Vehicle dynamics EXPO 2009
'open Technology Forum'

New mechanism design for generating traction force on the rear wheel for move ability in heavy traffic.

Presented by:

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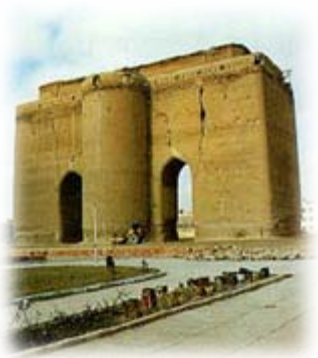
CHARKHESHGAR



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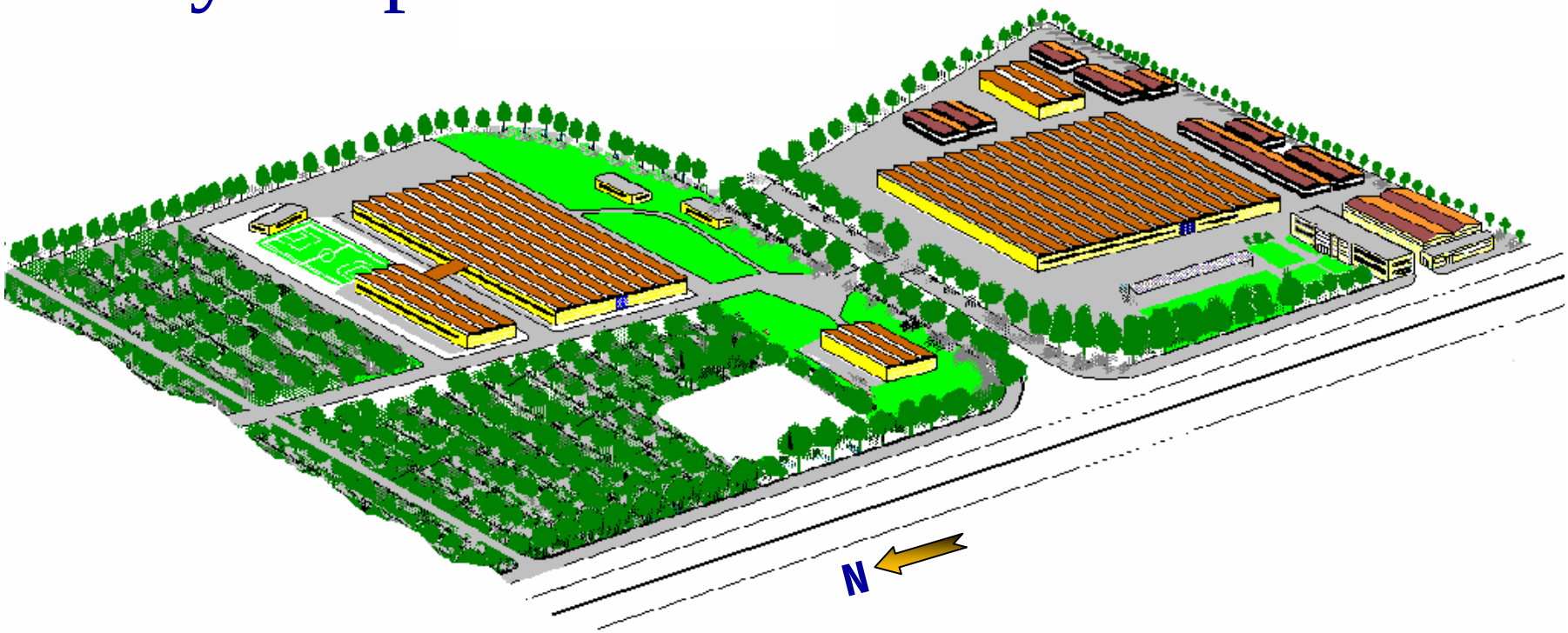
Factory Map



Land	332000 m^2
Covered	58700 m^2

Company Profile

- 1969 : Foundation of the company
- 1975 : Starting assembly of Leyland diesel engines
- 1982 : Assembly of land rover petrol engines
- 1987 : Contract with ZF company for production of gearboxes
- 1991 : Production of gearboxes for commercial vehicles
- 1994 : Production of steering box for Tractor
- 1995 : Production of gearbox for light vehicles
- 2000 : Production of steering box for cars
- 2002 : Agreement with Rane Company (TRW) for steering box of cars
- 2003 : ZF Company as a share holder of Charkheshgar

Products

Products under license of ZF (C.V.)

