




# NEW ENERGY 新世代 NEW GENERATION 2026 新世代

全港一年一度的中學生太陽能車比賽盛事

1<sup>st</sup> Workshop on Rideable Solar Car:  
An Introduction to High-Efficiency and Energy-Saving Design

## 2026工作坊內容 Workshop content

-  **01** 1)初談高效節能設計  
1月31日 An Introduction to High-Efficiency and Energy-Saving Design  
31/01
- 02** 車輛動力ABC  
2月28日 Vehicle Powertrain ABC  
28/02
- 03** 電力驅動技術 I  
3月14日 Electric Drive Technology  
14/03
- 04** 車身設計大不同  
5月23日 Differences in Vehicle Body Design  
23/05
- 05** 太陽能車攻略  
7月4日 Solar Car Strategy  
04/07
- 06** 技術支援 網上直播  
7月25日 Technical Support- Online Live Session  
25/07

Shell Nxplorers Programme - 5月尾



## Key points

1. Introduction to Solar Cars
2. Solar Car Competitions
3. New Energy New Generation 2026 Regulation
4. Main Components
5. Schedule
6. Energy Management Calculations



## 什麼是淨零(Net Zero)?

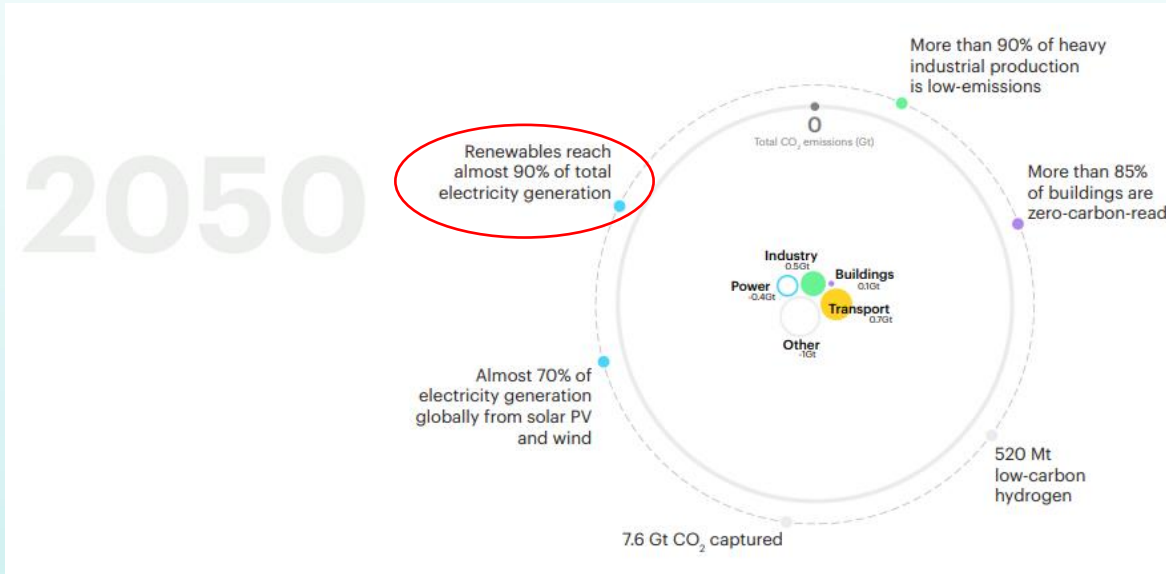
### What is Net Zero?

In short, net zero means reducing greenhouse gas emissions to as close to zero as possible, with any remaining emissions being reabsorbed from the atmosphere, for example through oceans and forests. [1]

淨零排放  
#可能實現



**Net Zero and Sustainable Development**



Picture 1 Net-Zero Emissions by 2050 Scenario[2]

Sector	Year	Milestone
Industry	2020	• Global average plastics collection rate = 17%.
	2030	• Global average plastics collection rate = 27%. • Lightweighting reduces the weight of an average passenger car by 10%.
	2050	• Global average plastics collection rate = 54%. • Efficiency of fertiliser use improved by 10%.
Transport	2030	• Eco-driving and motorway speed limits of 100 km/h introduced. • Use of ICE cars phased out in large cities. (circled in red)
	2050	• Regional flights are shifted to high-speed rail where feasible. • Business and long-haul leisure air travel does not exceed 2019 levels.
Buildings	2030	• Space heating temperatures moderated to 19-20 °C on average. • Space cooling temperatures moderated to 24-25°C on average. • Excessive hot-water temperatures reduced.
	2050	• Use of energy-intensive materials per unit of floor area decreases by 30%. • Building lifetime extended by 20% on average.

