Electric bicycles: An energy efficient mode of transportation

+Intro to dynamic wireless charging

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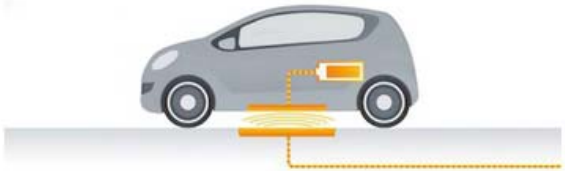
www.MICEV.eu

Standardized

Standardization in progress, R&D

Conductive Charging

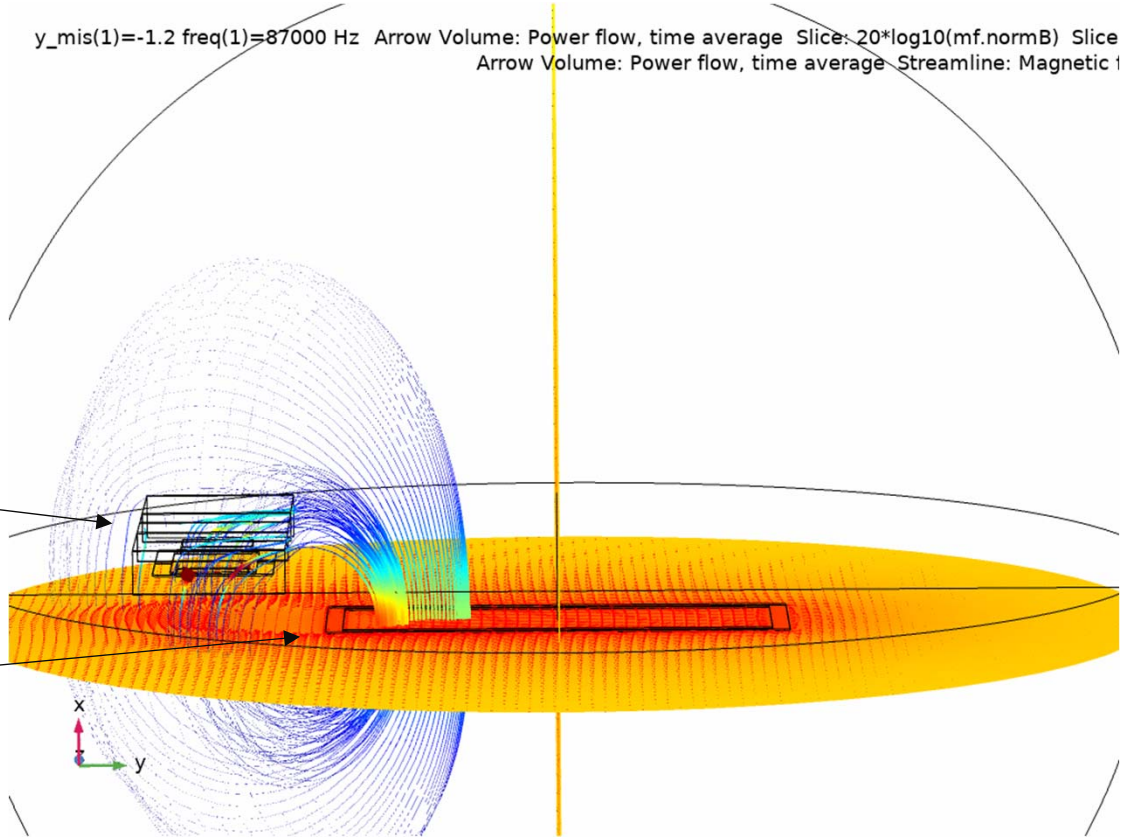


Static inductive charging

Dynamic Inductive Charging

Vehicle coil (moving)

Ground coil



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Definitions

(In Finland)

- Pedelec, e-assist <25 km/h
  Max 250 W Like a bicycle!

