An Ode to the IC Engine

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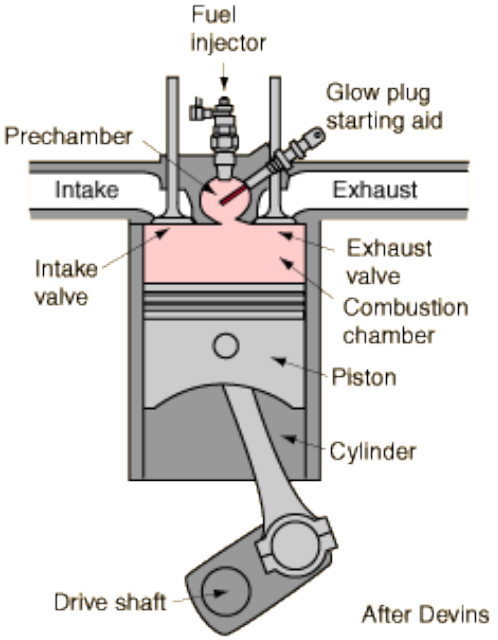
The IC (Internal Combustion) Engines, particularly Diesel engines used to be the workhorse alternative in many parts of the world with limited or no access to electricity. Along with the more silent Petrol Engine, it is the workhorse for many applications - mainly automobile, railways, ships, engine driven equipment and standby or standalone electricity generation systems. IC Engine has ruled the roost for nearly 100 plus years in powering many of our transportation and other needs. It was literally the 'Growth Engine' for the industry since the early decades of the last millennium. Automobile and auto component industries have spanned a huge swath of manufacturing industries and created millions and millions of jobs for a long time. For many decades the health and size of auto industry used to determine the overall development of a nation. Packing a good energy & power density, the IC engine was the invariable choice of engineers to power any equipment mechanically. Emergence of electric motor along with the Alternating Current distribution system, replaced the IC engine in most stationary equipment for delivery mechanical energy output. But the engines were still the first choice for mobile equipment including the cars, trucks, tractors, railways, etc.



One main advantage of diesel engine driven equipment is their mobility and ease of operation. India, which has the largest number of people without access to electricity and Africa where 2 out of 3 people do not have such access, are prime markets for such engine driven equipment. The diesel engine is used as prime mover in electricity generation systems, for a variety of applications, some of which are listed below:

- Electricity generation for industries, commercial complexes, cluster of apartments, hospitals, airports, data centers, etc., where interruption of electricity is not tolerated.
- Telecom Towers for backup power
- Cold storage and commercial refrigeration
- Air Compressors
- Automotive traction in trucks, cars, tractors, LCV's, etc.
- Water pumping in rural areas.

In some applications the engine is used as a prime mover to power the mechanical equipment directly. In many applications the Diesel Generator set is used as a backup for the grid power. Electricity is generated from the DG set and the output electric power is used to drive the conventional electric equipment and appliances.

Changing Scenario:

Since the beginning of the current millennium there are mainly three disruptive technologies that have threatened the very existence of the ubiquitous IC Engine, viz., Renewable Energy, Battery Storage Technology and LVDC (Low Voltage Direct Current) equipment. Together they pose an existential threat to the engine itself.

Distributed and renewable energy generation is the future scenario in the energy sector. It is already becoming common place to find small homes and big solar & wind farms generating electricity for their own needs and feeding the excess to the power grid. Solar energy prices have tumbled in recent years to touch a low figure of Rs.2.41 per kWh, which is cheaper than conventional thermal and nuclear power. It is far cheaper than the cost of power from DG set, which is about Rs.18 per kWh. From an individual home to big industries, they are becoming producer as well as consumer of electricity. In fact, a new term 'PROSUMER' has been coined to describe them.