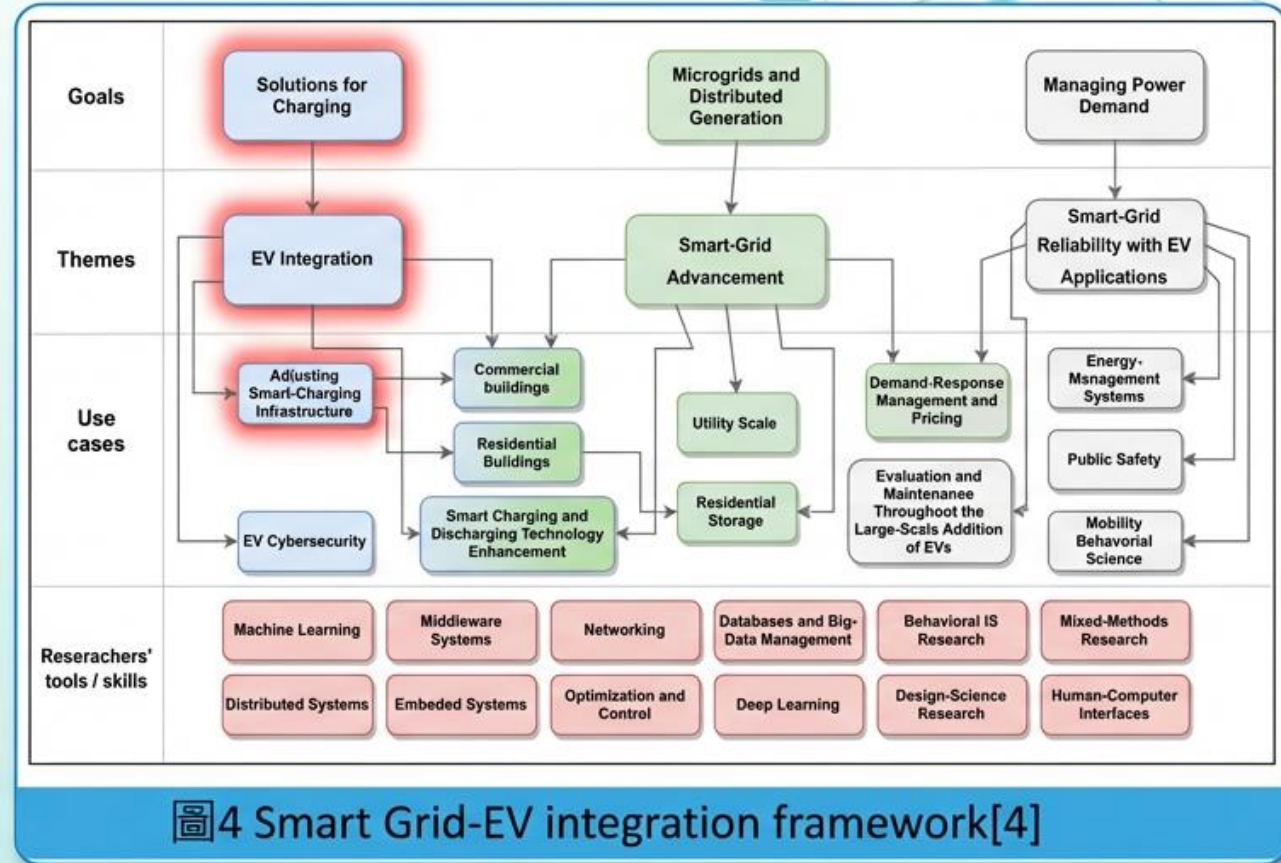
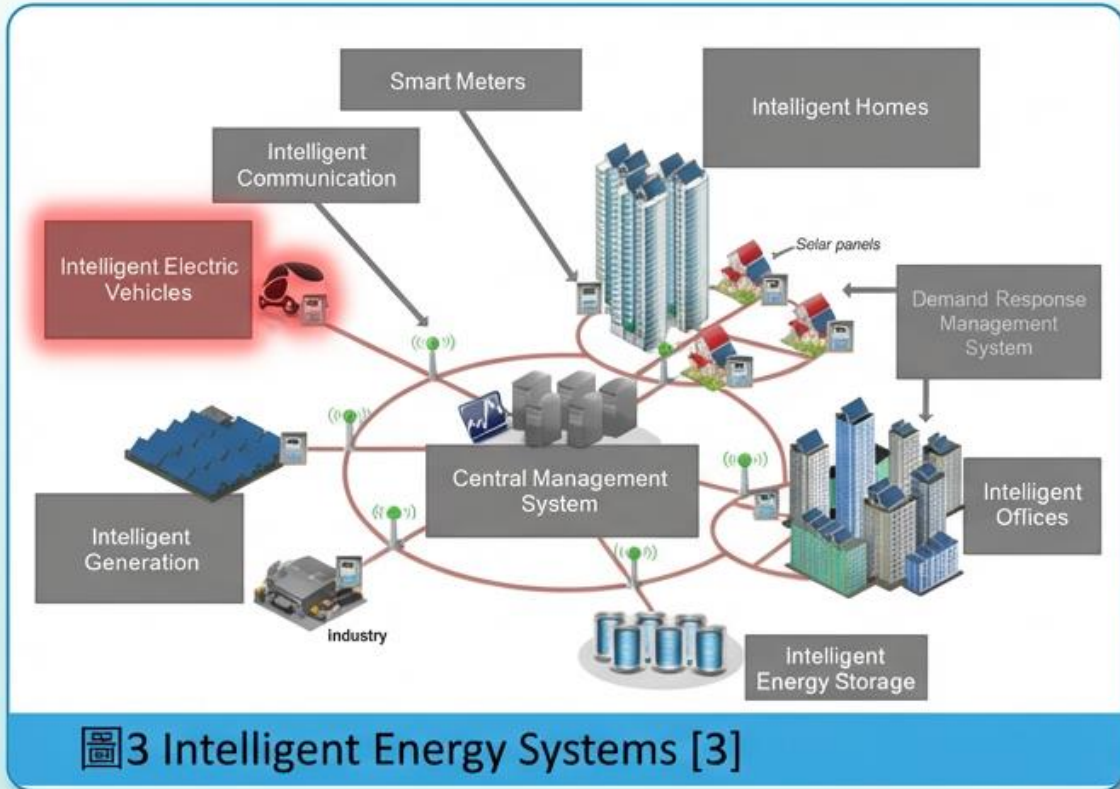
Note: Eco-driving involves pre-emptive stopping and starting; ICE = internal combustion engine.