- **Obsolete Products**
  - **S5-35/2**
  - **16S-130**
  - **16S-160**
  - **16S-190/1**
- **Current Products**
  - **S5-24/3**
  - **S6-90**
  - **S5-42**
  - **16S-1650**
  - **Ecomat (4HP-590 , 4HP-592C)**
  - **16S-221**
  - **16S-151**
- **Future Products**
  - **6S-850**
  - **6S-1600**
  - **Astronic**
  - **9S-75 , 9S-109**

Products

Other Products (L.V.)

– **Current products**

- **NISSAN JUNIOR S4-19 Gearbox**
- **NISSAN PATROL S4-19A Gearbox**
- **NISSAN PIKUP Gearbox**
- **NISSAN CARVAN Gearbox**
- **KIA PRIDE Steering box**
- **PAYKAN Gears**
- **LS-6 Steering box**
- **LS-8 Steering box**

– **Future products**

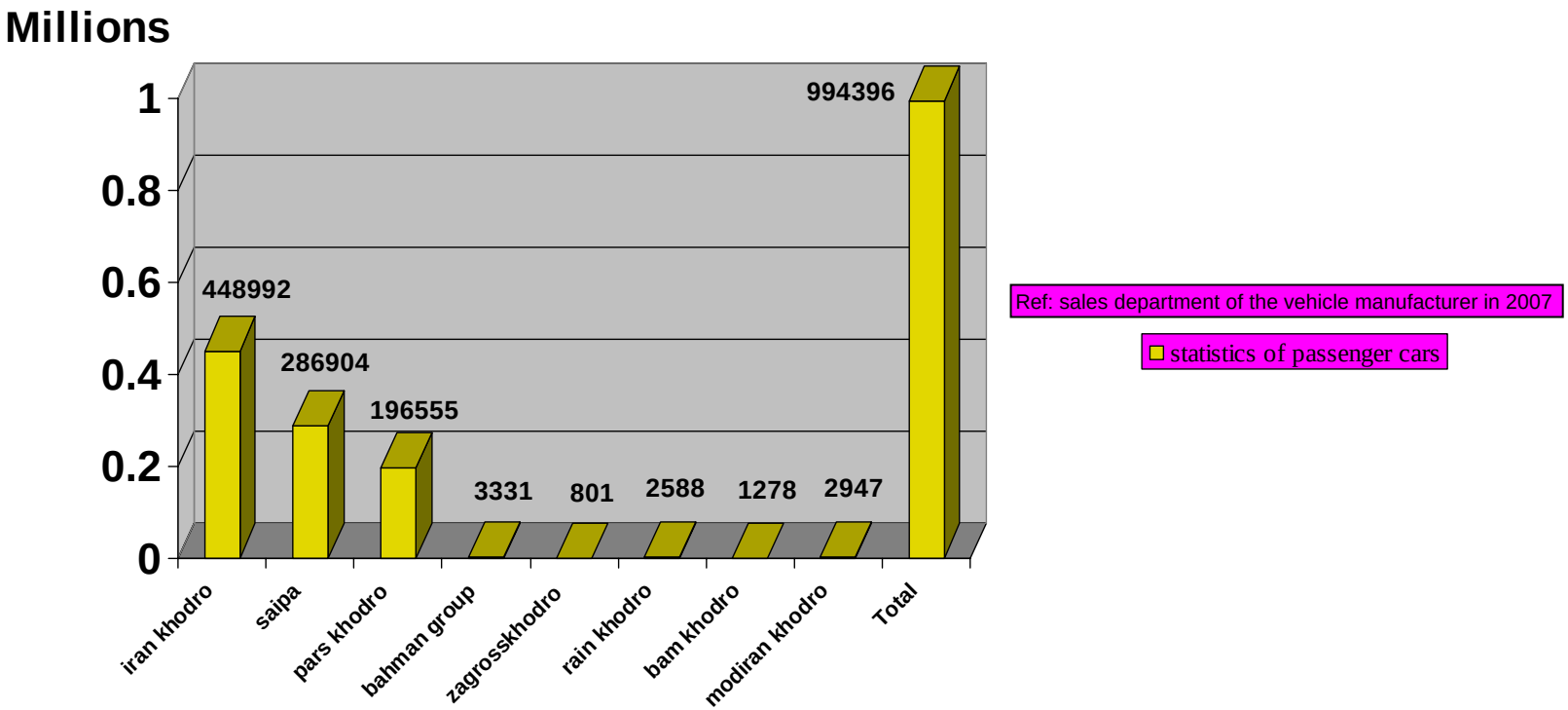
- **LOGAN Gearbox**
- **KIA PRIDE Steering box (Hydraulic)**
- **PEUGEOT Steering box (Hydraulic)**
- **TKPS Steering box (Heavy and Light)**

