



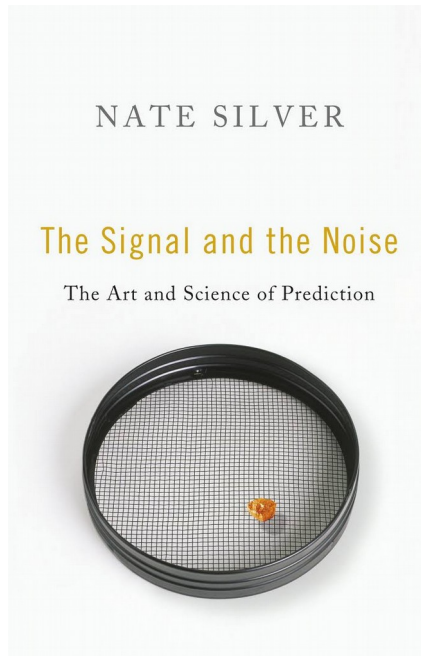
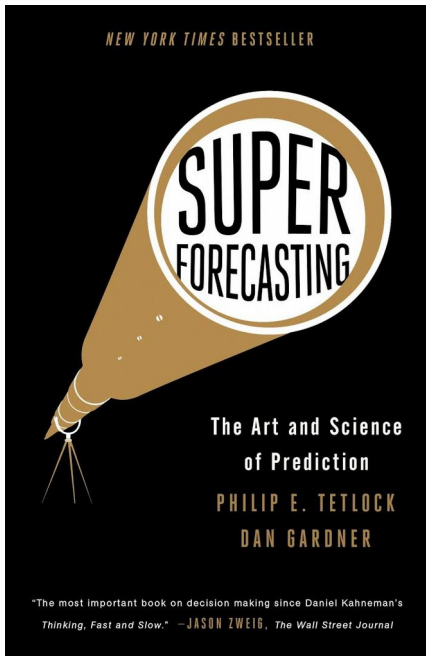
# **Enerji 101 – Ders 6**

## **Enerji Projeksiyonları ve Gelecek Tartışmaları**

**Barış Sanlı**

# Gelecek

Tüm modeller yanlıştır,  
bazıları kullanışlıdır.



Thoughts for the 2001 Quadrennial Defense Review

CF: An

- If you had been a security policy-maker in the world's greatest power in 1900, you would have been a Brit, looking warily at your age-old enemy, France.
- By 1910, you would be allied with France and your enemy would be Germany.
- By 1920, World War I would have been fought and won, and you'd be engaged in a naval arms race with your erstwhile allies, the U.S. and Japan.
- By 1930, naval arms limitation treaties were in effect, the Great Depression was underway, and the defense planning standard said "no war for ten years."
- Nine years later World War II had begun.
- By 1950, Britain no longer was the world's greatest power, the Atomic Age had dawned, and a "police action" was underway in Korea.
- Ten years later the political focus was on the "missile gap," the strategic paradigm was shifting from massive retaliation to flexible response, and few people had heard of Vietnam.
- By 1970, the peak of our involvement in Vietnam had come and gone, we were beginning détente with the Soviets, and we were anointing the Shah as our protégé in the Gulf region.
- By 1980, the Soviets were in Afghanistan, Iran was in the throes of revolution, there was talk of our "hollow forces" and a "window of vulnerability," and the U.S. was the greatest creditor nation the world had ever seen.
- By 1990, the Soviet Union was within a year of dissolution, American forces in the Desert were on the verge of showing they were anything but hollow, the U.S. had become the greatest debtor nation the world had ever known, and almost no one had heard of the internet.
- Ten years later, Warsaw was the capital of a NATO nation, asymmetric threats transcended geography, and the parallel revolutions of information, biotechnology, robotics, nanotechnology, and high density energy sources foreshadowed changes almost beyond forecasting.
- All of which is to say that I'm not sure what 2010 will look like, but I'm sure that it will be very little like we expect, so we should plan accordingly.