Picture 2 Key global milestones for behavioral change in the Net-Zero Emissions by 2050 Scenario[2]

[2] Net Zero by 2050 A Roadmap for the Global Energy Sector(2021) International Energy Agency. Reference: [https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector\\_CORR.pdf](https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf) (访问日期：18 Jan 2024).



## Net Zero and Sustainable Development



[3] National Climate Change Secretariat and National Research Foundation (2011) Smart Grid Technology Primer: A Summary

[4] Vivian S.(2022) Integration of EVs into the smart grid: a systematic literature review. California Statue University

# The Emergence and Development of Solar Cars



1912 First Solar Car  
Baker electric car [5]



1977 3-wheeled Solar Car  
Bluebird solar car [5]



1982 Solar Car Quiet  
Achiever First Driven in  
Australia, and World Solar  
Challenge Began in 1987 [5]



2022 Dutch Team Members  
Begin Commercial Solar Car  
Production at Finnish Factory  
Lightyear [6]

[5] Tathagata P. (2016) Electric Solar Vehicle – RavRacer KIIT University

[6] World's first solar-powered electric car enters production (2022) Drive.com. Ref. <https://www.drive.com.au/news/worlds-first-solar-powered-electric-car-enters-production/> (Accessed: 8 Jan 2024)

# 太陽能車賽事

- 世界太陽能車挑戰賽 (Bridgestone World Solar Challenge)[7]



- 美國太陽能車挑戰賽 (Electrek American Solar Challenge)[8]



- 南非太陽能車挑戰賽 (South African Sasol Solar Challenge)[9]



- 歐洲太陽能車挑戰賽 (iLumen European Solar Challenge)[10]



- Shell Eco-marathon Asia-Pacific and the Middle East[11]



[7] Bridgestone World Solar Challenge (2023) 參考: <https://worldsolarchallenge.org/> (訪問日期: 8 Jan 2024)

[8] Electrek American Solar Challenge (2023) 參考: <https://www.americansolarchallenge.org/> (訪問日期: 8 Jan 2024)

[9] South African Sasol Solar Challenge (2023) 參考: <https://www.solarchallenge.org.za/> (訪問日期: 8 Jan 2024)

[10] iLumen European Solar Challenge (2023) 參考: <https://www.europeansolarchallenge.eu/> (訪問日期: 8 Jan 2024)

[11] Shell Eco-marathon(2023) 參考: <https://www.shellecomarathon.com/> (訪問日期: 8 Jan 2024)

# World Solar Challenge



is a design competition aimed at designing the world's most efficient electric vehicles.

- The biennial event aims to inspire young people around the world to solve sustainable transport problems.
- The competition is divided into two main classes, representing the diversity of solar electric vehicles and different design concepts.





# World Solar Challenge



Projecta Challenger Class

Design a single-seat solar car  
Speed is the goal



CSIRO Cruiser Class

Design a multi-seat solar car  
Energy efficiency is the goal



Adventure Class

Non-competitive event

## Design requirement

- Overall vehicle dimensions
- Seating capacity
- Wheel count
- Solar panel specifications and type
- Battery capacity
- Safety features
- Brake and steering systems
- etc.





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**新能源** NEW GENERATION  
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How to build a solar car?



How to build a solar car?

