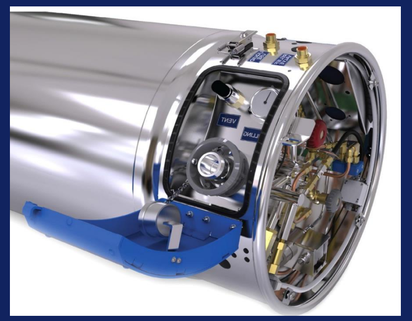
SMTR
GROUP

LNG - CNG - H2
Projesi

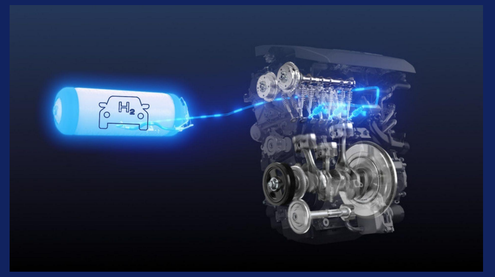
Proje Fazları



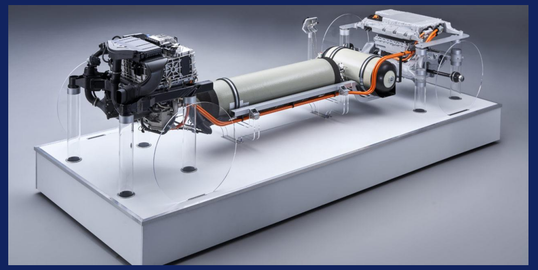
LNG

CNG

H2



H2 – IC



H2 – Fuel Cell

Doğal Gaz Öne Çıkan Özellikleri

Orta-Ağır Yüklü Taşıtlarda Araç Başına 200.000$ Tasarruf

Yakıt Maliyetinde %86 Azalış

%30 Daha Düşük CO2 Emisyonu

%100 Daha Az Metal Parça Emisyonu

5 yıllık Pazar İhtiyacı 63.250 Milyar USD

Türkiye'nin Yerli Doğal Gaz Rezervleri Üzerinde Olması

US DOE Alternative Fuel Prices Report - Ekim 2021

- Benzin Fiyatı = $ 3.25/gallon = $ 3.25/GGE
- Dizel Fiyatı = $ 3.48/gallon = $ 3.48/DGE
- CNG = $ 2.33/GGE
- LNG = $ 2.75/DGE
  - **1 DGE = 6.06 lbs LNG = 2.75 kg LNG**
  - **1 GGE = 5.66 lbs CNG = 2.56 kg CNG**

National Average Retail Fuel Prices on an Energy-Equivalent Basis, October 2021 *			
	Per Gasoline Gallon Equivalent ($/GGE)	Per Diesel Gallon Equivalent ($/DGE)	Per Million British Thermal Units ($/MBtu)
Gasoline	$3.25	$3.68	$28.43
Diesel	$3.10	$3.48	$27.04
CNG	$2.33	$2.63	**$20.38**
LNG	$2.45	$2.75	**$21.37**
Ethanol (E85)	$3.55	$4.01	$40.53
Propane**	$4.34	$4.88	$51.98
Biodiesel (B20)	$2.96	$3.35	$23.42
Biodiesel (B99/B100)	$3.73	$4.19	$31.85

*Includes public and private stations
**Includes primary and secondary stations

Hydrogen is still developing so very expensive $16.55/GGE.

US DOE Alternative Fuel Prices Report - Ekim 2021

Aynı miktar enerji eldesi için (Million Btu = 1055 Million Joule)

- Benzin = $28.43
- Dizel = $27.04
  - **CNG = $20.38**
  - **LNG = $21.37**

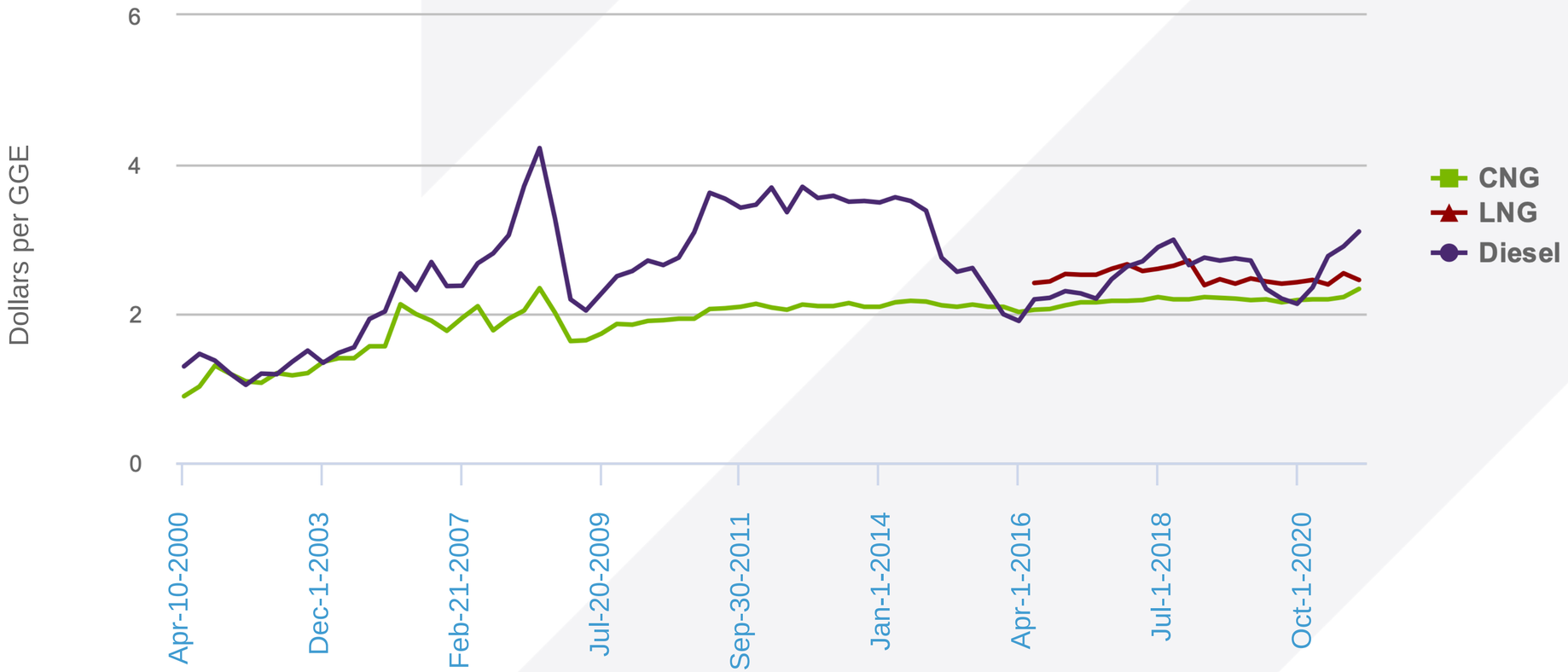
National Average Retail Fuel Prices on an Energy-Equivalent Basis, October 2021 *			
	Per Gasoline Gallon Equivalent ($/GGE)	Per Diesel Gallon Equivalent ($/DGE)	Per Million British Thermal Units ($/MBtu)
Gasoline	$3.25	$3.68	$28.43
Diesel	$3.10	$3.48	$27.04
CNG	$2.33	$2.63	**$20.38**
LNG	$2.45	$2.75	**$21.37**
Ethanol (E85)	$3.55	$4.01	$40.53
Propane**	$4.34	$4.88	$51.98
Biodiesel (B20)	$2.96	$3.35	$23.42
Biodiesel (B99/B100)	$3.73	$4.19	$31.85

