Perkembangan Teknologi Otomotif

Pencapaian performa yang efisien & ramah lingkungan
Perkembangan Teknologi Otomotif

1. Engine
2. Drive train
3. Chassis
4. Electrical
5. Safety Technology
6. Body

Kendaraan ringan
Garis Besar Perkembangan Mesin

1. Reducing CO₂
2. Making emissions cleaner
3. Adapting to diverse energy sources

Ultimate Eco-Car

- Alternative fuel HV
- Diesel HV
- THS II
- FCHV
- EV

- Biofuels
- Synthetic fuels
- DPNR
- Lean burn
- VVT-i

The right vehicle for the right place at the right time

- Alternative fuel engines
- Diesel engines
- Gasoline engines
- Electrical energy
<table>
<thead>
<tr>
<th>Mekanisme Katup</th>
<th>Sistem Bahan-bakar</th>
<th>Sistem Pengapian</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHV (Over Head Valve)</td>
<td>Karburator</td>
<td>Konvensional (Platina)</td>
</tr>
<tr>
<td>SOHC (Single Over Head Camshaft)</td>
<td>EFI - Analog</td>
<td>Transistorized / CDI</td>
</tr>
<tr>
<td>DOHC (Double Over Head Camshaft)</td>
<td>EFI - Microcomputer</td>
<td>IIA (Integrated Ignition Assembly)</td>
</tr>
<tr>
<td>VVT-I (Variable Valve Timing Intelligent)</td>
<td>Lean Burn Engine</td>
<td>ESA (Electronic Spark Advance)</td>
</tr>
<tr>
<td>VVTL-I (Variable Valve Timing &amp; Lift Intelligent)</td>
<td>D4 (Direct Injection Gasoline)</td>
<td>DIS (Direct Ignition System)</td>
</tr>
<tr>
<td>Teknologi Mesin</td>
<td>Sistem Pengisian</td>
<td>Sistem Starter</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>W/ Regulator tipe Kontak Point</td>
<td>Konvensional</td>
<td>Pompa injeksi In Line</td>
</tr>
<tr>
<td>W/ IC Regulator</td>
<td>Tipe Reduksi</td>
<td>Pompa injeksi Distributor</td>
</tr>
<tr>
<td>Alternator w/ Conductor segment</td>
<td>Tipe Planetari</td>
<td>EFI Diesel (ECD)</td>
</tr>
<tr>
<td></td>
<td>Tipe Planetari w/ Segment Conductor</td>
<td>Common Rail</td>
</tr>
</tbody>
</table>
TOYOTA Hybrid Technology
Background
Global Concern on Energy Savings

Expanding energy consumptions

Fuel price continue increase

>US$ 122.17/barrel (Feb, ’12)*

Source: Agency for Natural Resources and Energy (Japan)

* ESDM
Background

Global warming caused by CO2

Global CO2 emissions from fuel combustion

World CO2 emissions arising from fuel combustion, by sector - 2000

- Residential use: 5.8%
- Others (Commerce, etc.): 8.0%
- Transport: 24.0% (Road 17.7%)
- Energy production: 43.6%
- Manufacturing Industries and Construction: 18.5%

IEA CO2 EMISSIONS FROM FUEL COMBUSTION (2002 edition)
Customer basic needs on car is fun to drive and driving performance.

Focus on: **Fuel efficiency, low emissions**, while keep **driving performance**.
Improving Fuel Efficiency to Reduce CO2 Emissions
TOYOTA Milestone

1. Reducing CO₂
2. Making emissions cleaner
3. Adapting to diverse energy sources

Ultimate Eco-Car

- Alternative fuel HV
- Diesel HV
- THS II
- FCHV
- EV
- Plug-in HV
- D-4
- Lean burn
- VVT-i
- Common rail DI
- DPNR

The right vehicle for the right place at the right time

- Alternative fuel engines
- Diesel engines
- Gasoline engines
- Electrical energy
Apa itu Sistem Hybrid?

Gabungan antara dua sumber tenaga

HYBRID

Electric motor
± 50

Engine
± 50

= 100

CONVENTIONAL

Engine
100

= 100
**Series Hybrid**

Motor bensin memutarkan generator untuk mensuplai listrik ke motor listrik penggerak roda

Contoh:
Chevrolet Volt
Paralel Hybrid

Motor bensin sebagai penggerak roda utama, motor listrik hanya membantu akselerasi.