Overall Vehicle Requirements  
Competition Rules Reference



Updates(2026):  
-Added AI innovation award & 2026 Shell Nxplorers award

# Vehicle Body Requirements



## Vehicle Dimensions

- Length: 2.2m – 3.5m
- Width: 1.2m – 1.3m
- Height: 1.0m – 1.3m
- Weight (Maximum Allowed): 225 kg  
(Net solar car, excluding driver)



**Number of Seats:**  
Single Seat Only



**Number of Wheels:**  
3-4 wheels



# Power Requirements

- 🔋 Battery Capacity
- 🚗 Vehicle Interior Space
- 🛡️ Safety
- 💡 Vehicle Indicatights
  - 2 Headlights
  - 2 Front Indicators and 2 Rear Indicators
  - 2 Red Hear Brake lights and 2 Red Rear Runnights
- 🚘 Vehicle Equipment
  - Vehicle Horn
  - Seats
  - Seatbelt
  - Emergency Ptop
  - Odometer
  - Safety Equipment
- 🕒 Briking and Steering System

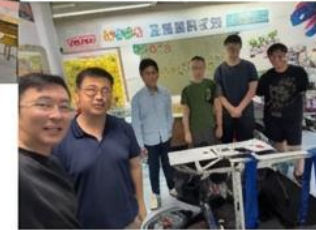


## Q&A

- Reference from NENG2024 Team visit summary

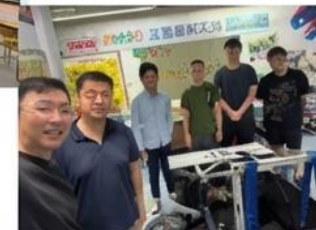
### Team Visit and Team Summary

- Most teams are well-prepared and have purchased the necessary components to start fabrication.
- Electrical part:
  - Requires electrical schematics
  - BMS and related manuals
  - Voltage must be at 48V rated value (including motor)
  - Solar panels must be on the roof
  - Lighting system can be powered by a separate auxiliary battery



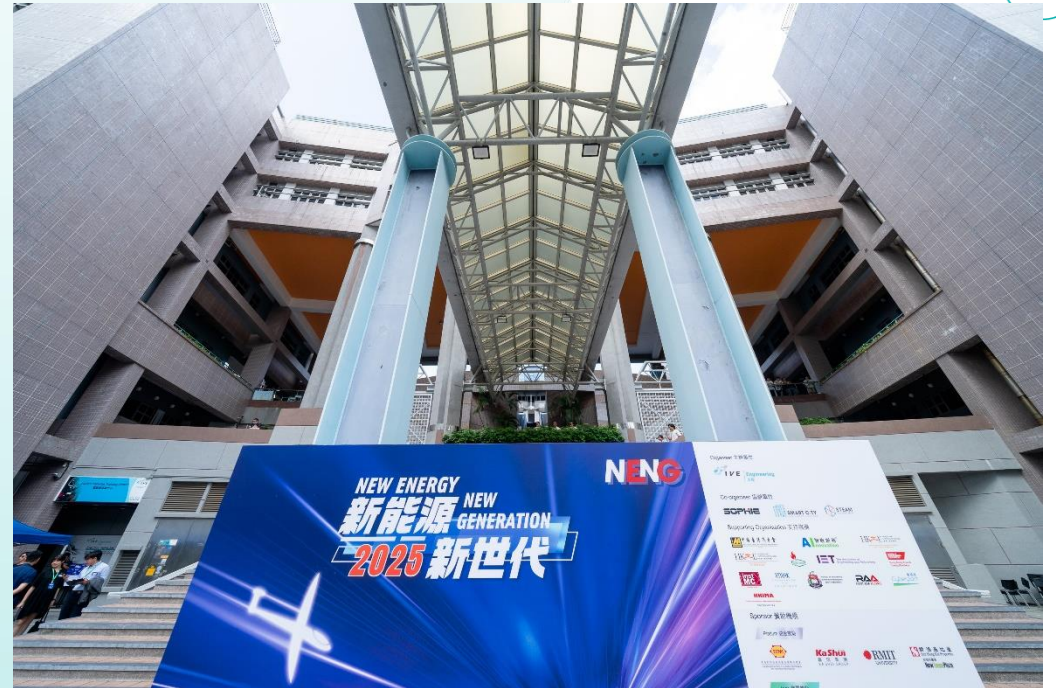
### Team Visit and Team Summary

- Mechanical part:
  - Must have doors
  - Safety belt must be 5-point
  - Rollbar & Bulkhead
  - Braking needs 2 sets
- Overall safety:
  - Driver must be 16 years old or older
  - Driver log for >10 hr
  - Radio, Fire extinguisher



**Rideable Solar Car**

Important Dates	Activity
January 31, 2026	Release of Competition Regulation Documents
Before January 31, 2026	Recruit Team Members and Registration
After the First Workshop	Prepare Procurement List and Assign Tasks to Team Members
During April 2026	Easter Holidays - Start Work (I)
During July to August 2026	Summer Holidays - Start Work (II)
Mid-July 2026	Submit Solar Car Documents and Off-track Award Application & Team Visit
August 25, 2026	Scrutineering
October 17, 2026	Semi-Final
October 31, 2026	Race Day and Award Ceremony