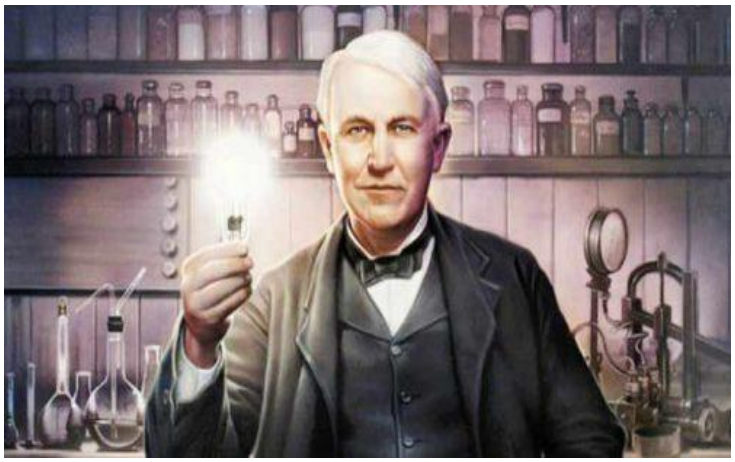
One major drawback in the solar & wind system is their basic unreliability. Sudden stoppage of wind or a cloud passing could complete disrupt the power flow. But this is now getting offset by storage of electricity in batteries. Although many new chemistries are under exploration, the Lithium battery is now totally stabilised and large plants are springing up in many industrialised countries. It is sad that India is proving to be an exception to this. The prices of this proven technology product is falling rapidly - prices have fallen from about 1000 $ per kWh in 2010 to about 230 $ per kWh in 2016. In fact, Elon Musk, the founder of TESLA, the EV Car maker has put up a huge plant in Nevada and has gone on record that they will sell the Li batteries at $ 150 per kWh.

The availability of cheap solar power and equally cheap storage options would completely change the scenario as to how individual customers, small or big, produce and store electric energy and use it at their convenience. Large scale 'Grid Defection' seems to be the order of the immediate future and even the utility companies would struggle to find a viable way to sustain their electricity generation, transmission and distribution business. With the emergence of Nano technology Li chemistry, the product life of a Li battery could touch 6000 cycles of deep charging & discharging. With the solar panels being guaranteed for 25 years and batteries with 16 - 17 years of life, it will be total freedom for the consumer. The energy companies have to strategies for their sheer survival. In fact, many of them are investing in local mini grids and massive storage facilities. Energy scenario as we have known for the last 120 years, is set to change drastically.

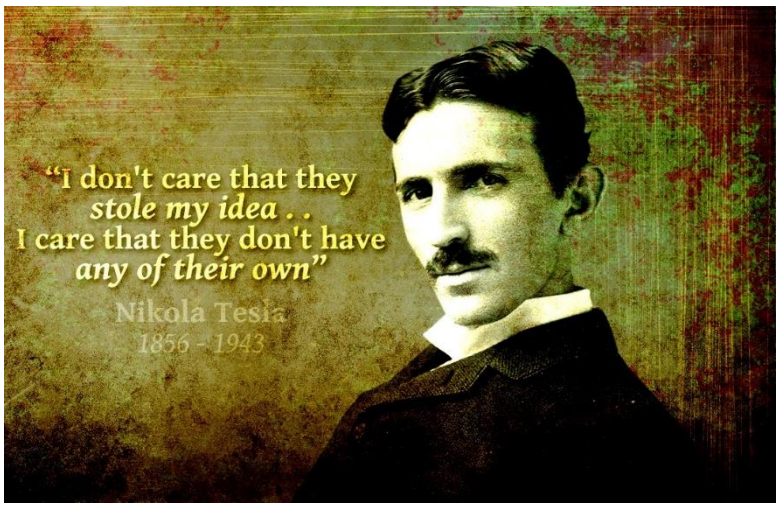
When even the main utility companies are now facing such disruptive market forces and are in deep introspection about their survival and future business prospects & strategies, it is easy to imagine the plight of diesel engines as a prime mover for standby source of power. Coupled

with the exorbitant cost of operation, the stringent norms that are forthcoming in relation to pollution, will make the business harder for diesel engines. The carbon footprint of the telecom infrastructure alone is staggering. As a pointer of things to come, Government of India has issued very strict norms for CO2 emission for the mobile telecom towers. The deployment of DG sets for standby power has virtually come to a stop in this segment. The stringent climate control norms that India has agreed to in the Paris Accord would further extend the search for alternatives to diesel engine in many other areas as well.