subject matter in this article

1. Statistics of Passenger cars manufactured in IRAN in 2007
2. Statistics of fuel consumption in IRAN
3. Heavy traffic in cities of IRAN
4. considering the new plan
5. Schematics of the new plan
6. Details of DC coupler
7. Traction force analysis
8. Mode 1: ICE is on
9. Mode 2: ICE is off
10. Fuel consumption Calculation
11. Conclusion

Statistics of Passenger cars manufactured in IRAN in 2007

According to following table in general about 1 million passenger cars have been manufactured in IRAN. This value, increases year by year almost 10 percent. IRAN KHODRO, SAIPA and PARS KHODRO have gone the furthest.



By presenting this plan we will can convert existing vehicles to the half-hybrid vehicles with a little cost for move ability in heavy traffic so fuel consumption and emissions partly will be decreased.

Statistics of fuel consumption in IRAN

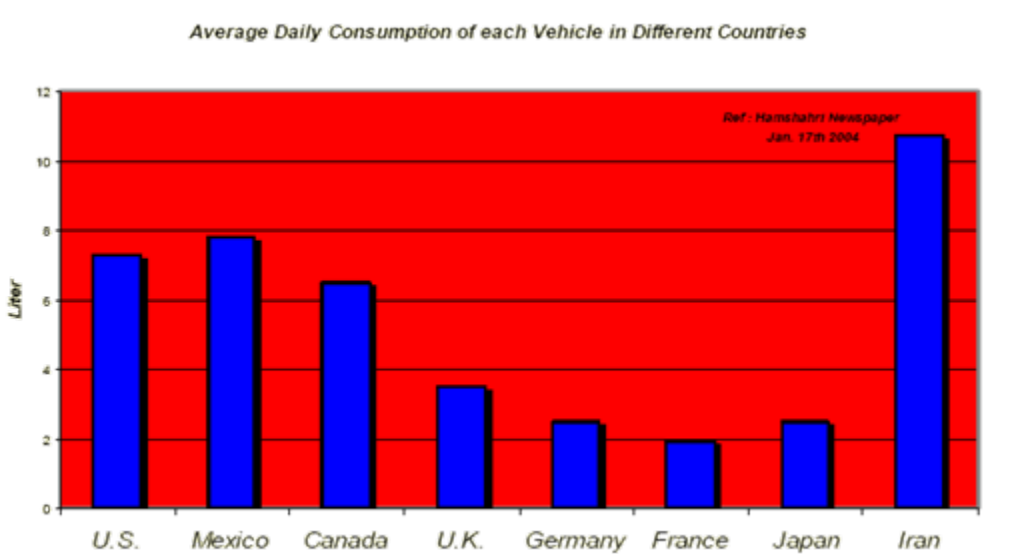
- Statistics of fuel consumption in IRAN is 67 million liters daily. interior product is Almost 44 million liters and almost 23 million liters import. . (Ref: NIORDC, National Iranian OIL Refining & Distribution Company)

- Fuel consumption in IRAN is almost 2 times of the world standards. (Ref: NIORDC, National Iranian OIL Refining & Distribution Company)

- Fuel consumption increases 10.4 percent yearly. (Ref: NIORDC, National Iranian OIL Refining & Distribution Company)

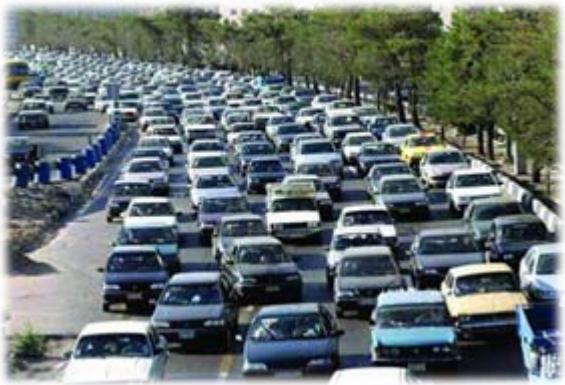
- A Third of the consumption gasoline and gas oil in Middle East is allocated to IRAN. (Ref: FARS News Agency 20 Apr 2009)

- According to Following table average daily fuel consumption of each vehicle in IRAN is higher than other countries.