Certified As Unclassified  
January 3, 2009  
IAW EO 12958, as amended  
Chief, RDD, ESD, WHS

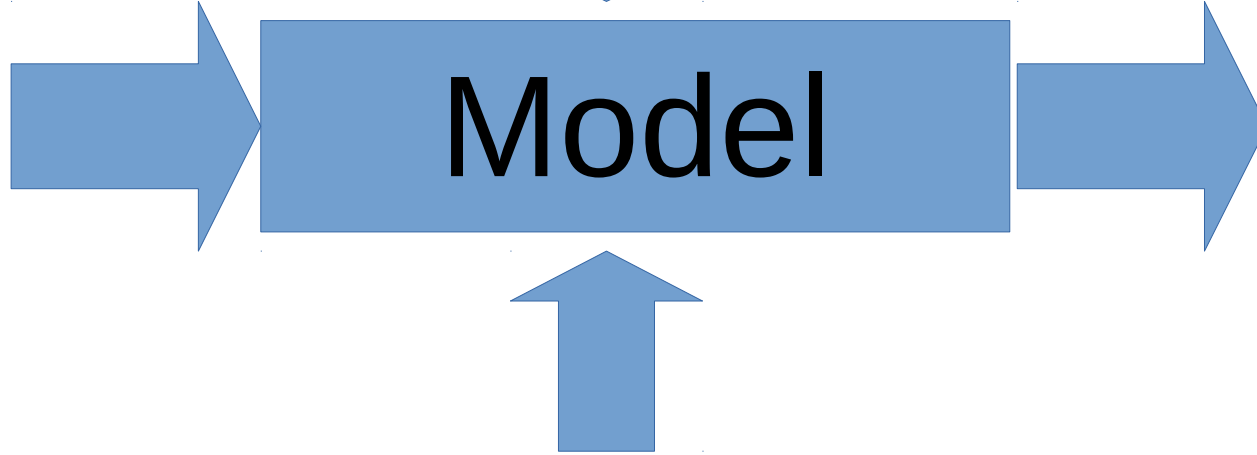
Lin Wells

# Talep

**Senaryolar**

Kabuller

Ekonomik büyüme  
Nüfus  
Fiyat tahminleri



Çıktılar

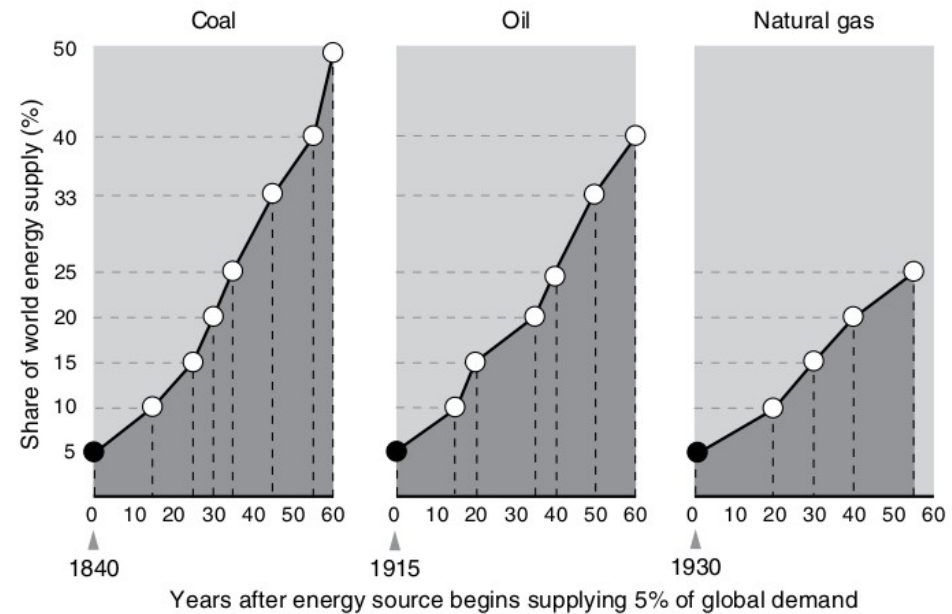
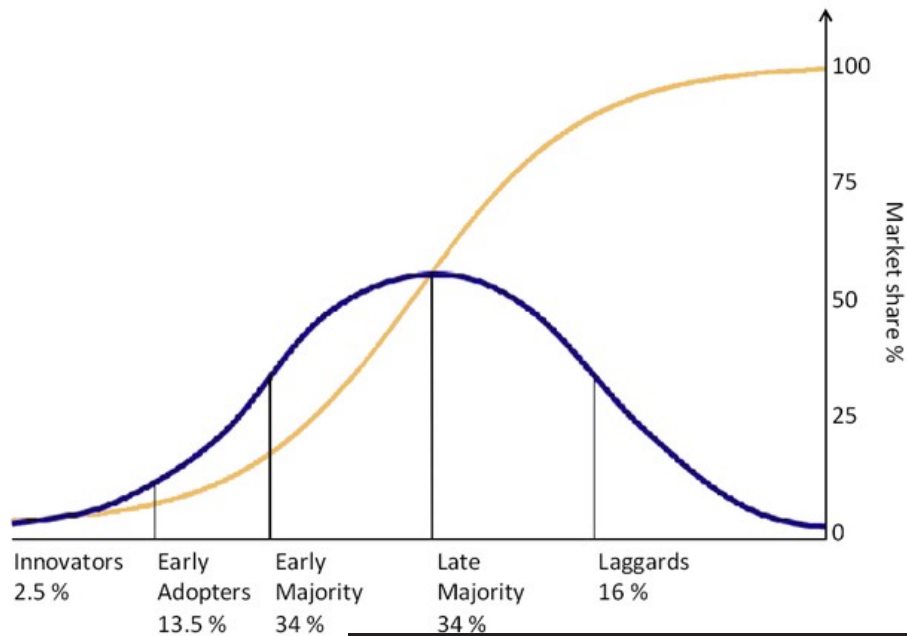
İlişkiler, Fonksiyonlar, Esneklikler