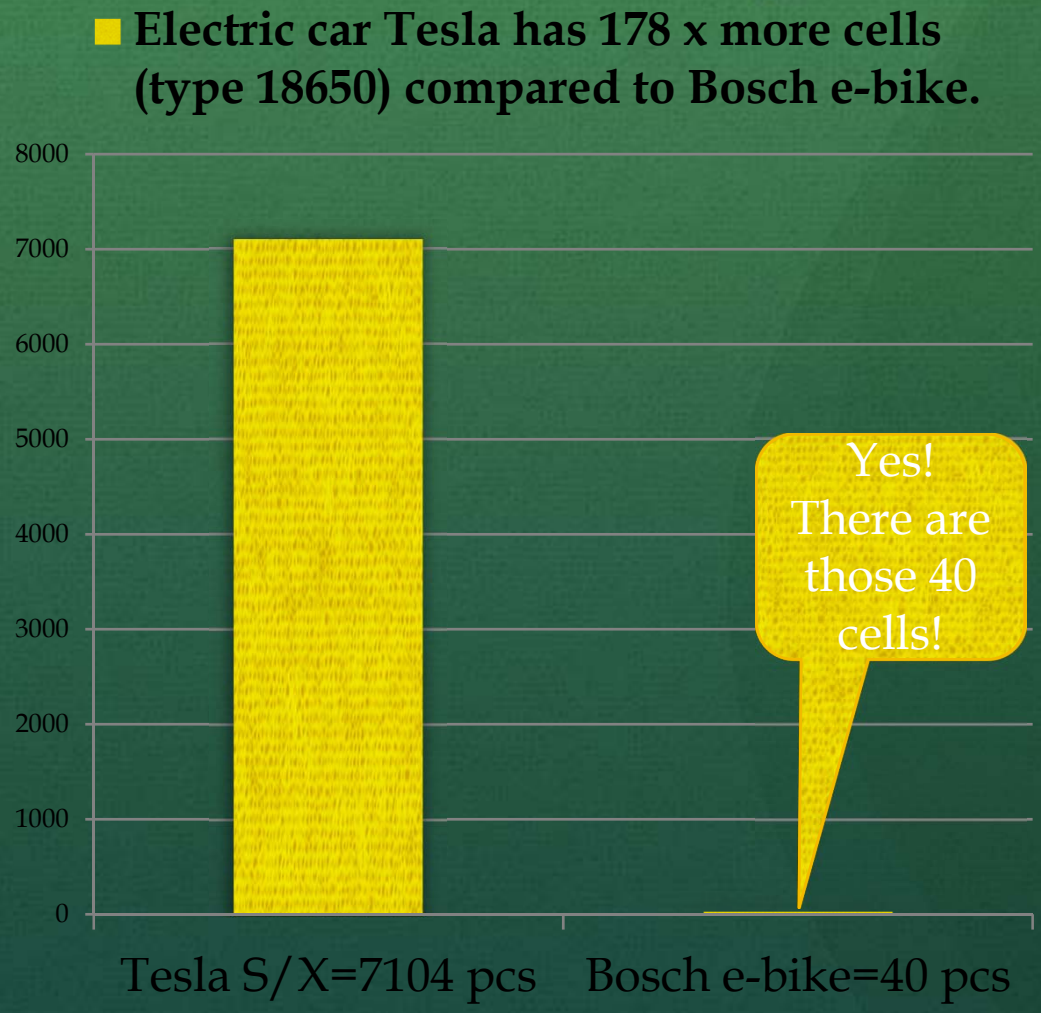
- Speed pedelec L-1eB
  <45 km/h, <1000W Like a e-moped

- Between these two: Motorized pedelec L-1eA
  <25 km/h, 250…1000W Insurance needed, no registration plate

