotho highlands hydropower stations from Phase I to Phase II (currently at ~72 MW with an added ~110 MW almost complete) and pump storage schemes (currently at ~1000 MW with ~1000 MW almost complete). South Africa's hydropower is only a fraction of our energy needs but orders of magnitude greater than the world's largest hydrogen electrolysis plant planned for Leuna, Germany to start production of green hydrogen in 2022 (24 MW).

We also have extensive local expertise and knowledge in the successful implementation of the 2 GW, 1 400 km, transmission line from the Cahora Bassa hydroelectric plant. Eskom should focus on maintaining an efficient electrical energy distribution system, which is an important piece of the decarbonization puzzle. It is likely that the best solution to the renewable energy transition in South Africa will be a combination of low cost solar, wind and hydroelectric schemes with local battery storage and efficient electricity transmission and schemes to balance power demand and supply like using privately owned electric vehicles to power the grid during periods of peak demand.

Before expensive decarbonization infrastructure is planned, the use of energy in the most efficient manner possible in industry, businesses, and homes needs to be pursued. These efficiency interventions alone will not get us to zero carbon emissions, but they importantly do reduce emissions, they pay for themselves, and they make the final infrastructure spend on low carbon energy production and storage less demanding. Plant managers should ensure controllers are at the correct set-points with continuous improvement plans in place to reduce energy costs.

**More than golf carts**

Although South Africa's office heating demands are modest in comparison to the Northern hemisphere, heating systems should use electricity and heat pumps. Innovative legislation to unlock high-capacity transport i.e., the Performance-Based Standards initiative which has demonstrated a reduction in CO2 emissions by 19%, should be supported by government. Government needs to further campaign and advocate for the slice of the electric vehicle manufacturing market. The automotive manufacturing sector in South Africa accounts for 6% of our current economy. We currently stand to lose an important export revenue stream if we continue to manufacture internal combustion vehicles.

Removal of the 25% import tax on electric car imports (which were intended for golfcarts), would send the correct message to the likes of VW, Tesla and BYD to consider manufacturing electric vehicle plants in South Africa. Upgrades and electrification of our train system (sadly dogged in recent years by tender corruption scandals) is needed to make rail transport more attractive. Using predicted GDP growth and freight models, South Africa's transport demand will require several additional lanes to the Durban-Gauteng and other major freight corridors in the next 20–25 years. Rail needs to play its appropriate role in the national freight transport system by reducing pressure on road infrastructure along long-distance, large volume corridors. This would further our national decarbonization efforts.

**Way forward**

South Africa will need to contribute to a decarbonized world economy and towards this end focus on using energy more efficiently. Energy efficiency is our only hope to dig ourselves out of the hole of being bankrupt but still make deep, meaningful cuts in CO2 emissions; the efficiency improvement interventions paying for themselves. In this respect, using hydrogen as an energy carrier and the hydrogen economy is a nonstarter.

The Koeberg nuclear plant should be maintained but any new nuclear build is unaffordable. Eskom and the government need to focus on a fair and conducive regulatory framework to allow solar and wind plants to be financed and built and focus on maintaining an efficient distribution system to transmit electricity. We advise the SA government and industry to be guided by the most recent developments. The current and most affordable power systems are based on solar, wind, battery energy storage and hydro where possible.

This article was submitted by Frank Kienhofer and has been collaboratively written by the Centre for Sustainable Road Freight - South Africa (SRF-SA), a collaboration which currently includes Stellenbosch University, University of the Witwatersrand (Wits), the CSIR, the University of the Western Cape (UWC), Tshwane University of Technology (TUT) and local industry partner Michelin South Africa. The SRF-SA has partnered with the SRF-UK (which includes Cambridge and Heriot-Watt Universities) and universities in China (Tong-ji, Jilin, and Zhejiang Universities) and India (IIT Madras and IIM Ahmedabad).

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**Michael Rossouw says...** ...
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I enjoyed the post and the concerns regarding Hydrogen is noted.

Can we pre-select technologies on the verge of a monumental shift in the energy paradigm? All the new technologies have their challenges, but they do make progress on the back of demand. I do agree hydrogen from SMR does not match the objective. I also agree on the shift to electrified train lines, but can battery-energised trucks alone satisfy the last mile demand? Can die batteries be supplied in the quantities needed? What is the nett carbon impact of this level of battery manufacture? I do not see the solution yet, beyond that it will not be business as usual.

I remember when I grew up milk delivery was with an electric truck. In this case the solution was not a better truck, but the termination of milk delivery. The future will demand novel solutions, which may ultimately not be better trucks.

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