Heavy traffic in cities of IRAN

- In IRAN some big cities meet with traffic problem.
- Following pictures shows some heavy traffic which sometimes continue for hours.



- Almost, 70 percent emission in Tehran is due to traffic. (Ref: NIORDC, National Iranian OIL Refining & Distribution)

Considering the new plan

- For considering the plan the basic parameters of the vehicle are shown in the table.1:

Table.1 Basic parameters of the vehicle

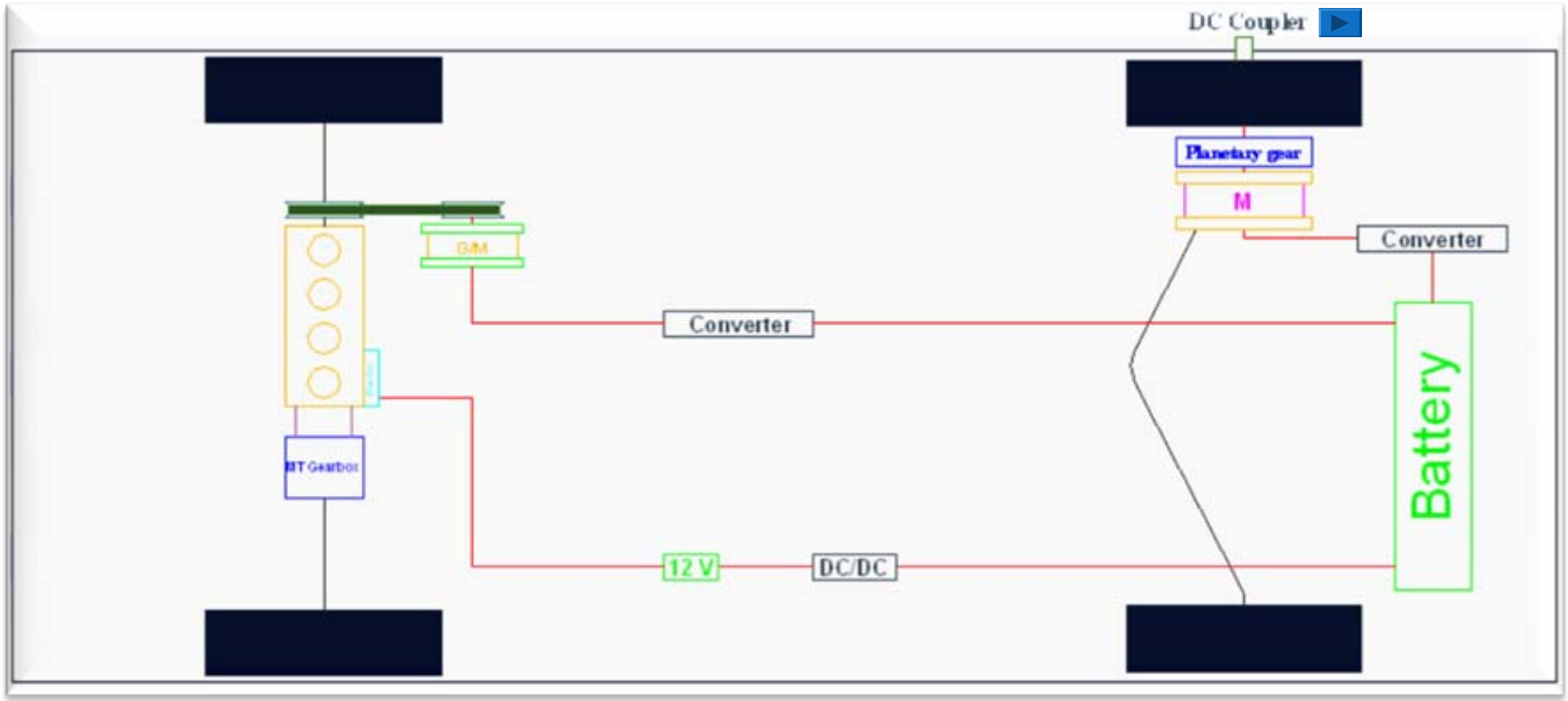
Mass/kg	Coefficient of rolling resistance	Coefficient of aerodynamic drag Cd	Vehicle frontal area /m^2	Wheel radius/m	Transmission efficiency
1300	0.00917	0.3	2.33	0.298	0.98
1 st gear ratio	2 nd gear ratio	3 rd gear ratio	4 th gear ratio	5 th gear ratio	Final gear ratio
3.454	1.944	1.275	0.861	0.692	3.777
Max. power ICE / kW at 5500 rpm		Max. torque ICE / Nm at 3500 rpm		ICE volume/ cc	
52		120		1323	