Fiqure: LiikkuvaLaatikko.fi

Efficient use of resources

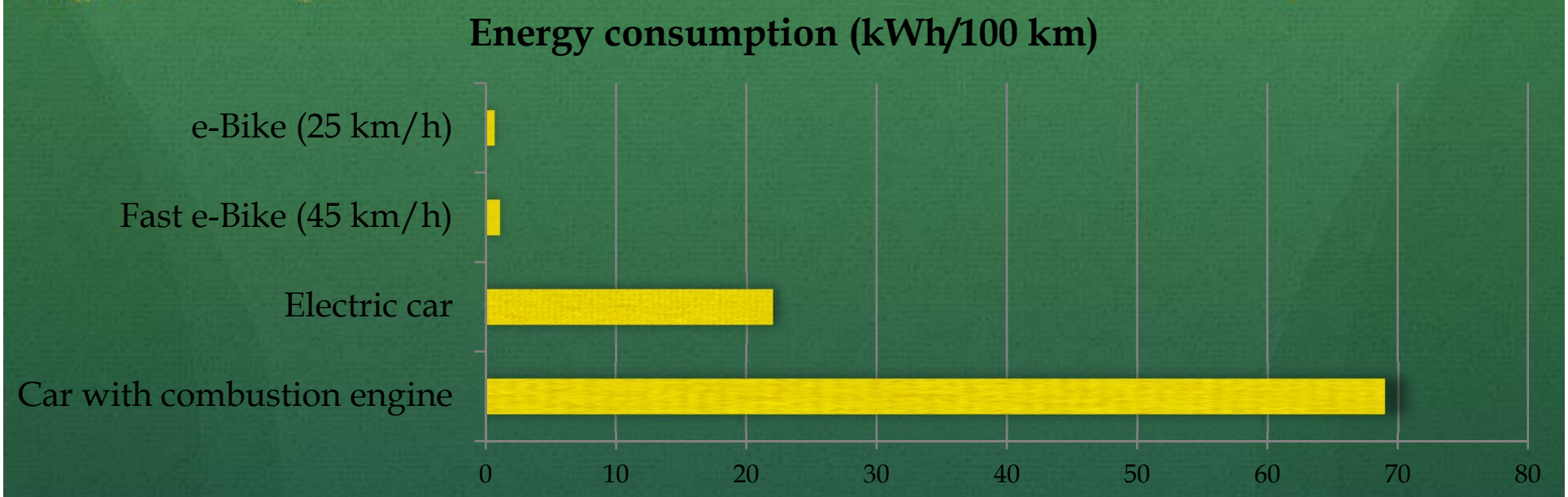
- Rare earth minerals are needed in batteries.
- The typical Tesla model S/X battery pack has 7104 pieces of type 18650 cells.
- Bosch e-Bike battery pack has 40 cells of the same type



Same amount of battery materials are enough for 178 e-Bikes or one car!