*Includes public and private stations
**Includes primary and secondary stations

Hydrogen is still developing so very expensive $16.55/GGE.

AFDC Prices

Average Retail Fuel Prices in the United States



Last updated: December 2021

US DOE Alternative Fuel Prices Report - Ekim 2021

Gasoline = $ 3.25/gallon = $ 0.86/lt

Diesel = $ 3.48/gallon = $ 0.92/lt

CNG = $ 2.33/GGE = $ 0.15/lt

LNG = $ 2.75/DGE = $ 0.43/lt

Türkiye (Ekim 2021)

- **Benzin = 8 TL/lt = 30.24 TL/GGE**
- **Dizel = 8.2 TL/lt = 30.99 TL/DGE**
- **CNG = 10.44 TL/GGE**
- **LNG = 14.5 TL/DGE**

CNG – LNG fiyatları EKİM 2021 BOTAŞ raporundan alınmıştır.

Alternative Fuels Data Center - Yakıt Özellikleri Karşılaştırması

	Gasoline/E10	Low Sulfur Diesel	Electricity	Biodiesel	Ethanol/E100	Compressed Natural Gas (CNG)	Liquefied Natural Gas (LNG)	Propane (LPG)	Hydrogen	Methanol
Chemical Structure [1]	C4 to C12 and Ethanol ≤ to 10%	C8 to C25	N/A	Methyl esters of C12 to C22 fatty acids	CH3CH2OH	CH4 (majority), C2H6 and inert gases	CH4 same as CNG with inert gasses <0.5% (a)	C3H8 (majority) and C4H10 (minority)	H2	CH3OH
Fuel Material (feedstocks)	Crude Oil	Crude Oil	Natural gas, coal, nuclear, wind, hydro, solar, and small percentages of geothermal and biomass	Fats and oils from sources such as soybeans, waste cooking oil, animal fats, and rapeseed	Corn, grains, or agricultural waste (cellulose)	Underground reserves and renewable biogas	Underground reserves and renewable biogas	A by-product of petroleum refining or natural gas processing	Natural gas, methanol, and electrolysis of water	Natural gas, coal, or woody biomass
Gasoline or Diesel Gallon Equivalent (GGE or DGE)	1 gal = 1.00 GGE 1 gal = 0.88 DGE	1 gal = 1.12 GGE 1 gal = 1.00 DGE	1 kWh = 0.030 GGE 1 kWh = 0.027 DGE	*B100* 1 gal = 1.05 GGE 1 gal = 0.93 DGE *B20* 1 gal = 1.11 GGE 1 gal = 0.99 DGE	1 gal = 0.67 GGE 1 gal = 0.59 DGE	1 lb. = 0.18 GGE 1 lb. = 0.16 DGE	1 lb. = 0.19 GGE 1 lb. = 0.17 DGE	1 gal = 0.74 GGE 1 gal = 0.66 DGE	1 lb. = 0.45 GGE 1 lb. = 0.40 DGE 1 kg = 1 GGE 1 kg = 0.9 DGE	1 gal = 0.50 GGE 1 gal = 0.45 DGE
Energy Comparison [2]	1 gallon of gasoline has 97%–100% of the energy in 1 GGE. Standard fuel is 90% gasoline, 10% ethanol.	**1 gallon of diesel has 113% of the energy in 1 GGE due to the higher energy density of diesel fuel.**	A typical battery that is the same size as a gallon of gas (0.134 ft3), when used for transportation, can store 15.3% of the energy in 1 GGE. [6][7]	1 gallon of B100 has 93% of the energy in 1 DGE, and 1 gallon of B20 has 99% of the energy in 1 DGE due to a lower energy density in biodiesel.	1 gallon of E85 contains 73%–83% of the energy in 1 GGE. 1 gallon of E100 has 67% of the energy in 1 GGE. Ethanol is blended with blendstock for oxygenate blending (gasoline component). [5]	5.66 lb., or 123.57 ft3, of CNG has the same energy as 1 GGE, and 6.37 lb., or 139.30 ft3, of CNG has the same energy as 1 DGE. [3][4](b)	**5.37 lb. of LNG has the same energy as 1 GGE, and 6.06 lb. of LNG has the same energy as 1 DGE. (a)**	1 gallon of propane has 73% of the energy in 1 GGE due to the lower energy density of propane.	**2.2 lbs. (1 kg) of H2 has the same energy as 1 GGE.**	**1 gallon of methanol contains 50% of the energy as 1 GGE.**
Energy Content (lower heating value)	112,114–116,090 Btu/gal (c)	128,488 Btu/gal (c)	3,414 Btu/kWh	*B100* 119,550 Btu/gal *B20* 126,700 Btu/gal (c)	76,330 Btu/gal for E100 (c)	**20,160 Btu/lb** [3](b)	**21,240 Btu/lb (a)**	84,250 Btu/gal (c)	**51,585 Btu/lb (c)** **33.3 kWh/kg**	**57,250 Btu/gal (c)**
Energy Content (higher heating value)	120,388–124,340 Btu/gal (c)	138,490 Btu/gal (c)	3,414 Btu/kWh	127,960 Btu/gal for B100 (c)	84,530 Btu/gal for E100 (c)	22,453 Btu/lb [1](c)	23,726 Btu/lb (c)	91,420 Btu/gal (c)	61,013 Btu/lb (c)	65,200 Btu/gal (c)

