

Reducing accidents and generating electricity on traffic crossings by using a new advance hydraulic based Continuously Variable Transmission system

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Abstract

Traffic junction accounts for half of the road deaths in India. The annual accident report also highlights the need for better designing of such junction. To overcome this problem, we have developed an efficient way of reducing accidents on traffic junctions and using the same mechanism to generate electricity.

This idea uses well programmed smart barriers synchronised with traffic lights, which functions with change in colour of traffic lights and prevents the vehicles to cross the roads, when signal is red. Since vehicles stop for about 30 seconds at road crossing, so we are making the vehicles to stop on a platform(synced with traffic lights) of height about 1m. Due to gravitational force between vehicles and earth, the platform will come down at the ground level then vehicles can pass the road crossing, when signal turns green. When, the platform will come down, it generates electricity with the help of a mechanism which uses rack and pinion gear, our newly designed CVT (Continuously Varying Transmission), a system of hydraulics, and dynamo. And when there will be no vehicle on the platform, the platform will go up with the help of the springs.

And again, when the signal turns red, the platform will again come up and the vehicles will go up on the platform and the same process will again continue.

As a result, a single traffic crossing can generate electricity 120 KWh/day. This system can also be installed at toll booths and petrol pumps. The output obtained>> Input supplied.

Introduction and objectives

The main hypothesis of this project was to reduce accidents on road crossing by using a new well programmed and advanced barrier synced with traffic lights. With our project we are hoping to decrease the number of accidents on road crossings by 90% and minimizing the loss of resources in road crossing accidents.

Another hypothesis is that, we have developed a new designed CVT (Continuously Variable Transmission) which is more efficient than the present technology of CVT. And, a hydraulic system which works without electricity to change the gear ratio of CVT.

Another hypothesis was how we can efficiently use the resting time of vehicles near traffic crossings to generate sufficient amount of electricity.

So, we thought of a device which is practical, useful alternative energy technology for generating clean electricity from the millions of vehicles on our roadways. This idea will be able to replace conventional electrical supplies for powering roadway signs, street and building lights, storage systems for backup and emergency power, and other electronic appliances, and even devices used in homes and businesses.

If this idea is implemented on the toll booth of national highways, it will generate about 100 megawatt per hour of electricity per day. And, if the same idea is implemented on all the petrol pumps of India, it will generate about 1060 megawatt hour per day.

The main reason why we chose this idea for making a project is that India has one of the highest shares of road accidents in the world. Statistics shows that 85% of all the road accident fatalities all over the world occur in developing countries and Asian-Pacific countries contribute about 50% of whole fatalities occurring all over the world. Each year, nearly 1.3 million people die as a result of road traffic collisions. According to World Bank estimates, road accidents cost India about 3% of its GDP. India witnessed 17 deaths and 55 road accidents every hour in 2016, one of the highest in the world, according to the latest report released by the Union Road transport and Highways ministry. This reflects an alarming situation of accidents on Indian roads which results in many more deaths. The latest data show at least 75,200 people loss their life in crashes at traffic collisions.

With our project, we are hoping to decrease the number of accidents on road crossings by 90% and minimizing the loss of resources in accidents and to increase the efficiency of current technology of CVT, and to produce large amount of electricity at different places like toll booths, petrol pumps, bus stops, parking lots, railway crossings.

FATALITIES AT CROSSINGS			
Junctions	Crashes	Killed	Injured
Traffic signal	27,173	5,010	24,300
Police-controlled	14,849	3,285	8,968
Stop sign	11,496	2,670	8,822
Flashing signal/blinker	12,484	4,171	13,943
Uncontrolled	2,13,324	58,381	2,06,667

Source: Road Accident Report 2014 (MoRTH)