OR

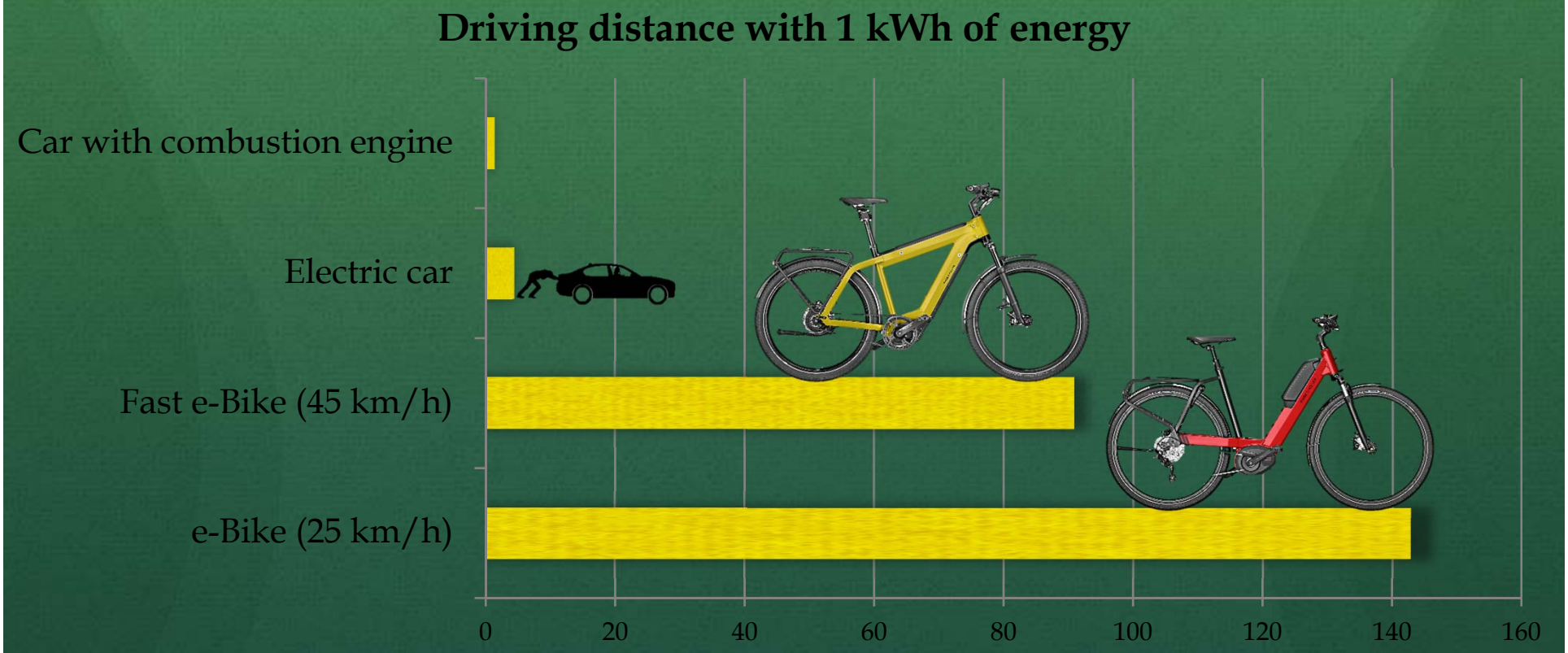
Energy use of vehicle



- Energy cost for 10 000 km:
  - 3 € for e-Bike
    vs.
  - 1220€ for ICE car!

Fiqure: DHL

How far you get with 1 kWh?