Alternative Fuels Data Center - Yakıt Özellikleri Karşılaştırması

	Gasoline/E10	Low Sulfur Diesel	Biodiesel	Ethanol/E100	Compressed Natural Gas (CNG)	Liquefied Natural Gas (LNG)	Propane (LPG)	Hydrogen	Methanol	Electricity
Physical State	Liquid	Liquid	Liquid	Liquid	Compressed gas (lighter than air)	Cryogenic liquid (lighter than air as a gas)	Pressurized liquid (heavier than air as a gas)	Compressed gas (lighter than air) or liquid	Liquid	Electricity
Cetane Number	N/A	40–55 (d)	48–65 (d)	0–54 (e)	N/A	N/A	N/A	N/A	N/A	N/A
Pump Octane Number	84–93 (f)	N/A	N/A	110 (i)	120+ (h)	120+ (h)	105 (g)	130+ (g)	112 (i)	N/A
Flash Point	-45°F (j)	165°F (j)	212° to 338°F (d)	55°F (j)	-300°F (j)	-306°F (k)	-100° to -150°F (j)	N/A	54°F (j)	N/A
Autoignition Temperature	495°F (j)	~600°F (j)	~300°F (d)	793°F (j)	1,004°F (j)	1,004°F (k)	850° to 950°F (j)	1,050° to 1,080°F (j)	897°F (j)	N/A
Maintenance Issues			Lubricity is improved over that of conventional low sulfur diesel fuel. For more maintenance information, see the Biodiesel Handling and Use Guidelines-Fifth Edition. (d)	Special lubricants may be required. Practices are very similar, if not identical, to those for conventionally fueled operations.	High-pressure tanks require periodic inspection and certification.	LNG is stored in cryogenic tanks with a specific hold time before the pressure build is relieved. The vehicle should be operated on a schedule to maintain a lower pressure in the tank.		When hydrogen is used in fuel cell applications, maintenance should be very minimal. High-pressure tanks require periodic inspection and certification.	Special lubricants must be used as directed by the supplier as well as M85-compatible replacement parts. Can cause serious damage to organs in the body if a person swallows it, breathes it in, or gets it on their skin.	
Energy Security Impacts	Manufactured using oil. Transportation accounts for approximately 30% of total U.S. energy needs and 70% of petroleum consumption. (l)	Manufactured using oil. Transportation accounts for approximately 30% of total U.S. energy needs and 70% of petroleum consumption. (l)	Biodiesel is domestically produced, renewable, and reduces petroleum use 95% throughout its lifecycle. (m)	Ethanol is produced domestically. E85 reduces lifecycle petroleum use by 70%, and E10 reduces petroleum use by 6.3%. (n)	CNG is domestically produced from natural gas and renewable biogas. The United States has vast natural gas reserves.	LNG is domestically produced from natural gas and renewable biogas. The United States has vast natural gas reserves.	Approximately half of U.S. LPG is derived from oil, but no oil is imported specifically for LPG production.	Hydrogen is produced domestically and can be produced from renewable sources.	Methanol is domestically produced, sometimes from renewable resources.	Electricity is produced domestically from a wide range of sources, including through coal-fired power plants and renewable sources, making it a versatile fuel.

CNG ve LNG’nin Kalorifik Değerleri Daha Yüksek

Enerji İçerikleri (lower heating value)

Benzin = 112.114 Btu/gal = 17.975 Btu/lbs

Dizel = 128.488 Btu/gal = 18.177 Btu/lbs

CNG = 20.160 Btu/lbs

LNG = 21.240 Btu/lbs

H2 = 51.585 Btu/lbs

Yüksek kalorifik değeri sayesinde LNG-CNG yakıtlarından dizel-benzine kıyasla daha çok enerji elde edilebiliyor.