Innovation

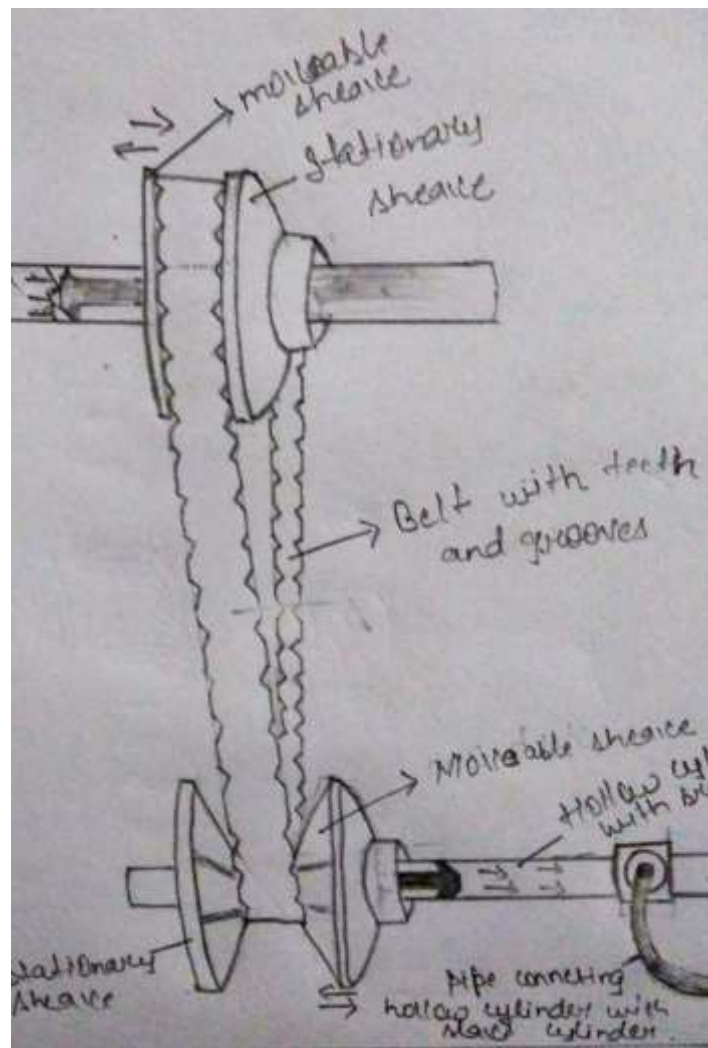
The main innovation of this project is that it converts the gravitational potential energy of the vehicles into electricity with the help of a new and advanced arrangement of rack and pinion gear, newly designed CVT and to change the gear ratio of the CVT as per the mass present on the platform, we have designed a new and advanced system of hydraulics which operates without any electricity.

The idea of using gravitational potential energy of vehicles standing on the platform to produce electricity is completely new.

And, we have also improved the existing technology of CVT by increasing the traction of belt on CVT disc by using gear teeth and groove structure, on both belt and CVT disc. The new designed CVT mechanism will increase the angle pressure between CVT disc and belt, thus making it more stable which will increase its efficiency. To change the gear ratio of CVT, currently a system of planetary gears, clutch and hydraulics with the help of electricity is used. But, we have developed an idea where gear ratio will be changed automatically with the help of new designed system of hydraulics which works proportional to the pressure of platform on hydraulic system due to the mass of the vehicles on the platform. The more the mass on the platform, the more the pressure will be exerted on the hydraulic system, then, the more the change in the gear ratio will take place. With the help of this mechanism, the torque of CVT will automatically be adjusted according to the mass of vehicles on platform.

Till now, no one has used this type of technology to prevent accidents as well as generate electricity on road crossing which is synced with traffic lights.