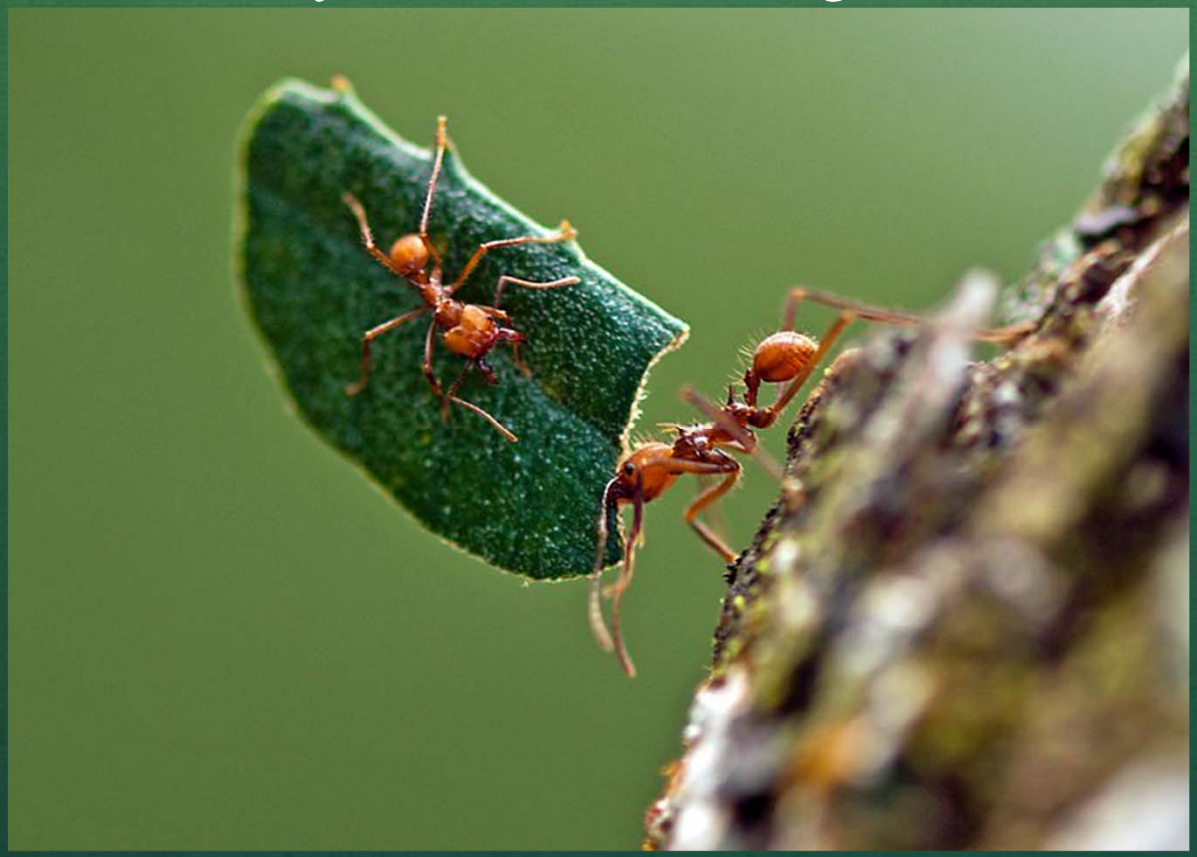


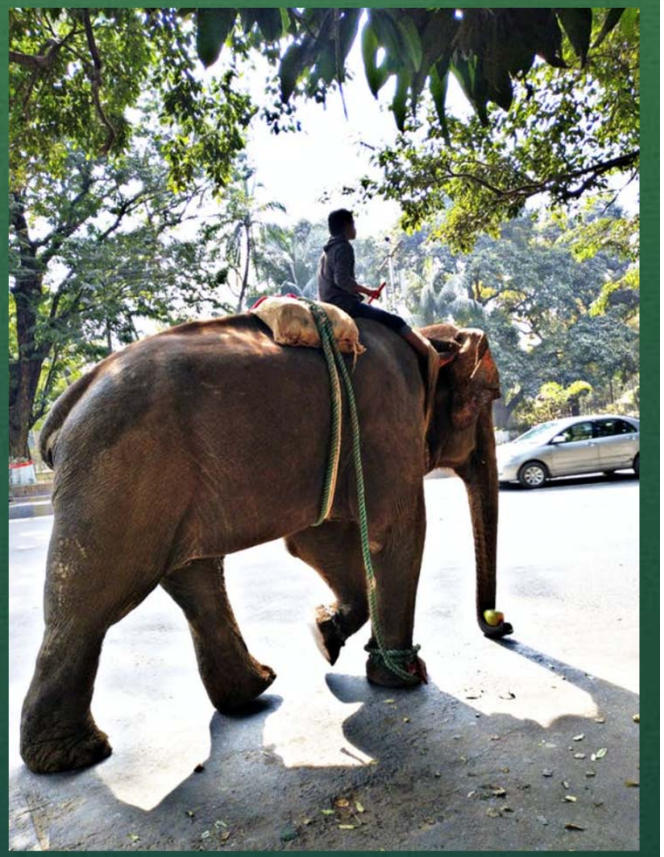
- With e-Bike you can still cycle with flat battery. You do not want to start pushing car!

Fiqure: Riese&Müller

Ant-effect (Strenght-to-weight ratios)

- Ant can lift 100 times their own body weight, but elephant lifts only 0,1 times its weight.