Auto-Ignition Sıcaklıkları ve Oktan Değerleri

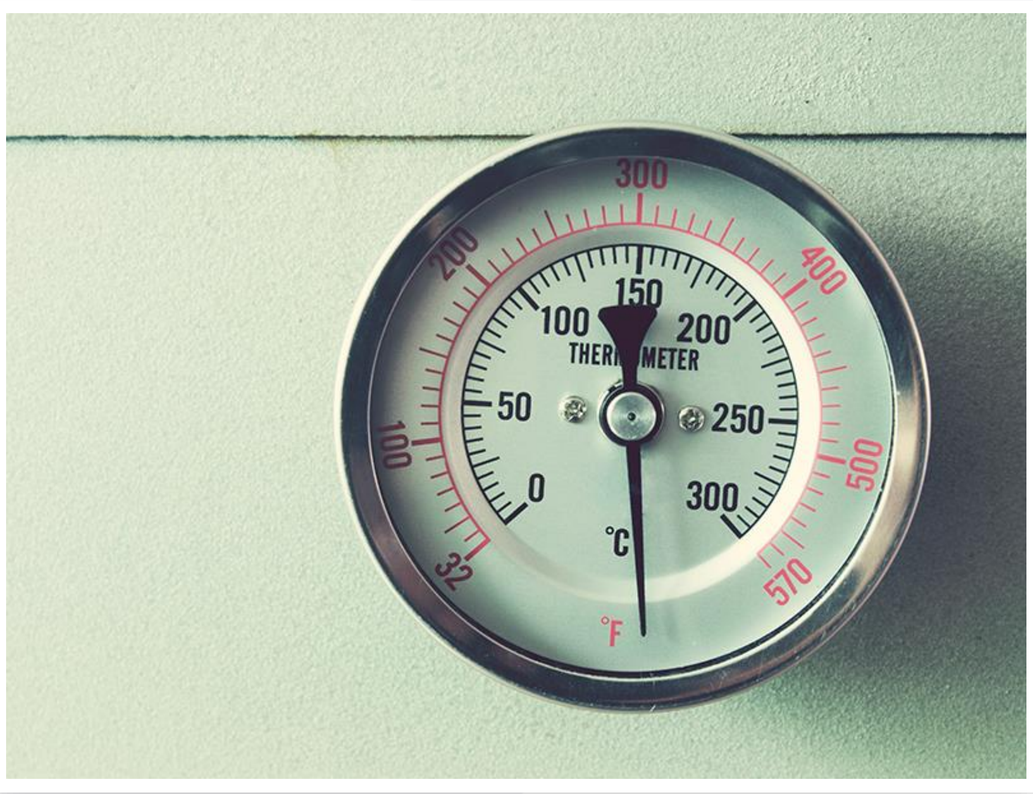
Natural Gas = 580 C, 120+ Oktan

Gasoline = 260 C, 95+ Oktan

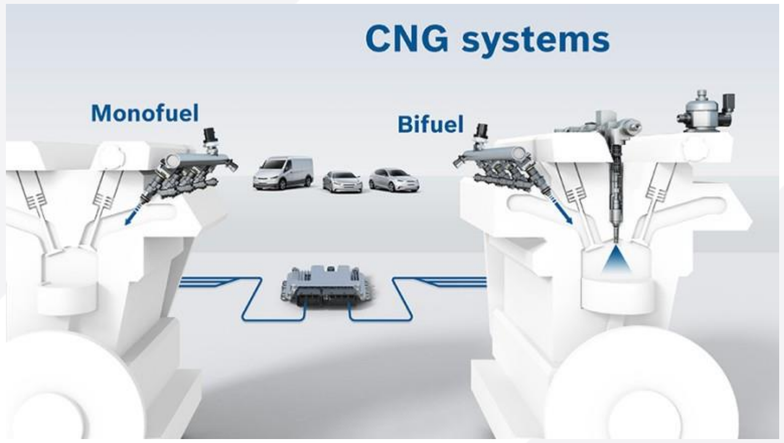
Diesel = 210 C

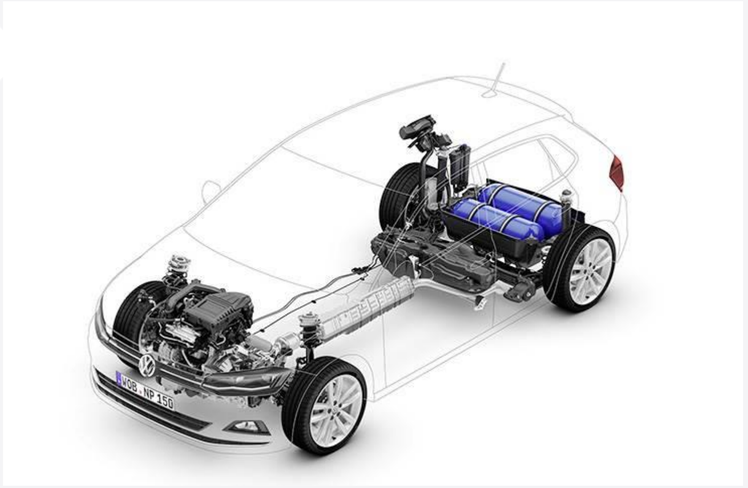
Hidrojen = 585 C, 130+ Oktan

Yüksek tutuşma (auto-ignition) sıcaklıkları ve yüksek oktan değerleri sayesinde; motor içerisinde yüksek sıkışma oranları ve yanma sıcaklıkları elde ediliyor. Bu durum sonucunda motor verimi yükseliyor.