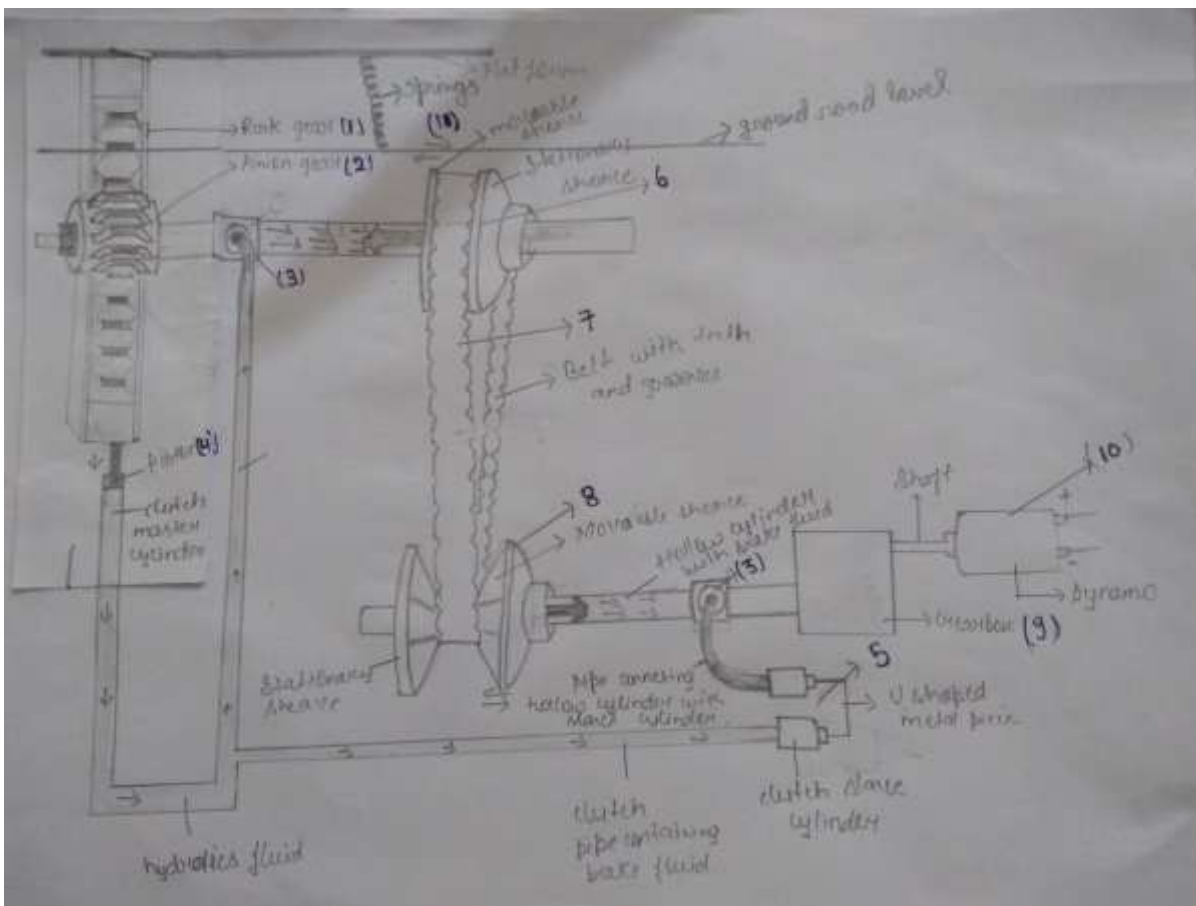
Also, no one has used any technology that will generate electricity on petrol pumps, toll booth and parking lot in large amount. The output supplied is much more than the Input supplied.



New designed and advanced system of CVT



Rack and Pinion gear



Total working system of a single platform

Algorithm (mechanisms of the project)

There is a platform which is at a height of 1 metre from the ground, and there are 2 barriers, one on the front side (a) and another on the back side (b) of the platform. The traffic lights, barriers and platform are synced with each other.