- Fuel consumption and emission for this vehicle are shown in the table.2:

Table.2 Fuel consumption and emission for this vehicle

Fuel consumption liter per 100 km	Urban : 10.6	
	Extra-urban: 5.9	
ECE R83-01	CO	HC+NOx
gr/km	1.28	0.39

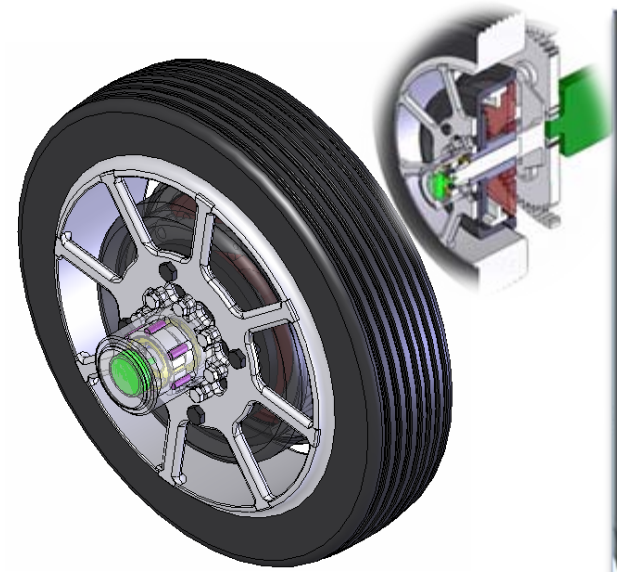
Schematics of the new plan

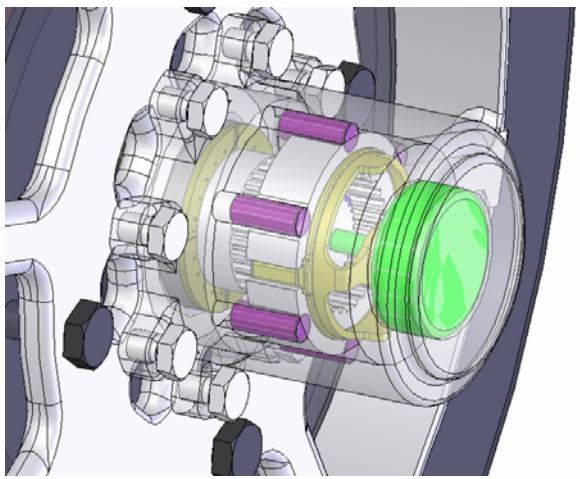


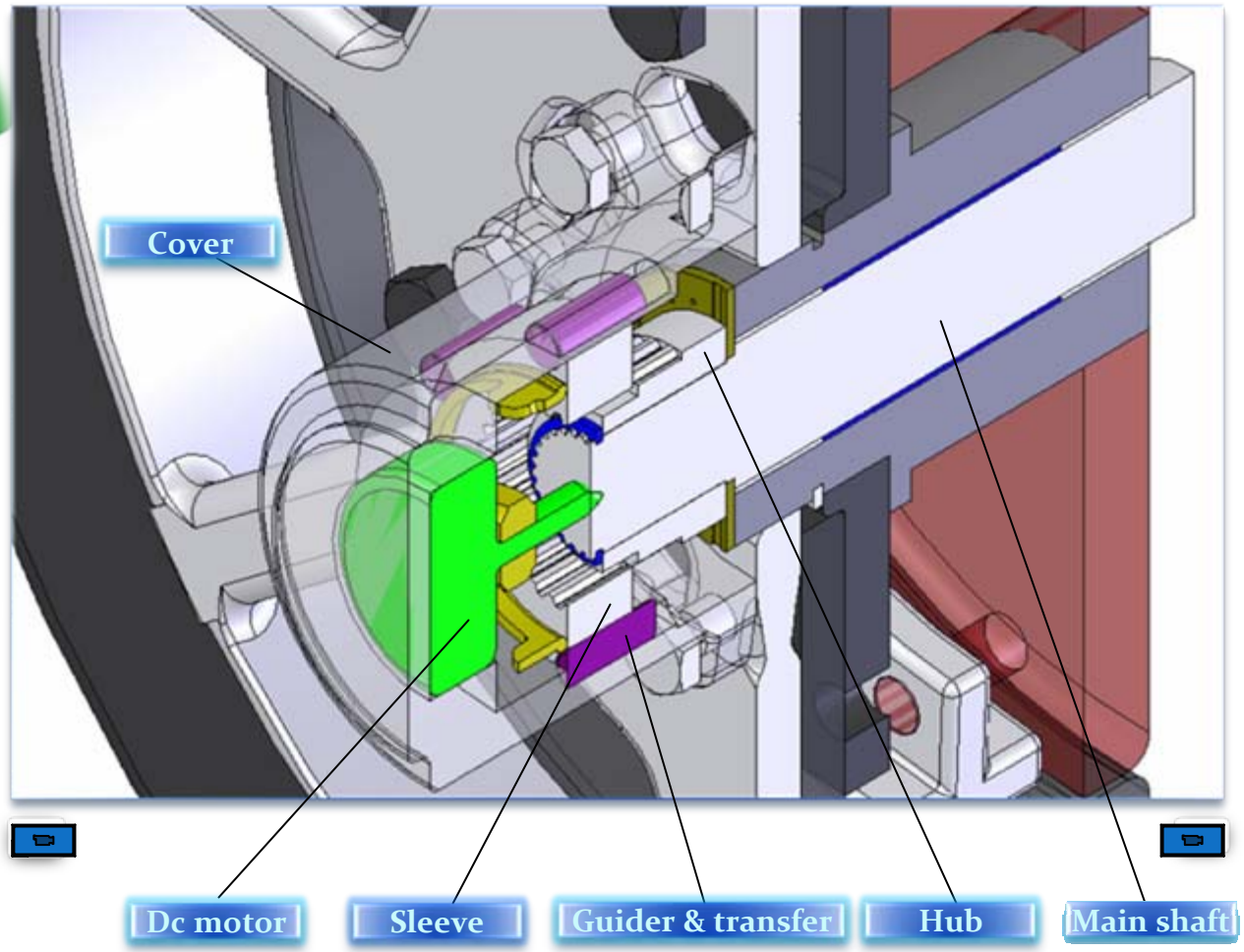
This plan consists of electric motor, planetary gear and one dc coupler. These parts will be mounted on the one of the rear wheels. In heavy traffic 1st and 2nd gears have a constant usage then we have a much fuel consumption and emission but with this plan we can control the fuel consumption and emission in the optimal state. this plan has two working modes.

Note! With use this plan the Maximum velocity we can receive is 25km/h.