Contoh:
Honda Insight, MB S400 BlueHybrid, BMW Seri 7 Hybrid
**Series & Paralel Hybrid**

“Power split device” secara konstan mengatur rasio tenaga motor bensin / listrik ke roda. Dapat menggerakkan kendaraan hanya dengan motor listrik saja.
**Plug-in Hybrid**

Baterai dengan kapasitas lebih besar (biasanya Lithium) dapat di charge dengan listrik “rumah” untuk memperbanyak penggunaan motor listrik dan mengurangi penggunaan motor bensin.

%CO2 emission of Prius is 104 g/km ≈ 55% less than others in the same class

%NOx emissions of Prius is 0.010 g/km and HC of Prius is 0.020 g/km ≈ less than half of others car in the same class
Prius Fuel Consumption

35.5 km/l
Japan 10 – 15 Mode

City drive : 23.2 km/l
Highway : 21.3 km/l
According to EPA test USA
Sejarah TOYOTA *Hybrid*

**1997**
- Prius (NHW10)
- Crown

**1999**
- Export to USA
- Estima (NHW20)

**2001**
- Prius (NHW20)
- Alphard

**2003**
- RX400h
- Highlander

**2004**
- GS450h

**2006**
- Camry
Sejarah TOYOTA Hybrid

2007

LS600h

2009

Prius (ZVW30)
Toyota Hybrid Sales

(Units = 10,000)

'97  '98  '99  '00  '01  '02  '03  '04  '05  '06  '07  '08

1st generation Prius

2nd generation Prius

RX400h

GS450h

LS600h

Highlander Hybrid

Camry Hybrid

Breakdown of hybrid market (to end of 2006)

20.0%

80.0%

Toyoda hybrid vehicles (inc. Lexus)

Other hybrids vehicles (reference)

Over 1.7 million vehicles!

Less than 0.4 million vehicles

Note: Available vehicles differ depending on region.

: Toyota hybrid vehicles (inc. Lexus)

: Prius only

: Other hybrid vehicles (Reference)
Fusion between an internal combustion engine and electric motor, achieving different function through different power combinations to create optimum synergy and output.
THS Main Components

- Engine
- Inverter/Converter

High Voltage Cables: Orange Color
THS Main Components

- Power-dividing Mechanism (Planetary Gears)
  - MG1 – Sun Gear
  - MG2 – Ring Gear \(\rightarrow\) Wheels
  - Engine – Planetary Carrier
THS Main Components

Hybrid Transaxle
THS Main Components

Blue: Engine
Yellow: MG1
Orange: MG2
THS Main Components

- Power-dividing Mechanism (Planetary Gears)

Planetary Carrier: fixed
Ring Gear: rotates (input)

Ring Gear: fixed
Planetary Carrier: rotates (input)
• Power-dividing Mechanism (Planetary Gears)

Planetary Carrier: fixed
Ring Gear: rotates (input) cnt : mundur mesin diam
Hybrid Transaxle

- Planetary Gears
- Chain-drive Sprocket
- MG2
- MG1
THS Main Components

Hybrid Transaxle

- Chain-driven Sprocket
- Differential Mechanism
- Counter Drive Gear
- Counter-driven Gear
- Final Drive Pinion Gear
- Final Ring Gear
- Reduction Mechanism
THS Main Components

Hybrid Transaxle

• MG1 / MG2
  
  – Compact and lightweight, highly efficient AC 650 V motor generator
Hybrid Transaxle

- MG1
  - Main operations → Generator
  - When engine starting → Starter

Stator Coil

Rotor

Speed Sensor
• MG2
  - When driving → Main power to engine power (Starting off) or provides supplementary
  - When braking → Converts kinetic energy to electrical energy

[Image showing components: Stator Coil, Rotor, Speed Sensor, MG2]
THS Main Components

1NZ-FXE Engine with Atkinson Cycle
(Same engine basis with Yaris & Vios)
Atkinson Cycle:
Compression < Expansion

Depending on driving condition, cylinder volume is varied by VVT-i operation
Engine

- Atkinson Cycle
  - Depending on the driving condition, the cylinder volume is varied by VVT-i
Engine

- Atkinson Cycle
  - Intake valve close timing is late

Valve Timing (Intake Valve)

Cylinder Volume

105°
Engine
  • Atkinson Cycle
    – Intake valve close timing is early
Inverter Assembly

- Components
  - Inverter
    • DC ↔ AC high voltage
  - Variable-voltage System
    • DC201.6V stepped up to max. DC500V
  - DC-DC Converter
    • DC201.6V stepped down to DC 12V
  - A/C Inverter
    • DC → AC to drives the A/C compressor
Inverter Assembly