DC Micro Grid Systems:



The classic battle DC Vs AC, which raged for nearly 30 ~ 40 years and in which two famous inventors, Thomas Alva Edison & Nichola Tesla, were bitterly engaged, is now revived. AC, backed by Tesla & Westinghouse comprehensively won the battle against DC promoted by Edison around 1910. But DC is making a comeback now with the emergence of new technologies in brushless electric DC motors, power semiconductors and smart controllers. (By a strange coincidence Westinghouse Electric, the original AC system pioneer, has filed for bankruptcy in US recently)!



The relevance of such DC system in the context of this note is that Diesel engine played (and still play) a very important role for energy access in remote and inaccessible areas of the world. This is more so in the lives of vast masses of people in India and Africa with little or no access to electricity. Solar power is inherently DC and super-efficient DC appliances are emerging. Due to the extremely efficient way of managing demand, the DC micro grid is very compact and small and with the new batteries, the system becomes optimised in terms of cost & performance and can easily replace the DG set . In fact, the LVDC Forum of IEC (International Electro Technical Commission) is specially promoting this concept. International agencies like UNDP, UNEP, WHO, World Bank and many leading foundations and donors are backing this concept in enabling electricity access to the deprived millions. This is also the most effective way of giving electricity access to the millions of poor people while simultaneously tackling emission of greenhouse gases. Also the operational and life cycle costs of such DC systems are very much lower than the engine powered systems.

Conclusion:

In light of the above observations, it can be safely concluded that engines for driving many equipment and providing backup or standby power will find their growth either flat or declining in the near future. While the electricity grid itself is getting increasingly challenged, the market for such expensive backup power would be facing even more reduction in the market. Coupled with the high operating cost, noise, vibration and pollution, deployment of such engine driven equipment would rapidly come down. The emerging technologies in Renewable Energy (like solar panels), Battery Storage Products and DC Micro Grid systems would further accentuate and exasperate the problem and drive the market for oil engines down with utmost certainty. The rapid stride that are taking place in Electric Vehicle market would totally disrupt the conventional automobile and auto component industry. Thus it is imperative for the existing industry to look out for alternate venues and/or join the green energy bandwagon. Many experts and consulting companies opine that by 2030 the existing auto and auto component industry would look totally different from today's scenario! At least 50% of vehicles will be EV. India will have to critically look at this fast changing scenario and plan for the same. Jobs will be created but with a different set of skills. Auto component makers for Starter Motors, Alternators, Fuel Injection, Lead Acid Batteries and many conventional components would not find a place in the automobile but several new components will be needed. Wheel mounted motors driving the vehicle without any transmission system will be the order of the day. The automobile will have far more electrical and electronic components & sub-assemblies. A 10 - 15 years' time frame will be there to make the transition.

It will be sad to bid good bye to IC Engines, which had transformed the way of transportation and which has created so many jobs in the last 100 years or so. But the growth will be declining, slowly to start with and rapidly thereafter when the aforementioned three disruptive technologies hit the market in a big way. Industry, Government and HR Personnel should seriously plan for this oncoming disruptive change. Else, this country would literally miss the 'Electric Bus'.

Similar future holds good for Electricity Generation, Transmission & Distribution. 'ENERNET' a network of micro, mini, regional and national grid would emerge, facilitating intra and inter community energy trading (online and real-time). More people will opt for 'Grid Defection' and become truly energy independent. These disruptive technologies would also mean better environment and climate control and the emphasis on energy efficiency would also drastically bring down the energy intensity of the economy. Newer technologies like Fuel Cell, IOT, AI would further add to the reach and creativity of tomorrow's engineers.