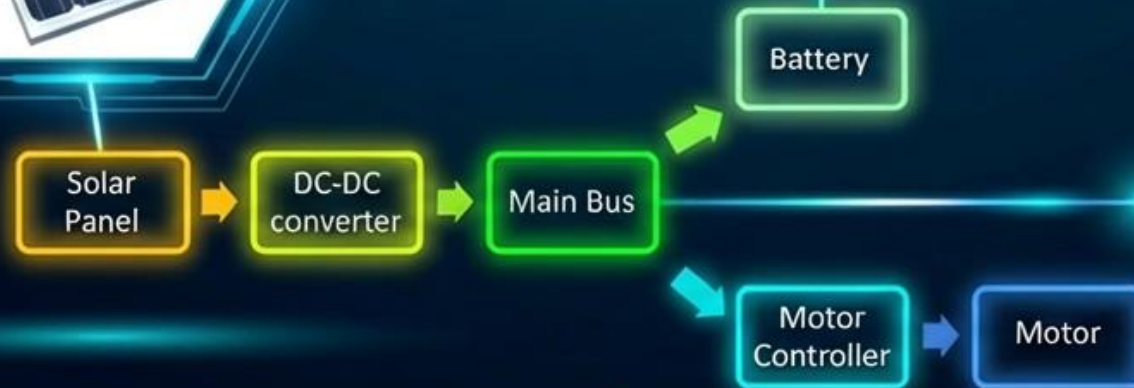
# TIMELINE



## Main Components

# Solar Car

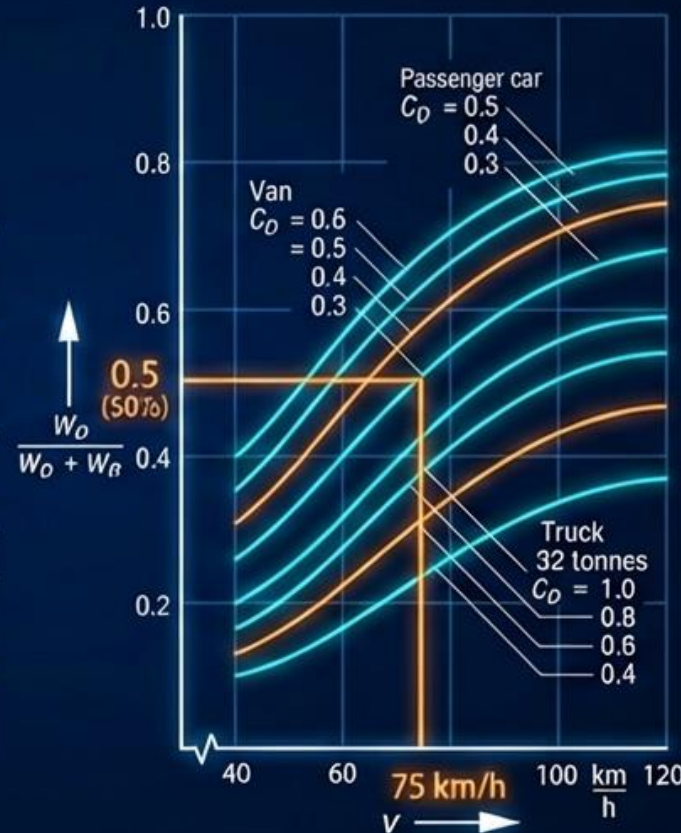
Using solar energy for on-board charging





# AERODYNAMICS

When speed reaches **75 km/h**,  
about **50%** of energy  
consumption is due to  
aerodynamic drag.

Percent aerodynamic drag to  
total power usage




# How to Reduce Drag

Shape	Drag Coefficient
Sphere → 	0.47
Half-sphere → 	0.42
Cone → 	0.50
Cube → 	1.05
Angled Cube → 	0.80
Long Cylinder → 	0.82
Short Cylinder → 	1.15
Streamlined Body → 	0.04
Streamlined Half-body → 	0.09

Measured Drag Coefficients



Frontal Projected Area



Car Class	Frontal area A m <sup>2</sup>
mini	1.8
medium size	1.9
upper medium size	2.0
full size	2.1

$A \approx 0.81 \cdot (b \cdot h)$

# Aerodynamic Development



Historical Pioneer: Rumber Tropfenwagen

## The Most Aerodynamic Cars

#1 Volkswagen XL1



Drag coefficient  
**0.19**

#2 Tesla Model 3



Drag coefficient  
**0.21**

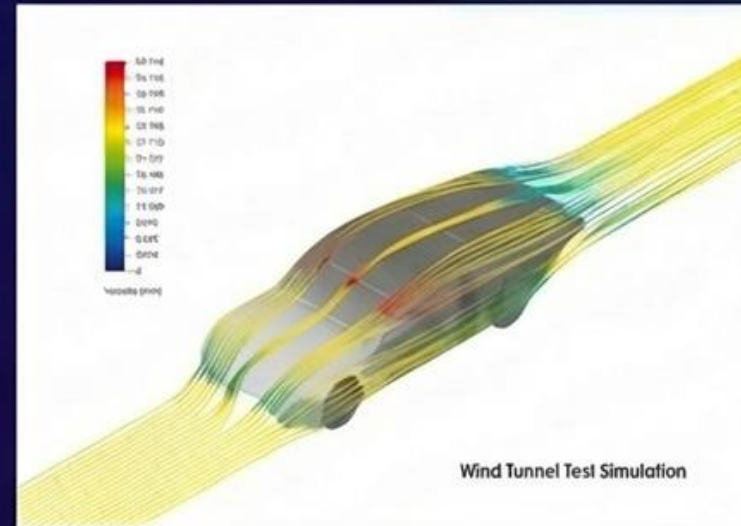
## Potential Difficulties

However, obtaining accurate Cd values is not easy...