- HV Battery
- Variable-voltage System
- Inverter
- A/C Inverter
- DC - DC Converter
- MG1
- MG2
Inverter Assembly

Max. DC 650V
↑↓
DC 201.6V

Variable-voltage System
- IPM (IGBT)
- Reactor

HV Battery

Inverter Assembly

DC 201.6V

DC500V

Inverter (IPM)

MG1

AC500V

MG2

: Discharge

: Charge
- Cooling circuit is used for inverter assembly
- Separate cooling system from engine
Batteray

- HV Battery
- 12V Battery
The Battery has been made from Nickel-Metal Hydride (201.6V)

'04 PRIUS: 168 cell ((1.2V x 6 cells) x 28 modules) = DC 201.6 V
HV Batteray

- Module
- Battery ECU
- SMR1
- SMR2
- SMR3
- Resister
- Current Sensor
- Service Plug Connector
THS Main Components

- Battery ECU
  - Maintains control of HV battery SOC (State of charge)
  - Ensures battery capability
• **Battery ECU**
  - Controls SOC to match THS characteristics
  - The SOC is maintained at approx. 60%. A margin is given for further recharging via regenerative braking
  - Sends requests to HV ECU to obtain desired SOC
THS Main Components

- SOC Control
  - When the SOC is dropped, battery ECU sends the “Charge Request” signal to HV ECU

```
Battery ECU
   + SOC

HV ECU
   + Charge Request
   + Power Request

Engine ECU

HV Battery
   + Charge

MG1

Engine
   + Drive
```
Information Display (New/3rd Gen Prius)
THS Main Components

Information Display (2nd Gen Prius)
THS Main Components
<table>
<thead>
<tr>
<th>Item</th>
<th>Prius</th>
<th>Corolla Altis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>2ZR-FXE 1.8L 16V DOHC VVT-I</td>
<td>1ZZ-FE 1.8L 16V DOHC VVT-I</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>13.0 : 1</td>
<td>10 : 1</td>
</tr>
<tr>
<td>Max Output PS/rpm</td>
<td>99/5,200</td>
<td>143/6,000</td>
</tr>
<tr>
<td>Maximum Torque kgm/rpm</td>
<td>14.2/4,000</td>
<td>19.1/4,200</td>
</tr>
<tr>
<td>Motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Synchronous AC motor (650 V)</td>
<td></td>
</tr>
<tr>
<td>Maximum output in PS</td>
<td>81.6</td>
<td></td>
</tr>
<tr>
<td>Maximum torque Nm</td>
<td>207 (546 setelah di reduksi)</td>
<td></td>
</tr>
<tr>
<td>Total System</td>
<td>Maximum output in PS</td>
<td>136</td>
</tr>
<tr>
<td>Battery</td>
<td>Type</td>
<td>Nickel-metal hydride</td>
</tr>
</tbody>
</table>
THS: How it Works

- Motor/Generator
- Battery
- Gasoline Engine
- PCU/Inverter
- Power-split Device
- Motor/Generator
1. Start and low to mid-range speeds

The engine stops when in an inefficient range, such as at start-up and in low to mid-range speeds. The vehicle runs on the motor alone.

Click, movie
2. Driving under normal conditions

Engine power is divided by the power split device. Some of the power turns the generator, which in turn drives the motor. The rest of the power drives the wheels directly. Power allocation is controlled to maximize efficiency.
3. Sudden acceleration

Extra power is supplied from the battery, while the engine and high-output motor provide smooth response for improved acceleration characteristics.
4. Deceleration, braking

The high-output motor acts as a high-output generator, driven by the vehicle’s wheels. This regenerative braking system recovers kinetic energy as electrical energy, which is stored in the high-performance battery.

Click, movie
5. Battery recharging

Battery level is managed to maintain sufficient reserves. The engine drives the generator to recharge the battery when necessary.

Click, movie
THS System Operation

Start-off: Electric motor only
Normal Driving: Motor and Engine
Acceleration: Motor and Engine (additional power drawn from battery)
Deceleration: Battery charging
Stop: Engine automatically shuts off
- Brake System
  - ECB (Electrically Controlled Brake)
  - Hydraulic brake pressure is controlled by electrical signal and cooperate regenerative brake
Brake System
- The total brake force provided by both hydraulic and regenerative brakes matches the braking power required.
THANK YOU