New Sankey Diagram

Like explained in the manual, we had to let our car roll of the ramp and measure how far it can get before it stopped. The distance that we measured, 1,95 m, was a lot smaller than in our ,simulation so the only conclusion we could make was that our rolling resistance coefficient is bigger than we expected. This is normal because in the simulation, we had only calculated the friction between the tires and the track while in real life there are more places on the car where there is friction. So based on the distance that we have measured, we have made some new calculations to make a better Sankey Diagram.
We have only made new calculations about the aerodynamic and rolling resistance losses. For the other parts we had already thought about extra losses so they should be rather fine.

Aerodynamic losses

In our first Sankey diagram, we have made some assumptions. Although the most of these assumptions were rather correct, there were also some things that has changed like the thickness of the wheels and the gear ratio.

Drag force: $F_D = 0,5 * \rho * C_D * A * v^2$.

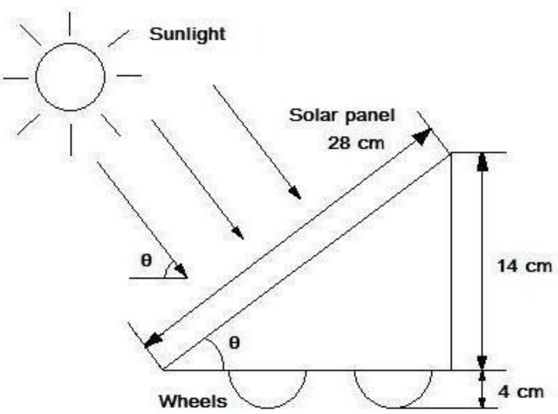
Density of the fluid (air): $\rho = 1,204\ kg/m^3$

Drag coefficient: $C_D = 0,09$ (Streamlined Half-body)

Reference area (frontal area):

Size of solar panel: 22 cm * 28 cm, θ = 30°

A = 14 cm * 22 cm + 4 cm * 4 cm * 2 = 0,034 m^2



Maximum velocity at the maximum power: $V = P_{real} / F_{wheel}$ = 4,31 / 1,19 = 3,43 m/s

According to the formula, drag force: F_D = 0,5 * 1,204 * 0,09 * 0,034 * 3,43²

$$F_D = 0{,}022 \text{ N}$$

Power of drag force at the maximum velocity: $P_A = F_D * v$ = 0,022 N * 3,43 m/s = 0,08 W

$\eta = (P_A / 4{,}0964) * 100\% = 1{,}95\%$

Conclusion: the frontal area was in real life a little bit bigger than we expected but the velocity of the car was also a little bit lower than we had calculated so the actual percentage is still the same.

Rolling resistance.

The rolling resistance of the car was bigger than we expected so we have calculated a new rolling resistance coefficient.

Mass (m) = 0,962 kg

Fr = Crr * N

N * cos 3° = - m * g

N = (- m * g) / cos 3°

N = (- 0,962 * 9,81)/cos 3°

N = 9,43 N

Potential Energy = m * g * h

m * g * h = F * s

$m * g * h = g * \cos 3° * C_{rr} * d_{slope} + g * C_{rr} * d_{flat}$

$0{,}962 * 9{,}81 * 1 * \sin 3° = C_{rr} * (g * \cos 3° * d_{slope} + g * d_{flat})$

$C_{rr} = (0{,}962 * \sin 3° * 9{,}81) / (9{,}81 * \cos 3° + 9{,}81 * 0{,}95)$

$C_{rr} = 0{,}026$

$F_r = 0{,}026 * 9{,}43$

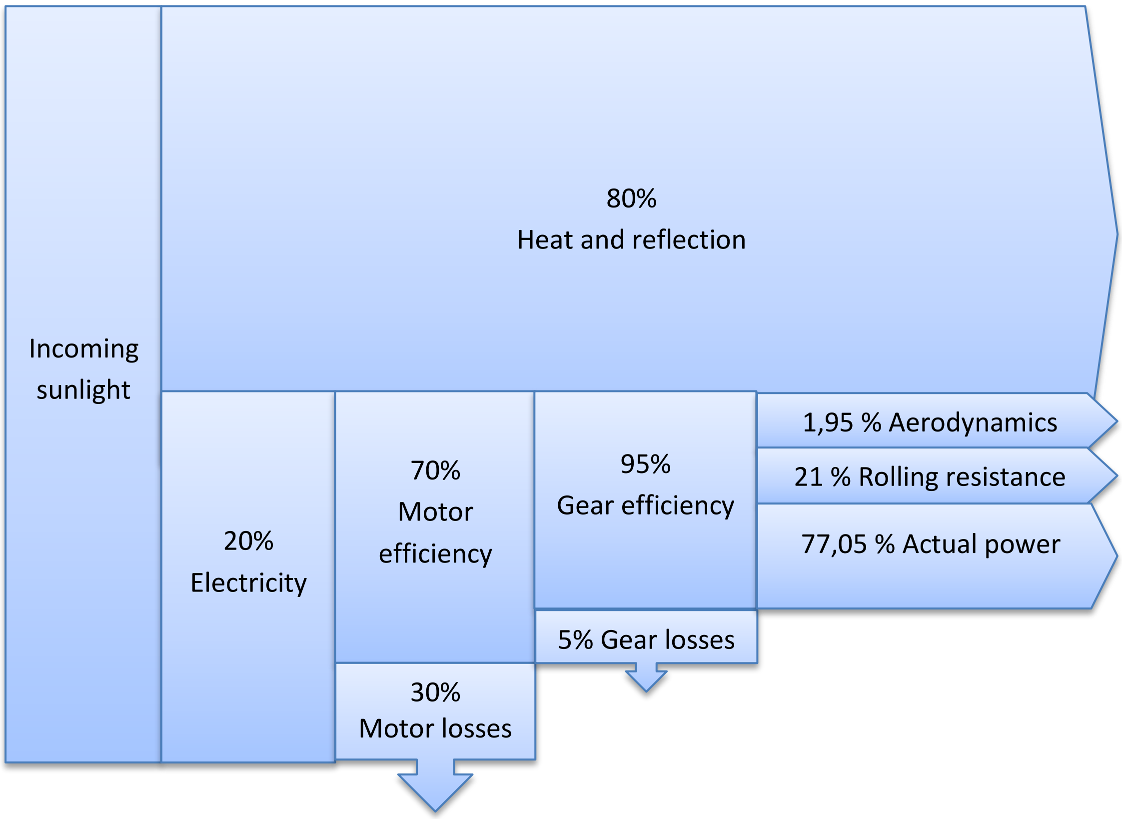
$F_r = 0{,}25$ N

Power of rolling resistance at the maximum velocity: $P_r = F_{rolling} * V = 0,25 * 3,43 = 0,86$ W

$\eta = (P_r / 4,0964) * 100\% = 21\%$

Conclusion: In the previous Sankey diagram we had a rolling resistance of 0,1 Newton while now we have one of 0,25 Newton. This means that there really is more friction on the car than only between the tires and the track.

Sankey Diagram



Actual power is again the energy that is used to move the car. This is no wasted energy.