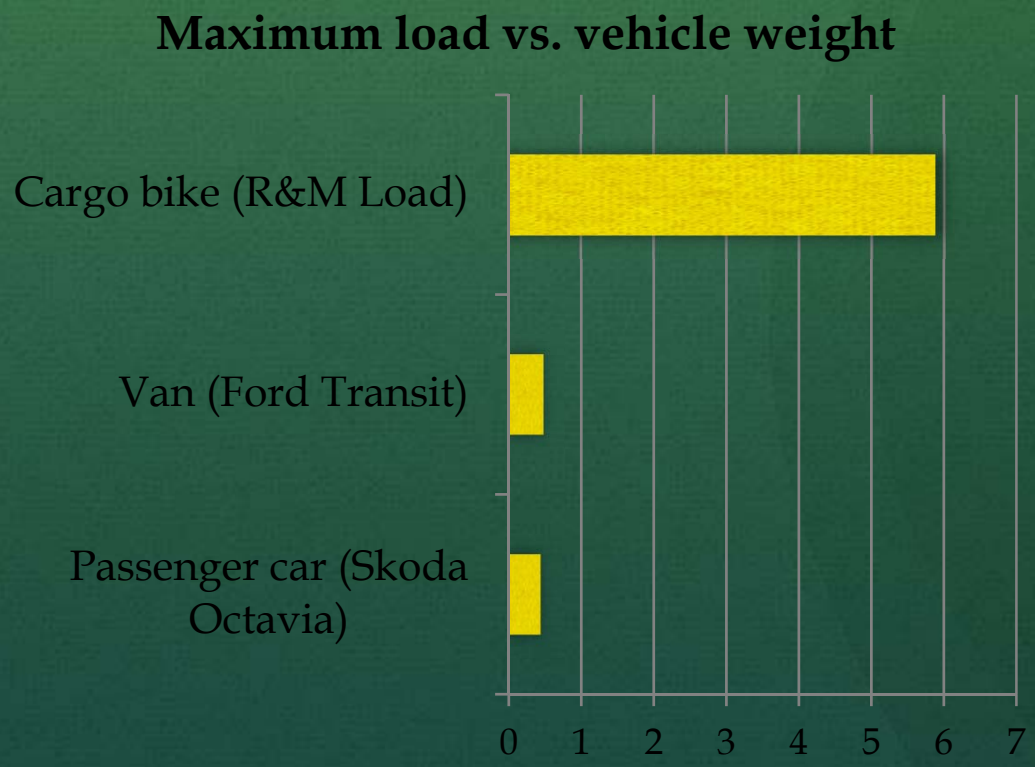




Fiqure: Wikimedia commons, CC, Kathy&Sam

Load capacity to weight

- Bikes can carry loads that are heavier than vehicle weigth, but cars can carry less than their own weight.



Fiqure: Workcycles / Liikkuva Laatikko.fi

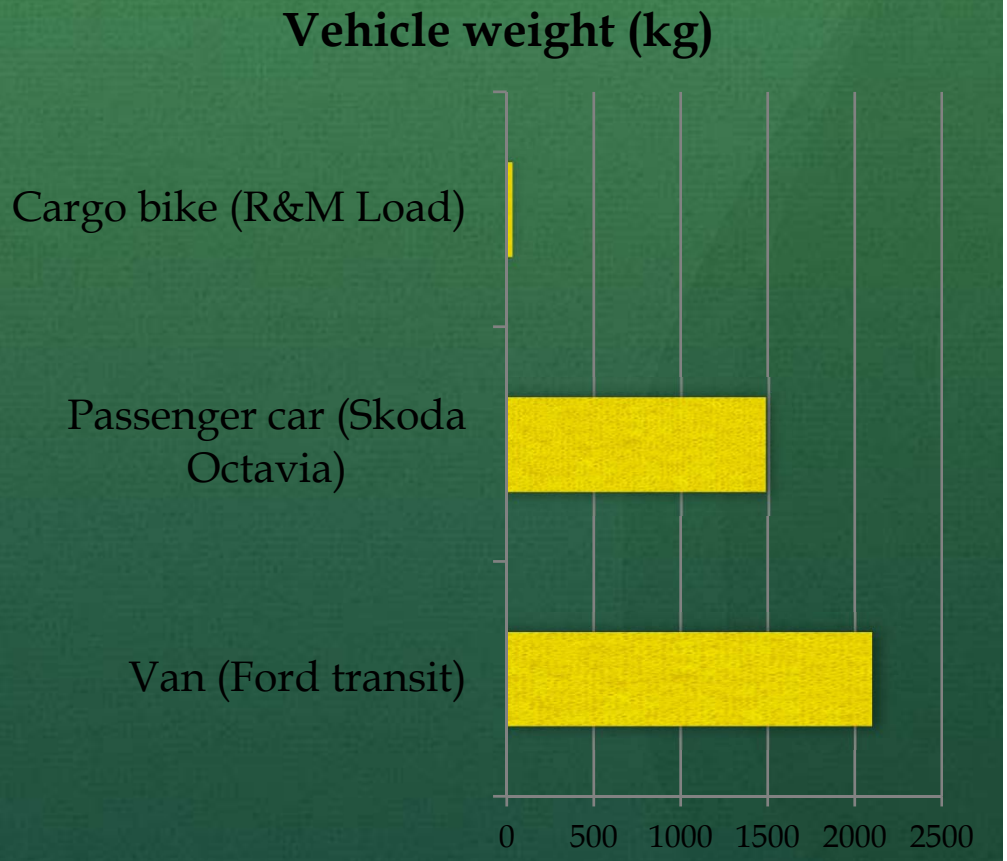
Scaling –you can´t cheat the physics!