Mechanism of the whole project

Our whole project works in these following steps:-

1. When the traffic signal is green, the vehicles are crossing the road freely.
2. When the signal is about to turn red, the vehicles will slow down and the barrier "b" starts raising up. This will not allow the vehicles to further cross the barrier "b"
3. When the barrier "b" is fully raised and the signal has turned red, then platform and barrier "a" raises up (prevents the vehicle to cross the platform when the signal is red) with the help of spring as there is no vehicle on the platform and barrier "b" goes down, so that the vehicles can come on the platform.
4. Now, the vehicles will stand on the platform for about 20 seconds and due to gravity, it will try to come down due to gravity and the spring will squeeze, and will move the gears, CVT, hydraulics, dynamo to generate electricity.
5. When the signal turns green barrier "a" goes down so that the vehicles can cross the road and barrier "b" raises up, so that no more vehicles can come on the platform, when signal is green.

Thus, only sufficient amount of vehicles will cross the road crossing which will control the traffic. In this one, the whole process will repeat again and again.

How the barriers are synced with traffic lights?

As we know that, the traffic lights change its colour in every 30 seconds, so we are connecting the barriers with the connection of traffic lights. The barrier "a" is connected with red light, so that when the signal turns red, the barrier "a" raises, as the circuit gets completed. So, no vehicles can cross the road when the signal is red and the platform gets raised up, as there is no vehicle. And, when the vehicles start coming on the platform, the platform starts going down. When the red signal turns off, the barrier "a" goes down as the circuit gets broken and the platform comes at the ground level and when the signal turns green, the barrier "b" raises, so that no more vehicles can come on the platform, and when all the vehicles which was on the platform passes, then the signal again turns red, then the barrier "b" comes down and barrier "a" raises. And, the same process is repeated again and again.