Details of DC coupler

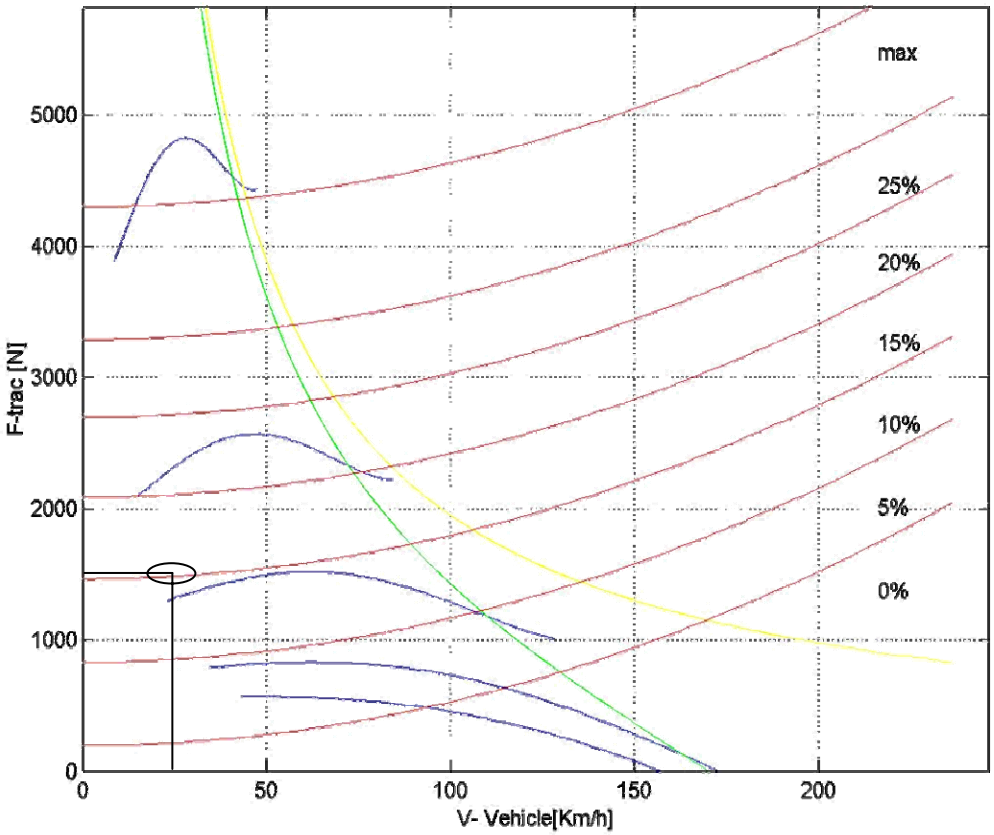






Traction force analysis

According to table.1 Traction force-speed diagram will be:



$$T_{Wheel} = F_{traction} \times r_{Wheel}$$

$$P_{Electric\ motor} = T_{Wheel} \times \frac{V_{Vehicle\ Speed}}{r_{Wheel}}$$

All of gears are designed according to:
DIN 3990 Part 41 (vehicle gearbox) Method B

Other parts are designed according to:
standards are used to design suspensions in vehicles

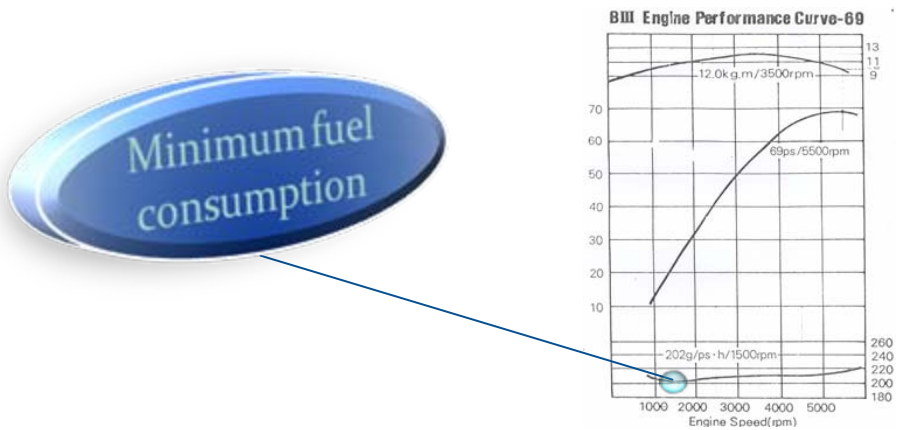
Electric motor power is selected for maximum 25km/h vehicle speed and 10% grade ability.
Planetary mechanism and dc coupler parts are designed for this state.

Mode 1: ICE is on

➢ These items must be checked for running the electrical mechanism when the ICE is on :

1. Gear box in the natural state.
2. Hand brake in the disengaged state.
3. Clutch in the disengaged state.

- All of these items are checked by the sensors. If one of options was engaged, mechanism won't work and will monitor error.
- In this case ICE will work without load and we will have a minimum fuel consumption and emission.
- If the battery charges decrease, ICE will work in optimal engine speed and will charge the battery. When ICE work in optimal engine speed we have minimum fuel consumption and emission. In this vehicle as following diagram optimal fuel consumption and emission will occur in 1500 rpm.
- In braking state motor will be converted to generator and battery will be charged.
- If clutch be engaged electric circuit will be off, and we will move by the traditional mechanism.



Mode 2: ICE is off

- These items must be checked for running the electrical mechanism when the ICE is off :

1. Gear box in the natural state.
2. Hand brake in the disengaged state.
3. Clutch in the disengaged state.
4. Battery have a enough charge.
5. ICE is off.

- All of these items checked by the sensors. If one of options has a problem mechanism won't work and will monitor error.
- If the battery charges decrease, ICE automatically will start and work in optimal engine speed and will charge the battery. when battery charged ICE automatically will turn off.
- In braking state motor will be converted to generator and battery will be charged.
- If clutch be engaged electric circuit will be off, and ICE automatically will start then we will move by the traditional mechanism.