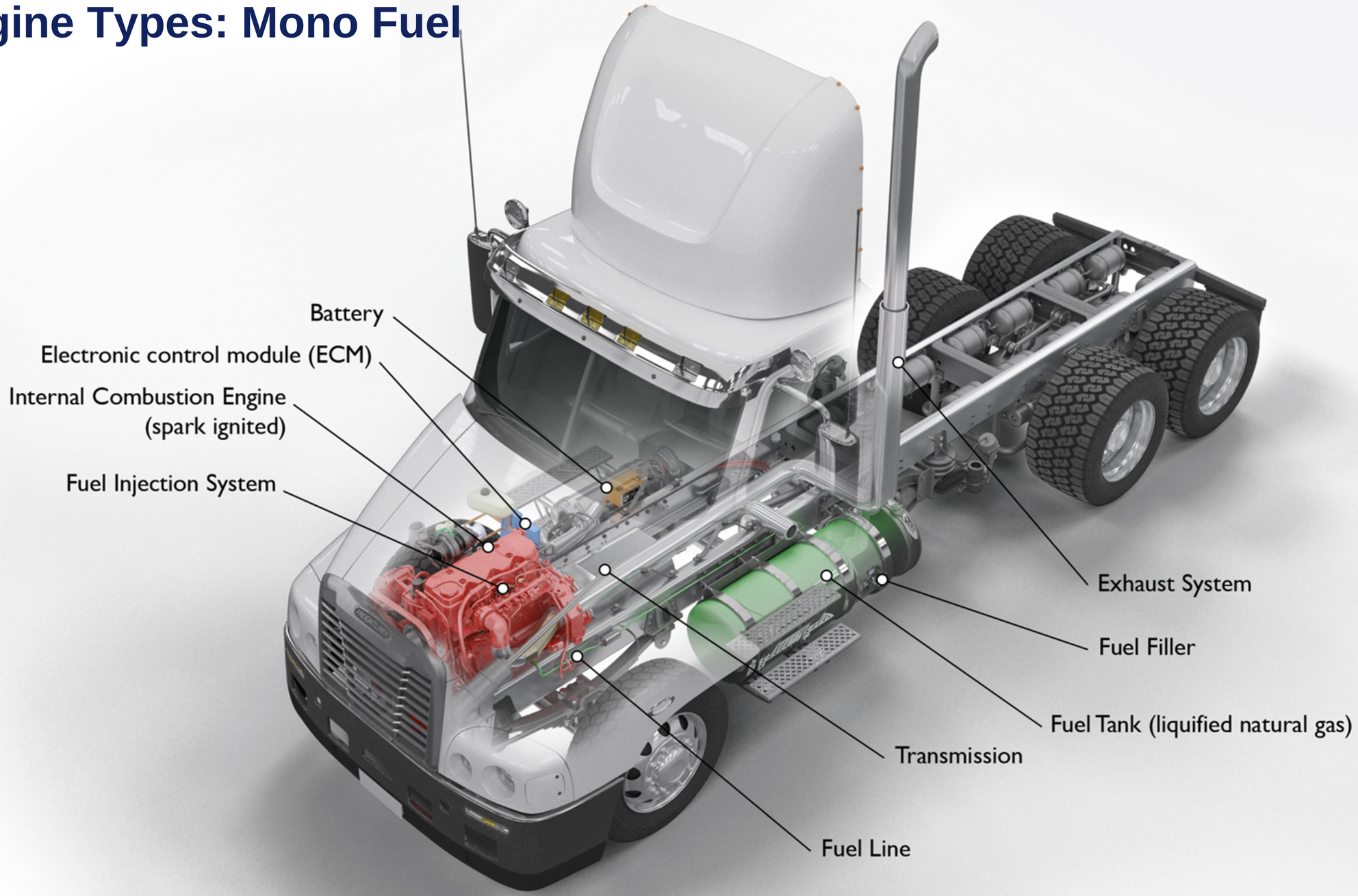
Engine Types



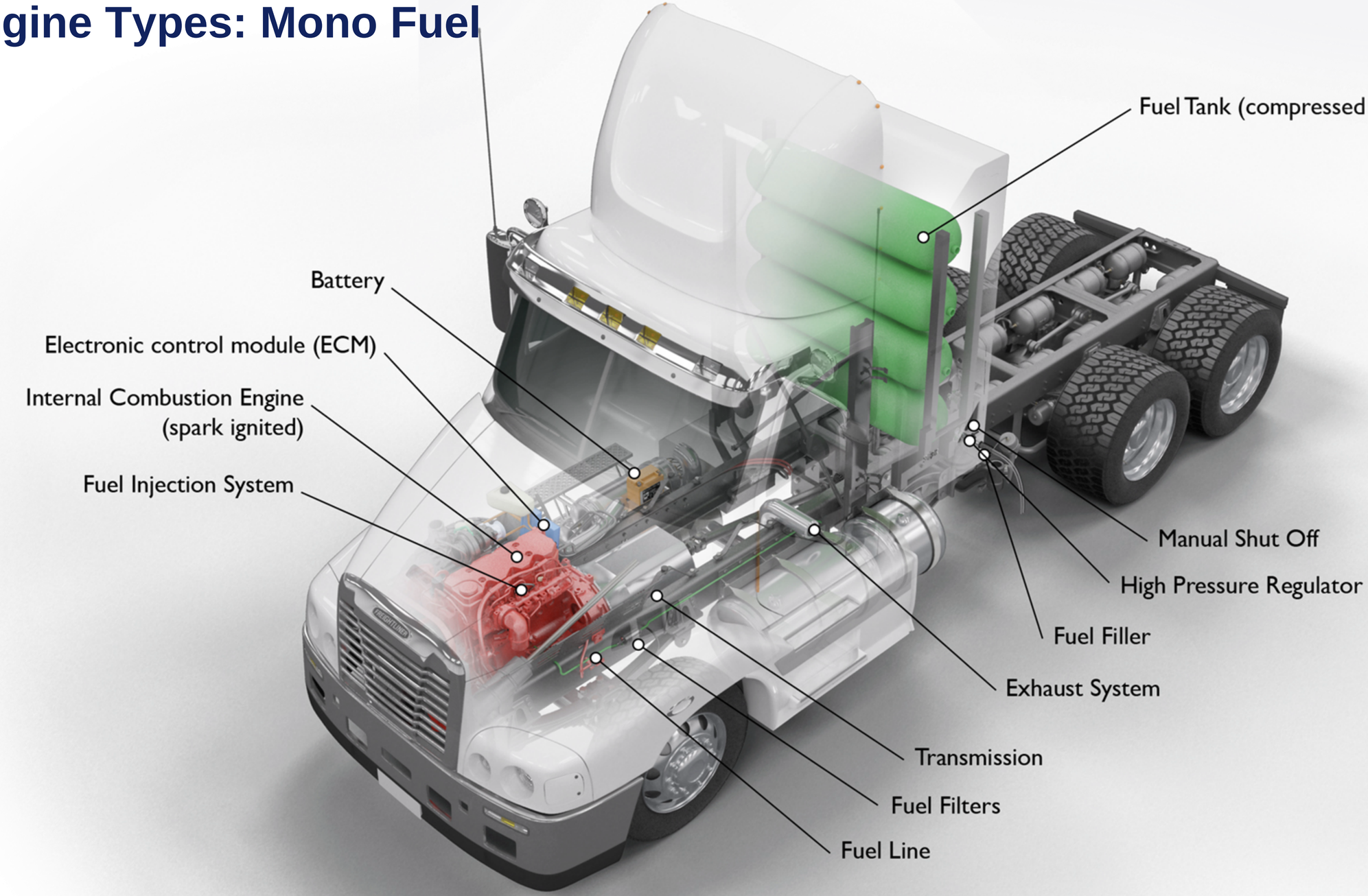


LNG-CNG uyumlu binek araç, ağır yüklü tır, kamyon vb. üretimi; hem OEM'ler tarafından yapılmakta hem de 'after-market' dönüşümleri tüm araçlara uygulanabilmektedir.