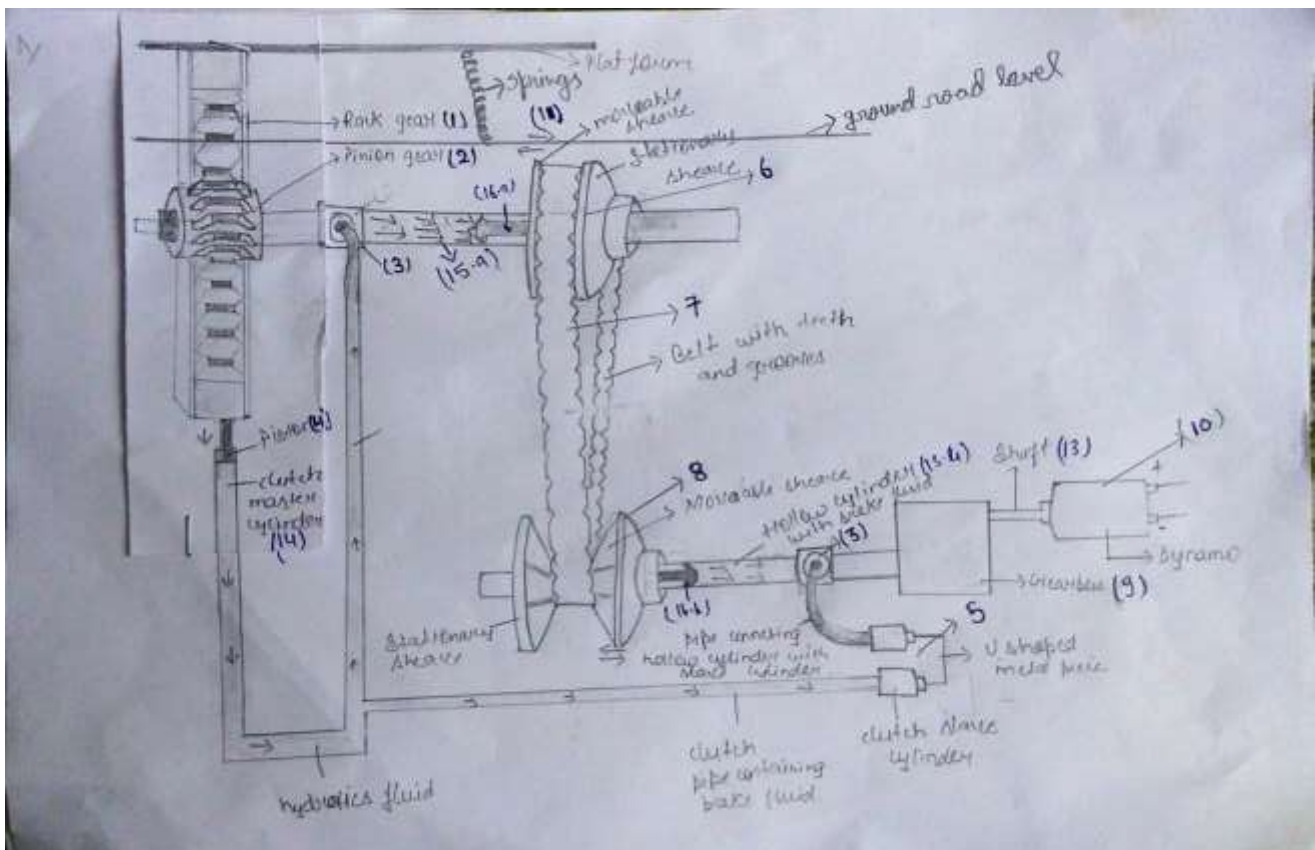
Mechanism of production of electricity

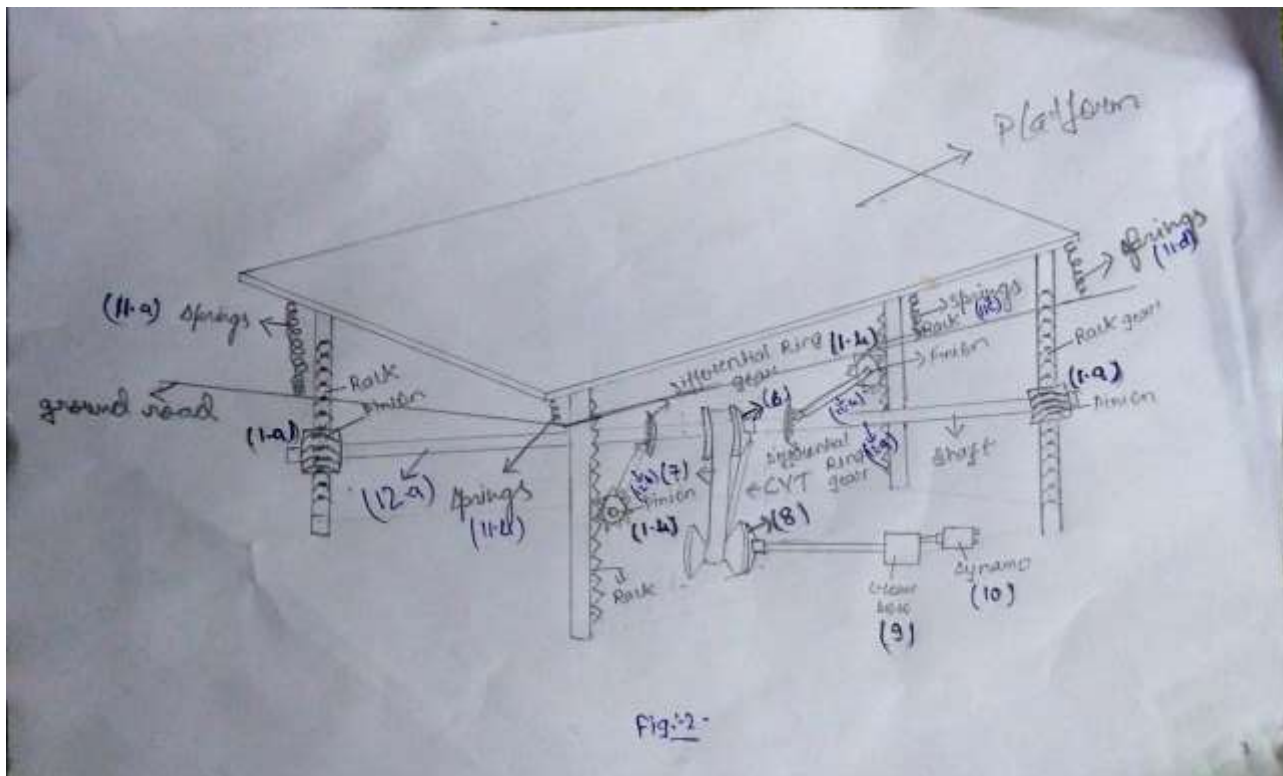
1. When the vehicles are on the platform, they will possess gravitational potential energy. This energy will force the platform to go down.
2. At first, the platform is connected with 4 rack gears (1.a, 1.b, 1.c, 1.d). These rack gears are further connected to pinion gears (2), which will convert linear motion into rotatory motion.
3. 2 of the pinion gears (12.a) are directly connected with shaft while other 2 are connected to the shaft with the help of differential ring gears (12.b).
4. As platform comes down, so it will produce linear motion in rack gears which gets converted into rotatory motion by pinion gears and this rotates the shaft (12.a, 12.b).
5. Now, gear with larger diameter of CVT (6) is connected with shaft. So, rotation of shaft also rotates the larger diameter gear of CVT. This large gear (6) is connected with small gears (8) of CVT by a belt (7) to reduce the torque and increase the speed of the rotation.
6. This small gear is connected to gear box (9) via a shaft (13). Here, the gear box (9) is used to further increase the RPM and lower the torque, so that electricity could be generated efficiently.
7. Finally, gear box is connected to produce electricity.