Fuel consumption Calculation:

- In each vehicle we can calculate fuel consumption during the t time as follow:

1). $FC = \frac{2\pi}{60}\int_0^t (bsfc) T_e n_e dt = \int_0^t (bsfc) P_e dt$

But by decreasing space of boot (trunk) this problem resolves

2). $T_e = \frac{r}{N_t N_f \eta_t \eta_f}\left(M_e a_x + R_x + D_A\right)$

3). $n_e = 2.65\frac{v}{r} N_t N_f$

4). $M_e = M\left[1.04 + 0.0025 N_{tf}^2\right]$

M increases because of the additional parts (electrical equipment)

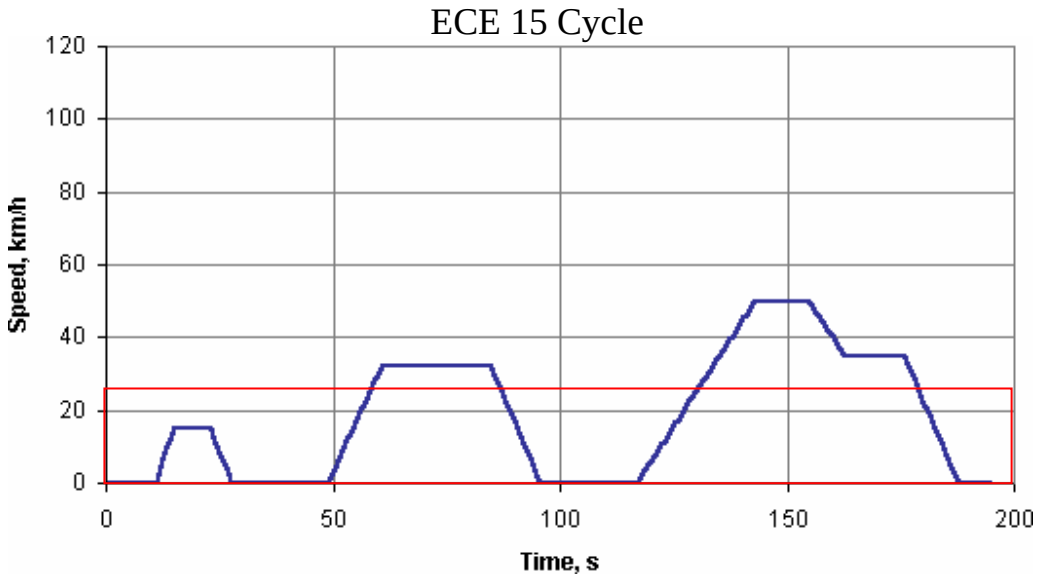
- Considering standard cycle (ECE15) consists of moving with constant acceleration, constant speed, deceleration and a state of rest vehicle, fuel consumption in each step be calculated as follow:

- 1) $a > 0$ using of the equations mentioned above FC will be obtained.
- 2) $v \geq 0$ In this case FC will be obtained from this equation: $FC = (bsfc) P_e t$

If $v = 0$ In this case FC will be obtained from this equation: $FC = \dot{m}_{idle} t_{idle}$

Note!
When we drive in electric case fuel consumption will be obtained from the equation mentioned Above that in this case fuel consumption will be minimize. (ICE is on)

- 3) $a < 0$ In this case FC will be obtained from this equation: $FC = \int_{F_{x<0}} \dot{m}_n dt$



The following table includes a summary of the parameters for the ECE cycle.

Characteristics	unit	ECE 15
Distance	km	4*1.013=4.052
Duration	s	4*195=780
Average speed	km/h	62.6
Maximum speed	km/h	120

Suppose the battery is full, in this case if we test vehicle when we drive under electrical condition in the ECE15 cycle until 25 km/h speed, fuel consumption will be minimize. After this speed we will continue with traditional mechanism and we will see how much fuel consumption and emission will decrease.

Conclusion

- **The advantages of using this system are:**

- Decreasing emission by low fuel consumption.
- Low NVH levels in heavy traffic.
- Smooth acceleration in heavy traffic.
- Comfortable driving in heavy traffic.
- easy assembly and disassembly process.
- Can be installed on the vehicle with AT,AMT and CVT transmissions.
- Low cost.
- Decreasing of engine depreciation.

- **The disadvantage of using this system is:**

- Decreasing space of boot.

Charkheshgar Company is ready for cooperation with any company in this project.

Thank you for your attention

If you have any question you can contact with me by this email address:

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