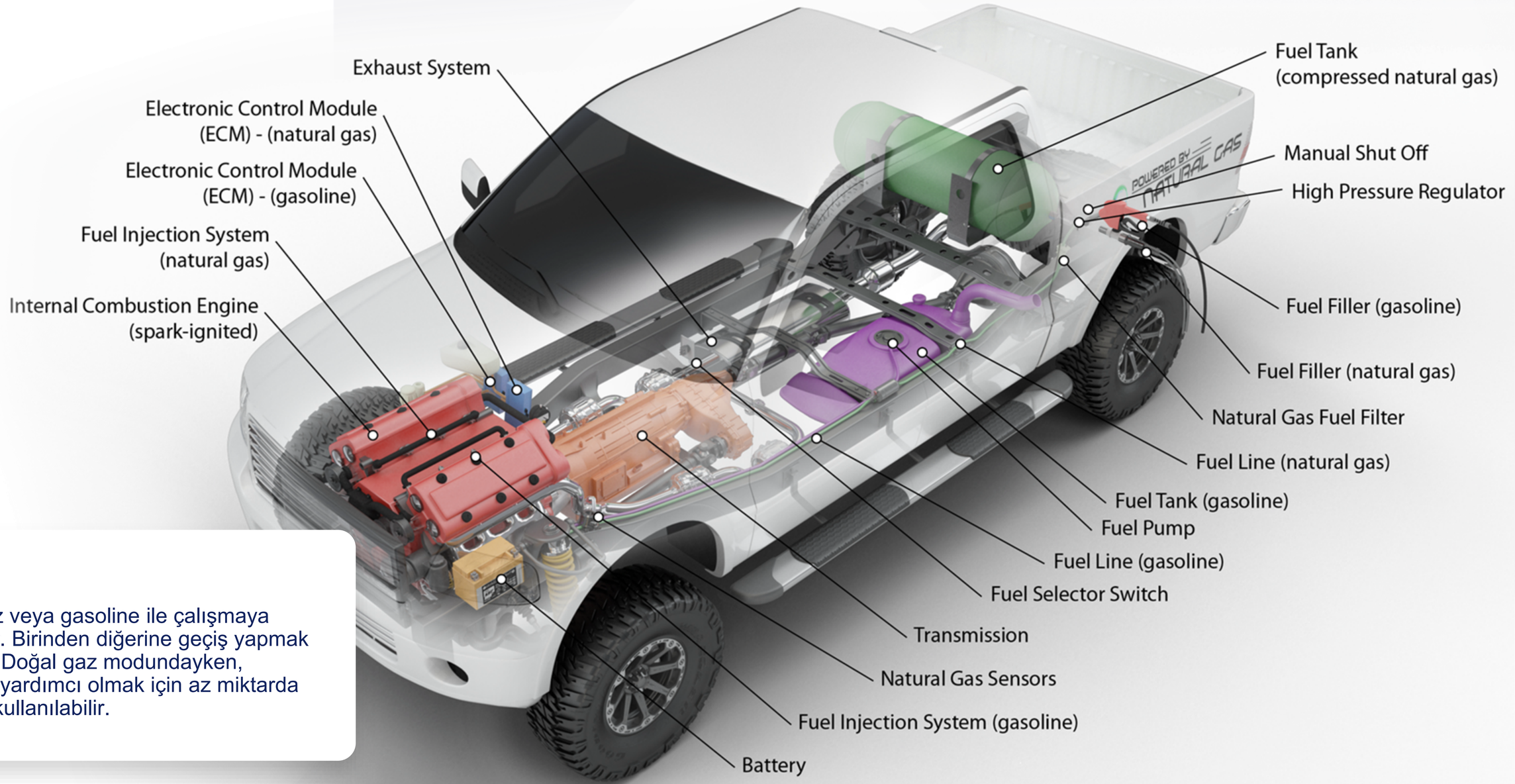
Engine Types: Mono Fuel



Engine Types: Mono Fuel



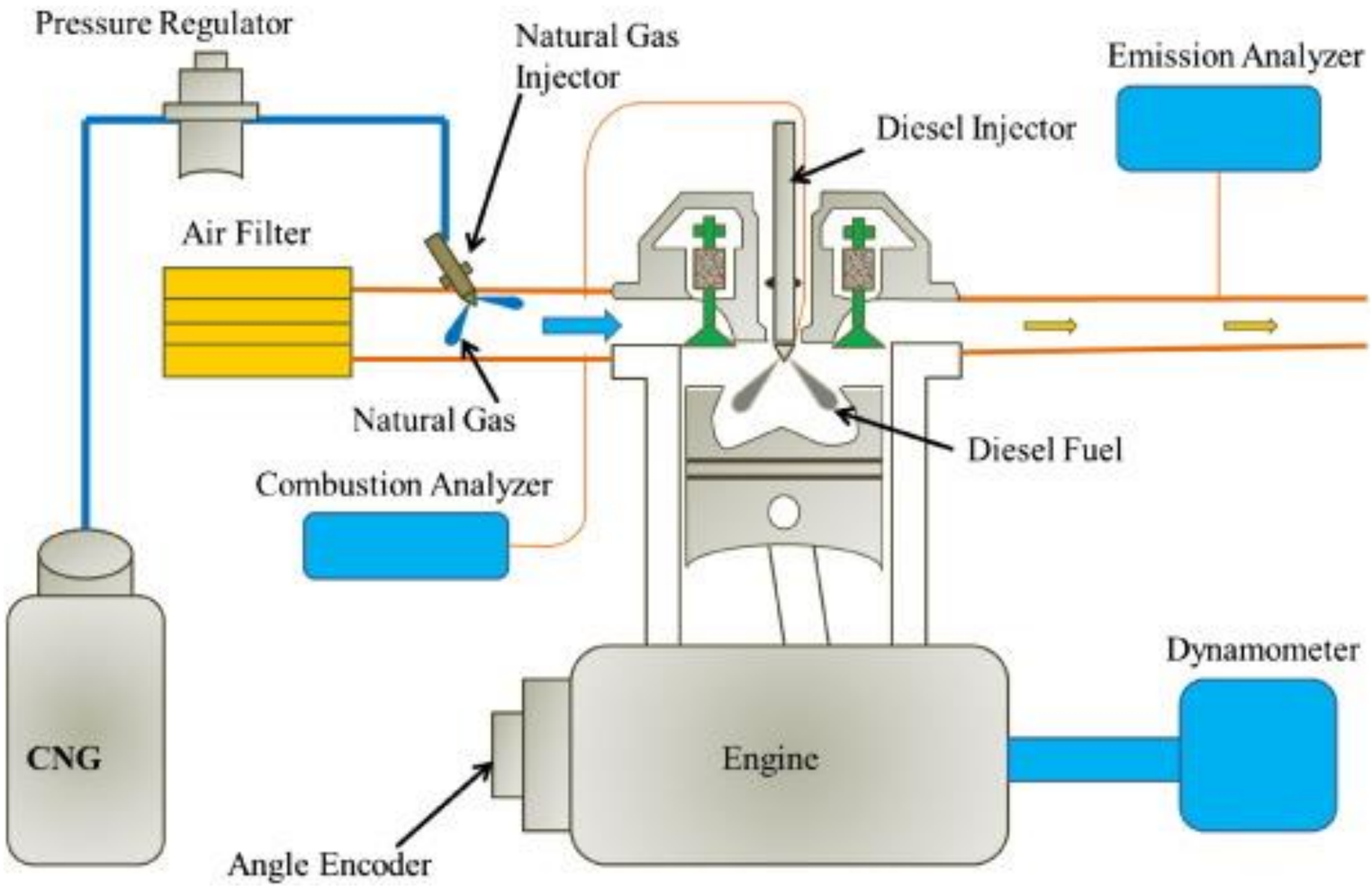
Engine Types: Bi-Fuel



Bi-Fuel

Doğal gaz veya gasoline ile çalışmaya uyumlular. Birinden diğerine geçiş yapmak mümkün. Doğal gaz modundayken, yanmaya yardımcı olmak için az miktarda gasoline kullanılabilir.