Mechanism of changing of gear ratios with the help of hydraulics

1. All the 4 rack gears are connected to hydraulic cylinder (14) with help of piston. Then, hydraulic cylinder is connected to hollow shafts 15.a, 15.b) of large gear (6) and small gear (8) with help of pipes filled with hydraulic fluid.
2. Pipes are connected to hollow shafts with a special part (3). This special part is connected with hollow shafts by ball bearing and has a hole to connect hydraulic pipe. This part is used because we want a fix connection of pipe with hollow shaft but shaft is rotating.
3. In hollow shafts, a piston is present which is connected with moving sheave of CVT. So, when piston is moved, the moving sheave of CVT will also move, thus adjusting the gear ratio.
4. The larger diameter gear (6) is moved by push mechanism of piston while small diameter gear is moved by pull mechanism. The direction of movement is shown in diagram in fig. 1.
5. When any vehicles come, it will force the piston (4) to move downward in hydraulic cylinder. Then, this force will be transferred to pistons (16.a, 16.b) which will move the moving sheaves of larger gear will be compressed while sheave of small gear will be pulled apart. The compression and pulling of gears will be proportional to the mass in platform, thus it would have infinite gear ratios for different masses. Higher the mass on platform, larger the movement of sheaves of CVT, thus higher the torque and similarly if mass will be less then torque would be less then torque would also be less. This automatic infinite gear ratio mechanism makes the system compatible for different masses.

Full mechanism





Platform mechanism

Method to come up with this idea

We have studied about various ways to reduce accident on roads but no one had used the technology to reduce accident as well as produce electricity by the same technology on the road crossings.

There is presence of traffic lights on the road crossings, and then also, people cross the road crossings in red signals. So to stop this we have designed our project.

We have also studied about different devices that are producing electricity on road but no one has used the standing position of vehicles near traffic crossings and petrol pump, stations, toll booths to generate electricity.

So, we thought of an idea to reduce accidents on traffic crossings and produce electricity by the same idea. We have made a hypothesis about our idea, then, tested this idea practically and we get the desired result. We have also studied about the various design of automatic transmission and then we finally come to a result that CVT is one of the best automated transmissions. So, we worked on CVT and then, improved its design according to our needs and tested it which also gives the desired result and then we worked on changing the gear ratio of CVT. For this, now, hydraulics are used which is powered by electricity. So, to remove the use of electricity to control hydraulics, we have designed a new system of hydraulics, which works without electricity and uses the pressure of platform on hydraulics Piston. The pressure is caused when vehicles stop on the platform. The arrangement of all this system gives us the desired result. The main thing is that it will reduce the accidents for about 90%.