- Energy efficiency is all about size, mass and speed.
- When we scale up the vehicle:
  - The material strenght stays the same $\mathbf{L^0}$
  - Mass goes up $\mathbf{L^3}$ (and thus material cost goes up to L^3)
  - Power/mass ratio $\mathbf{L^{-1}}$
  - Mass moment of inertia L^5 (!)

- Kun Ca= $\frac{\rho v^2}{E}$=vakio ja työaines on sama,eli ρ=E= vakio, on v = vakio , tällöin geometrisen yhtäläisyyden vallitessa muuttuvat pituuden porraskertoimen φ_L mukana alla mainitut suureet seuraavasti:
- Kierrosluvut n, ω; taivutus- ja vääntökriittiset kierrosluvut n_{kr} , ω_{kr} suhteessa φ_L^{-1}
- Hitaus- ja kimmovoimista johtuvat venymät ε, jännitykset σ ja pintapaineet p; nopeudet v φ_L^0
- Jousen jäykkyydet c, kimmoiset muodonmuutokset Δl painovoiman aiheuttamat venymät ε,jännitykset σ, pintapaineet p φ_L^1
- Voimat F Tehot P φ_L^2
- Painot G, vääntömomentit T, vääntöjäykkyys c_t, vastusmomentit W, W_t φ_L^3,
- Pintahitausmomentit I, I_t, φ_L^4
- Massahitausmomentti Θ, φ_L^5

Vehicle mass

Heavy-duty cargobikes may have the capacity of delivery van, but with higher efficiency and faster delivery times in city centres (Velove armadillo)



Spike tires and emissions

- Zero emission electric car in city traffic?
- Passenger car with spike tires may emit 8 g of fine dust from road surface per kilometre*.

*Liikenne- ja viestintäministeriön julkaisuja, Nastarenkaiden kuluttavuus, yliajokoe 2004

- Reduction of vehicle weigth reduces particle emissions

Fiqure: biohybrid.com and podbike.com

ISO-standardization for e-Bikes, ISO 4210-10

- Globally, there are now several standards for e-bikes. Global standard would help the progress of cycle industry and cycling in general.
- For example, pedelec maximum assisted speeds:
  25 km/h limit in the EU
  vs.
  20 mph (32 km/h) in the USA.
- New ISO-standard needs 2/3 majority to proceed. In last voting 65% voted yes. Finland did not vote. Why?

ISO/DIS 4210-10.2

Cycles — Safety requirements for bicycles — Part 10: Safety requirements for electrically power assisted cycles (EPACs)