- Cd Value: Drag Coefficient.
- Measures the drag on an object during fluid flow.
- Low Cd value indicates high aerodynamic efficiency.
- Used to optimize vehicle design, improving efficiency.

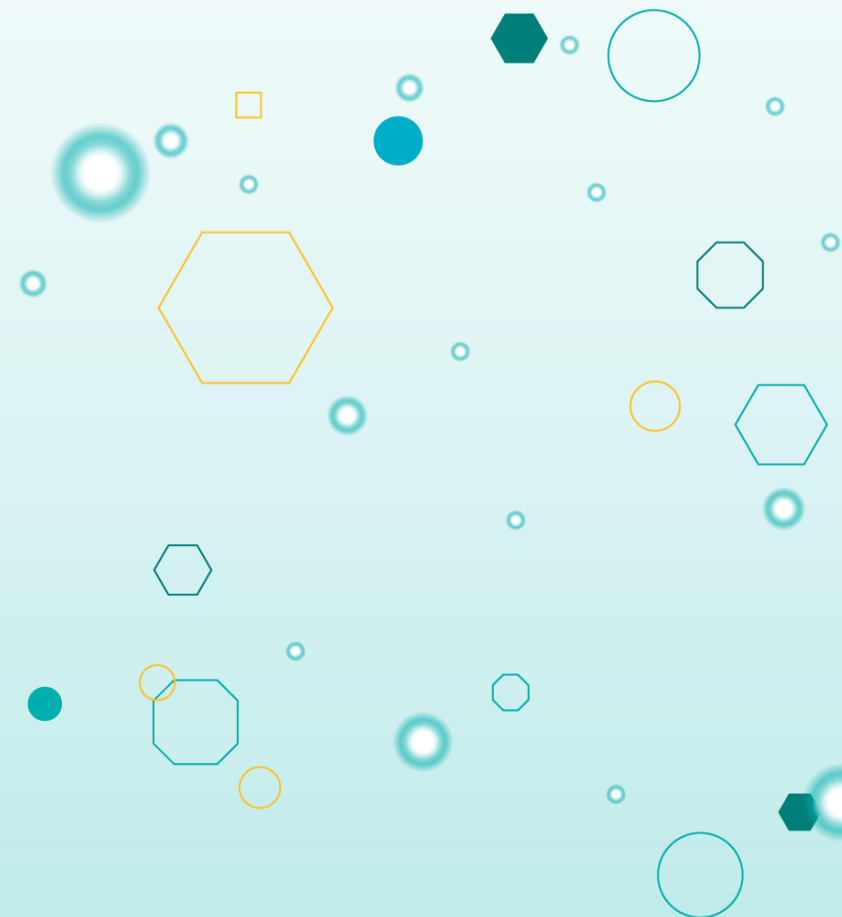


風洞測試  
(Wind Tunnel Test)



計算流體動力學  
(Computational Fluid Dynamics)

Break



## Main Parts

What to do before  
building a solar car?

- Car shell?
- Power system?
- Mechanical system?

### Important Parts

- 1 Bodyshell
- 2 Chassis and Rollbar
- 3 Wheels and tires
- 4 Braking system
- 5 Safety belts
- 6 Motor
- 7 Solar Panel
- 8 Battery pack
- 9 Lighting
- 10 Horn
- 11 Radio
- 12 Fire Extinguisher

Energy Application

**Input Power**

Solar Panel →  
Battery → Motor

**Output Power**

Rolling Resistance  
Air Resistance  
Acceleration



Driving force

Air Resistance



Rolling  
Resistance



Acceleration

# MECHANICS



a) Rolling Resistance



b) Air Resistance



c) Acceleration



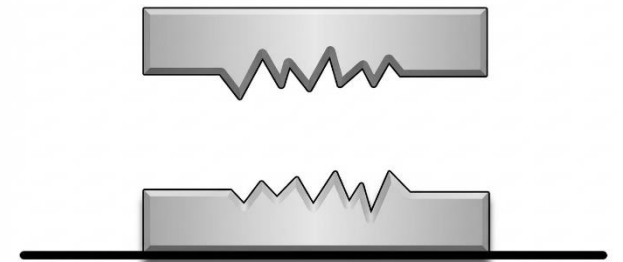
d) Climbing (Gradient)



## Rolling Resistance

Rolling resistance is the force needed when riding to overcome mechanical resistance from bicycle parts that are not part of the drivetrain.

These parts move as the bike is being ridden, including friction between the tires and the road. To lower rolling resistance, make sure your tires are not underinflated.