Results and Conclusions

By successfully testing this idea practically, we have arrived at a result that the system will reduce accidents near road crossings by 90% and if this system is installed at a particular (single) road crossing, then, it will produce about 120 KWh/day.

Average mass of car = 1200 kg

Height of platform = 1 metre

Potential energy of car any height "h" = mgh

So, total P.E. = $1200 * 1 * 9.8 = 11760 \text{ joule} = 3.266 \text{ Watt-hour}$

So, energy produced by a single average mass of car is 3.26 watt-hour.

As per our observation of road crossing of Ranchi (a city in India), about 10-15 vehicles passes one side per 30 seconds.

So about 20-30 vehicles will pass from both sides per 30 seconds. According to this 60 vehicles will pass per minute.

So, per hour $60 \times 60 = 3600$ vehicles will pass a road crossing per hour.

If, we calculate only for 10 hours of high traffic. Then total number of vehicles passing road crossing will be $3600 \times 10 = 36000$ vehicles.

As we have calculated earlier that a single vehicles produce about 3.26 Watt-hour.

So 36000 vehicles will produce about

$$36000 \times 3.26 \text{ Watt-hour} = 117.36 \text{ KWh/day on a single traffic crossing.}$$

If this system is installed in Ranchi, where total number of crossings is about 40, then all the crossings together will produce $117.36 \times 40 = 4694.4 \text{ KWh/day}$, which is large amount of electricity.

There are about 223 NH toll booths in India.

As per the report of times of India, on an average 50,000 vehicles pass through any single toll booths per day.

So, 50,000 vehicles will generate about $50,000 \times 3.26 \text{ watt-hour} = 163 \text{ KWh/day}$ by a single toll booth.

If we calculate this data for all toll booth of NH, then it will produce about $163 \times 228 = 35,860 \text{ KWh/day}$