LIFE CYCLE

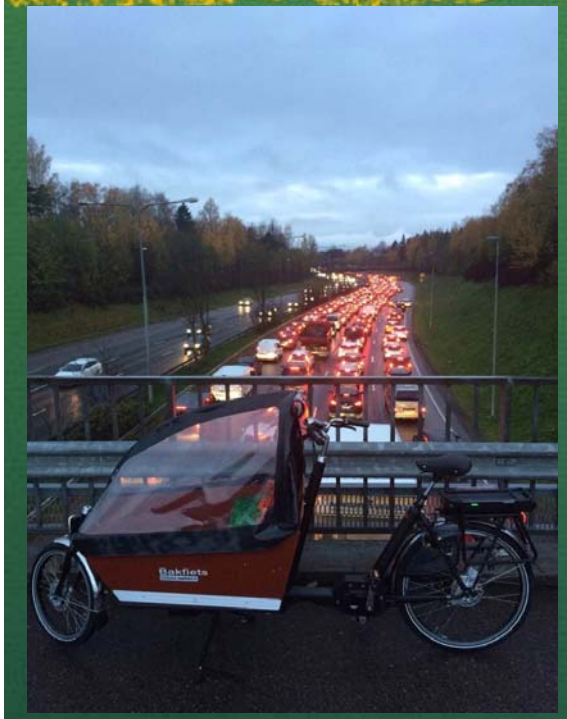
A standard is reviewed every 5 years

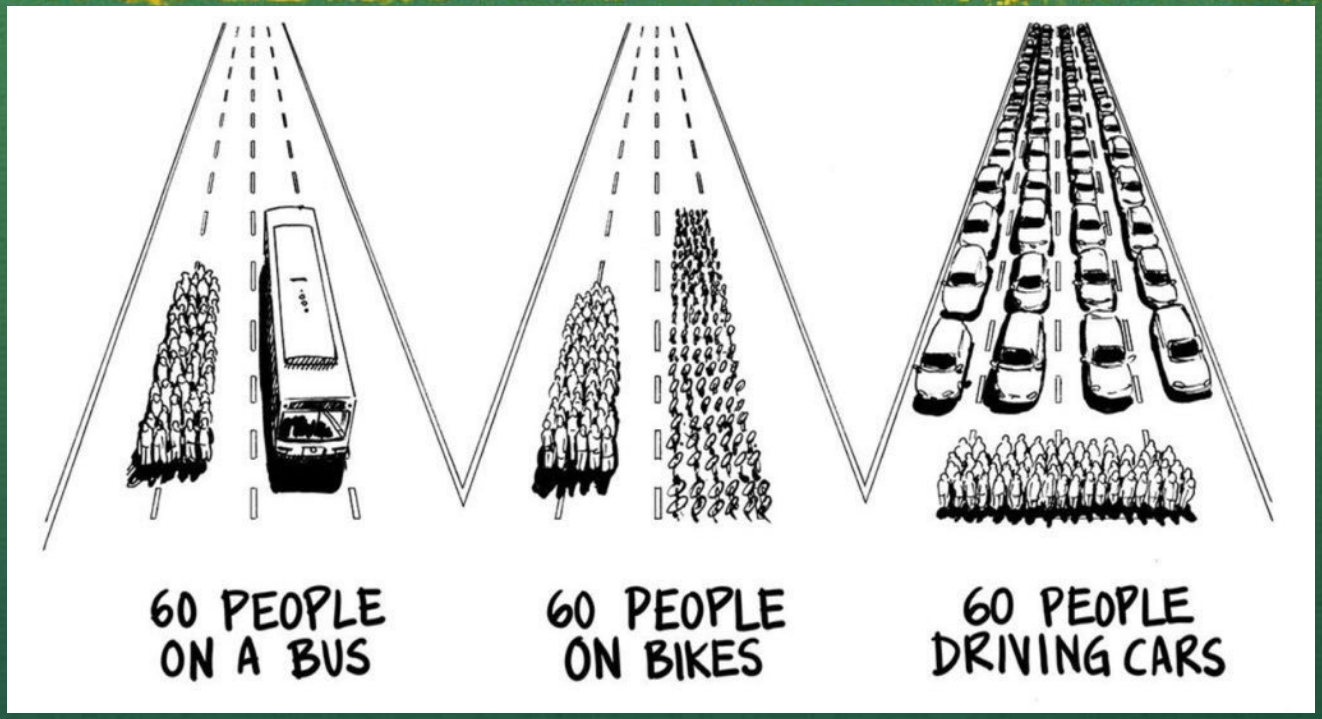
00 | 10 | 20 | 30 | **40.00** Enquiry | 50 | 60 | 90 | 95

Revonte - Finnish motor+gearbox developer

Fiqure: Revonte

Does the emperor have clothes on?





- Our transport system should not cause more problems than solutions.
- Lighter modes of transport and vehicles must be prioritized.

Any questions?

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Extra material

VEHICLE COMPARISON

- One person commute -

PODBIKE

Vehicle	Vehicle mass/ transported mass	Consumption/ 100 kms	Avg. speed intercity	Avg. speed city normal	Avg. speed city peak hours	Avg. speed city traffic separate lane (traffic jams)
 Car	25 kg	7,5 l	65	25	15	15
 E-car	30	20 Kwh	65	25	15	15
 Motorcycle	4	5,5 l	65	30	20	20
 Podbike	0,9	0,6 Kwh	27	25	20	25
 S-Velomobile	0,6	0,5 Kwh	40	30	20	
 Moped	1,5	1,5 l	25	20	20	25
 E-bike	0,25	0,7 Kwh	25	22	20	22
 Bike	0,15	0,15 Kwh	20	18	18	20

Sources: Velo-Promo-Biel, Podbike.