# 滾動阻力

$$F = \mu_{\text{rolling}} \times m \times g$$



**F** (Force)

Force used to cover rolling resistance when driving.  
Unit = N



**$\mu_{\text{rolling}}$**  (Coefficient)

Rolling coefficient of friction (dimensionless)



**m** (Mass)

Total mass of person and solar car.  
Unit = kg











**g** (Gravity)

Acceleration of gravity, directed downwards.  
10 N/kg



Solar Car Project Team & Vehicle

# 滾動阻力

Rolling Resistance Coefficient		
$c$	$c_1$ (mm)	
0.001 - 0.002	0.5	 railroad steel wheels on steel rails
0.001	0.1	 bicycle tire on wooden track
0.002 - 0.005	0.2	 low resistance tubeless tires
0.002	0.2	 bicycle tire on concrete
0.004	0.4	 bicycle tire on asphalt road
0.005	0.5	 dirty tram rails
0.006 - 0.01	0.1	 truck tire on asphalt
0.008	0.8	 bicycle tire on rough paved road
0.01 - 0.015		ordinary car tires on concrete, new asphalt, cobbles small new
0.02		 car tires on tar or asphalt
0.02		 car tires on gravel - rolled new
0.03		 car tires on cobbles - large worn
0.04 - 0.08		car tire on solid sand, gravel loose worn, soil medium hard
0.2 - 0.4		car tire on loose sand

# 空氣阻力 (Air Drag)

Any object moving through a fluid experiences **drag** – the net force in the direction of flow due to pressure and shear stress forces on the surface of the object.

$$F_d = c_d \frac{1}{2} \rho v^2 A$$

where:

$F_d$  = drag force (N)

$c_d$  = drag coefficient

$\rho$  = density of fluid (1.2 kg/m<sup>3</sup> for air at NTP)

$v$  = flow velocity (m/s)

$A$  = characteristic frontal area of the body (m<sup>2</sup>)

## Measured Drag Coefficients



Sphere  
0.47



Half-sphere  
0.42



Cone  
0.42



Cone  
0.50



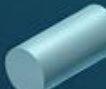
Cube  
1.05



Angled Cube  
0.80



Cube  
0.82



Long Cylinder  
0.82



Short Cylinder  
1.15



Short Cylinder  
1.15



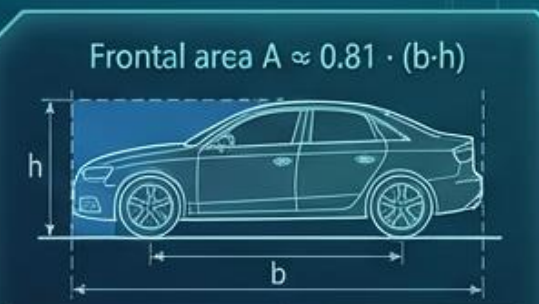
Streamlined Body  
0.04



Streamlined Half-body  
0.09

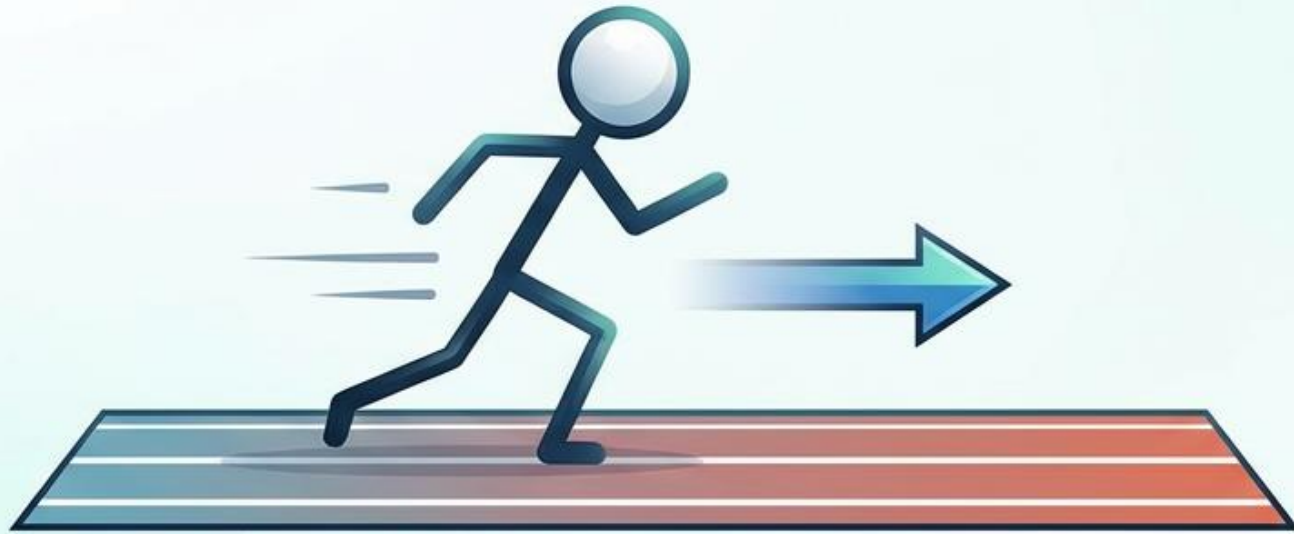


Frontal Projected Area



Car Class	Frontal area A m <sup>2</sup>
mini	1.8
medium	1.9
upper medium	2.0
full size	2.1