Engine Types: Dual Fuel



Doğal Gaz ile Çalışan Araçlar

- CNG binek araçlar
- CNG ticari araçlar
- CNG forkliftler
- CNG - LNG otobüsler
- CNG - LNG ağır yüklü araçlar
- LNG trenler
- LNG gemiler (dual fuel)
- LNG hava araçları (Boeing LNG ile mevcut yakıt tüketimini %62 azaltabileceklerini söylüyor)

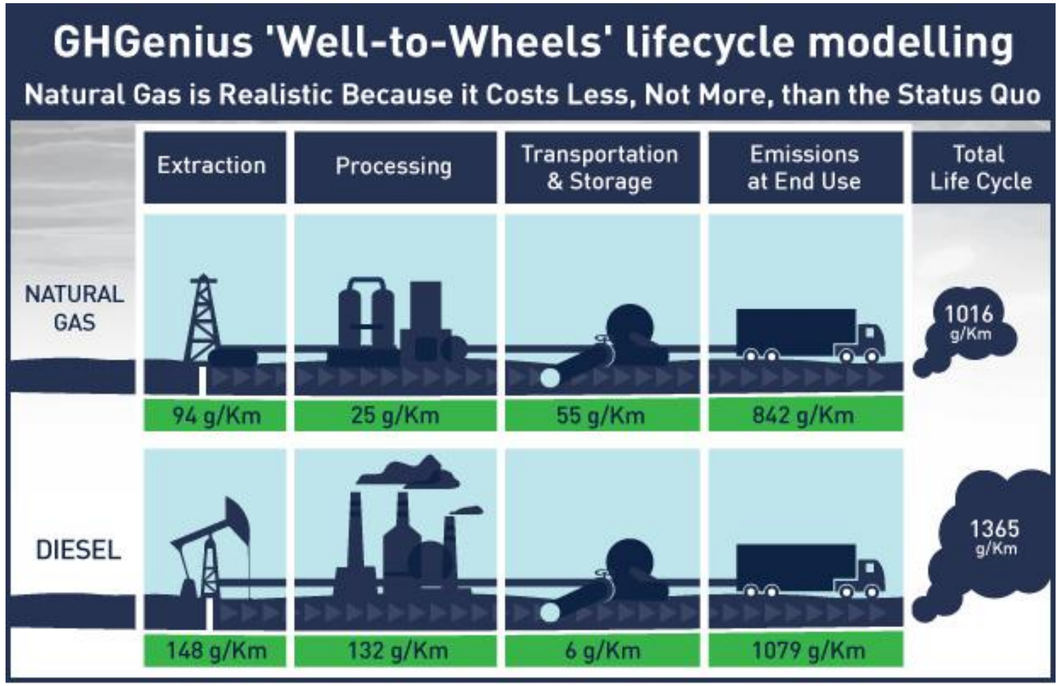
Doğal Gaz Üstünlükleri: Çevresel

Doğal gaz havadan hafif olduğu için herhangi bir kaza ya da dökülme anında havaya karışarak dağılacaktır. Benzin, dizel veya LPG gibi havuz oluşturup daha büyük yangın tehlikeleri yaratmaz. Bu durum su yollarına ve vahşi hayata büyük fayda sağlamaktadır, çünkü doğal gaz bu bölgelere zarar veremez.

Doğal Gaz Üstünlükleri: Emisyonlar

Ulaşım sektörü; global GHG (Green House Gas) emisyonlarının %25'inden sorumludur.

Well-to-wheels yaklaşımı: çıkarımdan, işlemeye, taşımadan, son kullanıma kadar yakıtların yarattığı emisyonu ölçme yöntemi.



Doğal Gaz Üstünlükleri: Emisyonlar

CO2 emisyonunda %30 azalış.

- Green Natural Gas üretimi ile bu oran daha da yükselmektedir.

SOx (Sulphur Oxide) emisyonunda %99 azalış.

NOx (Nitrogen Oxide) emisyonunda %80 azalış.

Sıfır ağır metal atıkları (zinc, iron, calcium, phosphor, barium, lanthanum)

Unilever Vaka Analizi

- Temmuz 2017 fiyatları:
  - LNG = $2.52/GGE = $1.03/kg
  - Dizel = $2.20/GGE = $0.76/kg
- LNG Vehicle – 10.637 km – 2.506 kg LNG = 2581 USD
- Dizel Vehicle – 9.504 km – 4.477 lt = 3.805 kg = 2.892 USD

Test result	LNG[1]	Diesel[2]	LNG vs Diesel
Average fuel consumption [/100 km]	23,6 kg	27,7 l	-%15
Average fuel gross cost in test [/100 km]*	23,1 €	27,4 €	-%15
Average fuel net cost in test [/100 km]*	18,9 €	22,2 €	-%15
Accessible fuel net cost [/100 km]**	16,6 €	21,7 €	-%23
Average CO2 emissions	0,65 kg/km	0,73 kg/km	-%11

Source: Test results provided by LINK Transport - Excel file.

Unilever Vaka Analizi

- 2017’den bu zamana LNG teknolojisindeki ilerlemeler ve ucuzlamalar göz önüne alınMAmaktadır.
- Ekim 2021
  - LNG = $2.75/DGE = $1/kg
  - Dizel = $3.48/DGE = $1.08/kg
- LNG Vehicle – 10.637 km – 2.506 kg LNG = 2506 USD
- Dizel Vehicle – 9.504 km – 3.805 kg diesel = 4109 USD
- Unilever çalışmasının güncel değerlerine göre:
- **LNG = $0.23/km**
- **Dizel = $0.43/km**
- **%86 maliyet azalışı**

Maliyet

- 1.000.000 km menzilde
  - Dizel = $0.43/km
  - LNG = $0.23/km
- Toplam Dizel yakıt maliyeti = 430.000 $
- Toplam LNG yakıt maliyeti = 230.000 $
- **Yakıt Maliyetinden Tasarruf = 200.000 $ = yaklaşık 4 tır**

Pazar Analizi

- Yahoo Finance raporuna göre:
  - 2020 yılında dünyada 23.2 Milyon NGV (Natural Gas Vehicle) mevcut.
  - 2027 yılında 34.7 Milyon NGV olması bekleniyor.
- 7 yılda artış: 11.5 Milyon NGV
  - 1.15 Milyon LNG
  - 10.35 Milyon CNG
- LNG tank fiyatı, motor çevrim/montaj veya OEM fiyatları toplam varsayım = 10.000$
- CNG tank fiyatı, motor çevrim/montaj veya OEM fiyatları toplam varsayım = 5.000$
- **LNG Pazarı (2027'ye kadar oluşacak ihtiyaç) = 11.5 Milyar USD**
- **CNG Pazarı (2027'ye kadar oluşacak ihtiyaç) = 51.75 Milyar USD**
- **5 YILLIK TOPLAM PAZAR = 63.25 Milyar USD**

Doğal Gazın Üstünlükleri

	$/gallon	Btu/lbs	Octane	Havadan hafif	CO2 Emisyonu	SOx Emisyonu	NOx Emisyonu	Sert Metal Emisyonu
LNG	**2.75**	**21.240**	**120**	**+**	**-30%**	**-99%**	**-80%**	**Yok**
Dizel	3.48	18.177	-	-	Ref.	Ref.	Ref.	Var
CNG	**2.33**	**20.160**	**120**	**+**	**-30%**	**-99%**	**-80%**	**Yok**
Benzin	3.48	17.975	95	-	-	-	-	Var