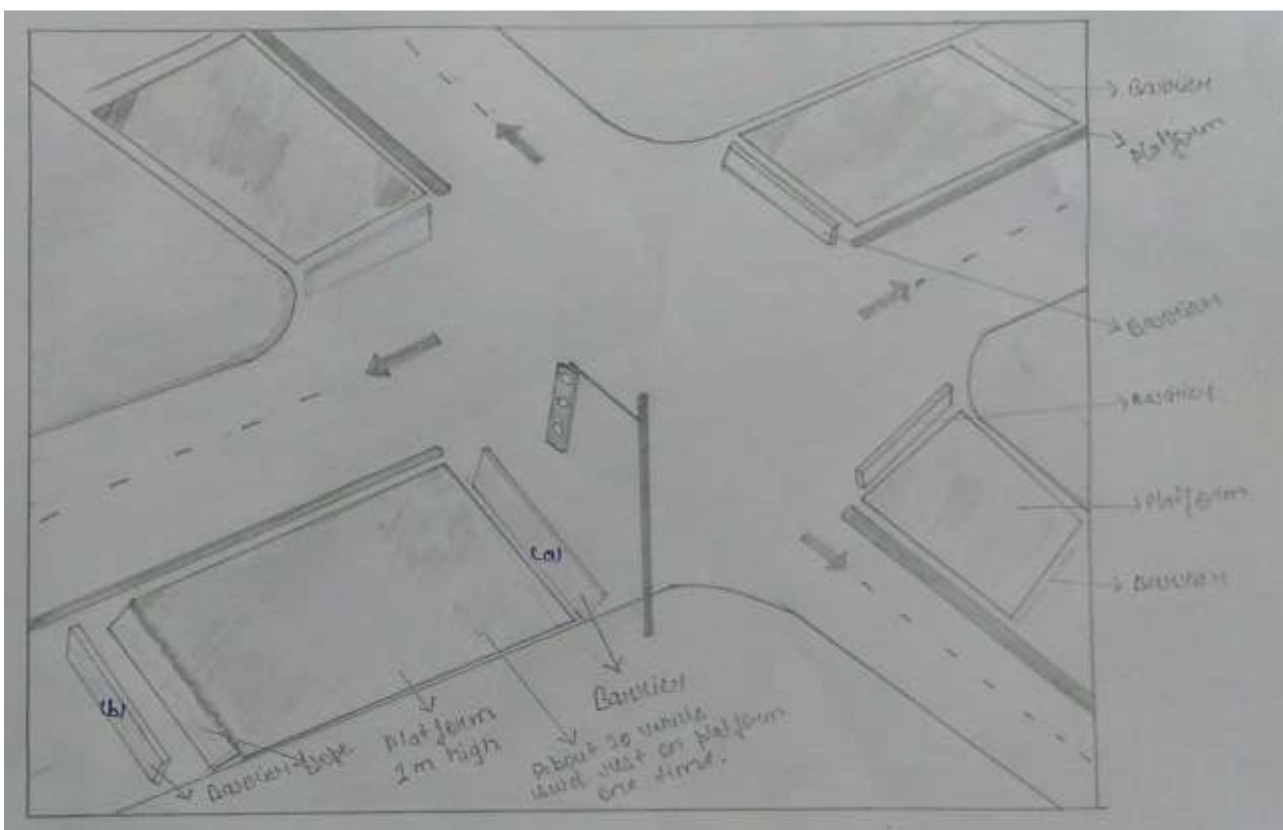
$$= 35.86 \text{ megawatts hour/day}$$

If we calculate this data for a single petrol pump, then the electricity produced will be about $3900 \times 3.26 = 12.7 \text{ KWh/day}$.

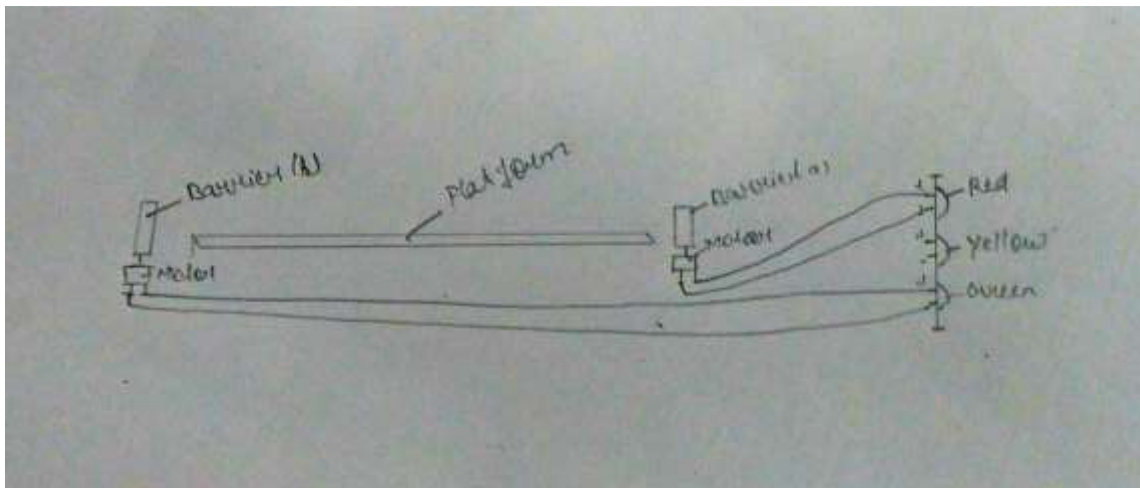
According to data of times of India, there are more than 60,000 petrol pumps in India. And, if this system is installed on all petrol pumps, then, it will produce about $60,000 \times 12.7 = 762 \text{ Megawatts-hour/day}$

And, if we think about economy of this project, then it is very economical, as the installation cost will not be more than 5,000 per system. And the energy which is wasted in making the vehicle climb the platform is very less than the energy produced.

The output is very much more than the input.



Installed system on the traffic crossings



Synchronization of traffic lights with barrier