# 加速 (Acceleration)



$$\text{Force (accel)} = m \times a$$

Equation for average acceleration

$$a = \frac{\Delta v}{\Delta t}$$

- $m$  = mass
- $a$  = acceleration
- $\Delta v$  = velocity change
- $\Delta t$  = time change



**Acceleration**

$$Force (accel) = m \times a$$

$\Delta v = v_f - v_i$   
 $\Delta t = t_f - t_i$

$v_f$  → final velocity  
 $v_i$  → initial velocity  
 $t_f$  → ending time  
 $t_i$  → starting time

equation for average acceleration

Velocity = Car speed =  $\frac{distance}{time}$   
Unit normal in km/h



# Acceleration

$$Force (accel) = m \times a$$

Example:

$$\Delta v = v_f - v_i$$

$$\Delta t = t_f - t_i$$

$v_f$  → final velocity  
 $v_i$  → initial velocity  
 $t_f$  → ending time  
 $t_i$  → starting time



### EXAMPLE 1:

#### Positive Acceleration

Givens:

$$v_f = 46.1 \text{ m/s}$$

$$v_i = 18.5 \text{ m/s}$$

$$t_f = 2.47 \text{ s}$$

$$t_i = 0 \text{ s}$$

Formula & Substitution:

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

$$a = \frac{46.1 \text{ m/s} - 18.5 \text{ m/s}}{2.47 \text{ s} - 0 \text{ s}}$$

$$a = 11.17 \text{ m/s}^2$$

### EXAMPLE 2:

#### Negative Acceleration

Givens:

$$v_f = 0 \text{ m/s}$$

$$v_i = 22.4 \text{ m/s}$$

$$t_f = 2.55 \text{ s}$$

$$t_i = 0 \text{ s}$$

Formula & Substitution:

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

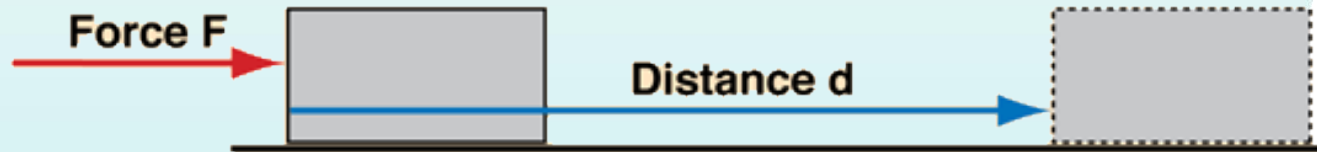
$$a = \frac{0 \text{ m/s} - 22.4 \text{ m/s}}{2.55 \text{ s} - 0 \text{ s}}$$

$$a = -8.78 \text{ m/s}^2$$



# Power consumption

$$Power = (Force(rolling) + Force(accel)) \times Velocity$$



**Work = Force x distance moved in direction of force**

Work  
concepts

$$P_{avg} = \frac{Work}{time} = \frac{Force \times distance}{time}$$

Special case for constant force acting in the direction of motion.

## Driving Speed

Find  $N$  (rpm of the wheel):

$$V = r \times \omega$$

$$V = \text{linear velocity} = \frac{\text{distance}}{\text{time}} = \frac{dS}{dt}$$

$\omega$  = angular velocity (rate of change of angular displacement)

Since our displacement/distance is the length of the arc which is made by the angle  $d\theta$ :  $s = r d\theta$

$$V = \frac{r d\theta}{dt}, \omega = \frac{d\theta}{dt}, r \text{ is the radius of wheel}$$

## Torque

Torque (Nm needed at the wheel)

$$P = T \times \omega$$

P= Power (W)

T= Torque from the wheel

$\omega$ =angular velocity (rate of change of angular displacement)



# Checking

$$P = (Force(rolling) + Force(accel)) \times Velocity$$

$$P = T \times \omega$$

$$\omega = \frac{V}{r}$$

$$P = T \times \frac{V}{r}$$

$$T = P \times \frac{r}{V}$$

Should be the same result with previous slide!

$$T = (Force(rolling) + Force(accel)) \times V \times \frac{r}{V}$$

Torque = (Force(rolling) + Force(accel)) x r (radius of the wheel)

## Energy needed

Motor Compliance for Solar Vehicle:

Power  
Torque  
Speed



## Key questions

- 1) What are the key factors for a solar vehicle?
- 2) Is your design optimized for speed or endurance?

# Questionnaire

Talk to us



新能源新世代2026 活動問卷  
NENG2026 Questionnaire



# Next Lessons topics

## Vehicle Powertrain ABC

- Links Between Mathematics and Engineering Design
- Driving Force, Friction and Inertia
- Four-Wheel Alignment and Measurement
- Wheel Speed and Acceleration

## Time to design the electrical system for your car

### Rideable Solar Car Electrical System Outline