H2 Öne Çıkan Özellikleri

Uzun Menzil Kapasitesi

Dolum Sürelerinde %90 Azalış

%100 Daha Düşük CO2 Emisyonu

%100 Daha Az Metal Parça Emisyonu

En Yüksek Büyüme Potansiyeline Sahip Sektör

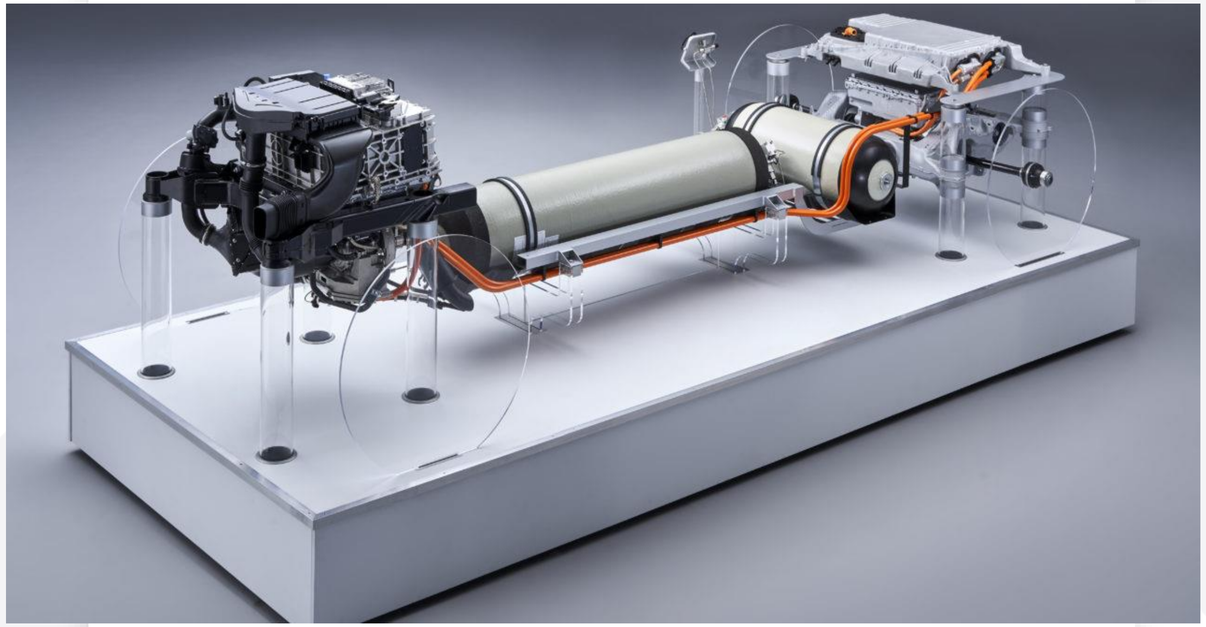
Türkiye'nin Kendi Hidrojenini Üretebilme Kapasitesi

H2 Özellikleri

- Sıfır zararlı gaz emisyonu
- Yalnızca su buharı, elektrik ve ısı üretimi
- 4-5 dakika dolum zamanı
  - EV Battery 45-60 dk. dolum süresi
- Dünyada en bol miktarda bulunan element
- Yüksek enerji kapasitesi
- Depolama zorluğu
- Hidrojen üretim maliyetleri

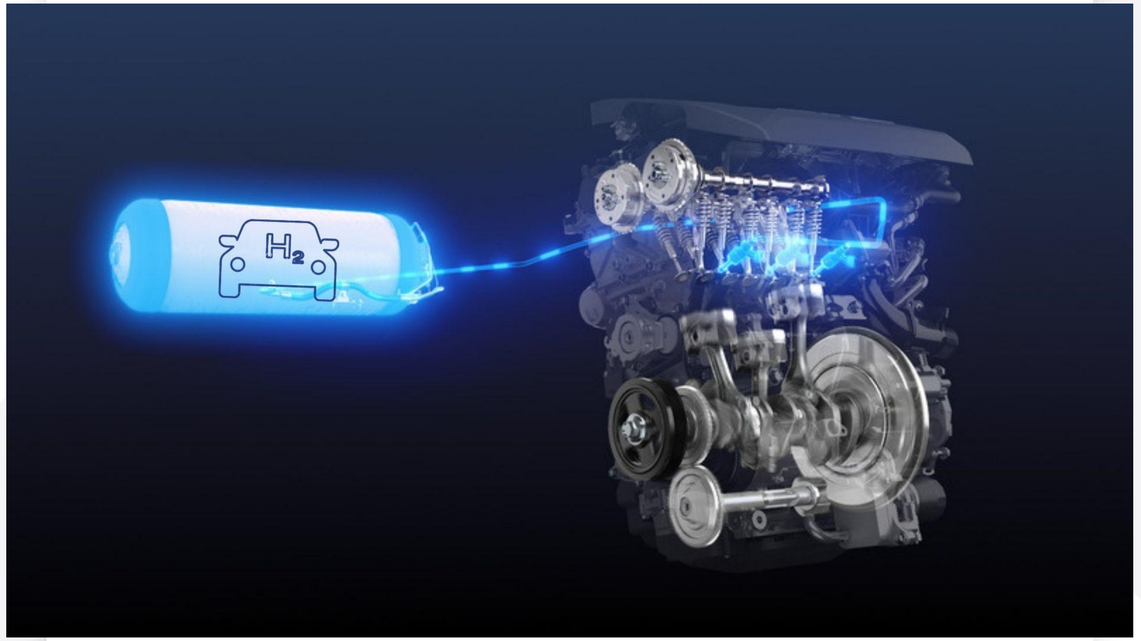
Hydrogen Fuel Cell Vehicle (HFCV)

- Elektrik motoru hidrojenden elde edilen elektrik enerjisi ile çalışır.
- Kimyasal enerjiyi %60 üzerinde verim ile elektrik enerjisine dönüştürebilir
- Sıfır emisyon
- EV Battery araçlara göre uzun menzil ve kısa dolum süresi
- 700 Bar Hidrojen Tankları



Hydrogen Internal Combustion Engine Vehicle (HICEV)

- İçten yanmalı motor teknolojisi
- Mevcut araçlara adapte edilebilir
- Sıfıra yakın zararlı gaz emisyonu
- Elektrikli araçlara kıyasla çevresel şartlara uyumlu
- 700 Bar Hidrojen Tankları



H2 Araç Örnekleri

Toyota Mirai

Hyundai Nexo

Toyota Corolla Sport (HICEV)

Toyota Kenworth

Hyundai Xcient

Toyota Forklift

SMTR GROUP

know us, know the quality!