# Onlarca farklı kurgu mümkün

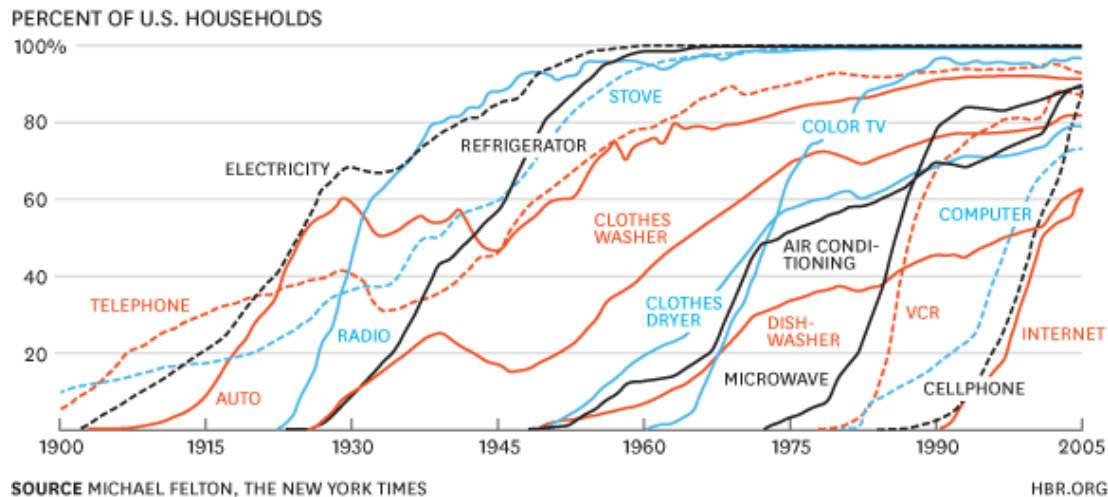
- Bir çok “Enerji Talebi” model kurgusu
  - Kişi başı enerji talebi
  - \$ GDP başına enerji talebi
  - Alt sektörler bazında enerji talebi
- Birden çok farklı sonuç. Mesela konutlarda
  - %100 kömür
  - %100 doğalgaz
  - %100 elektrik
  - %100 yenilenebilir

Hepsi  
Farklı  
Sonuç  
Verir

# Bu talebe cevap verecek arz



## CONSUMPTION SPREADS FASTER TODAY

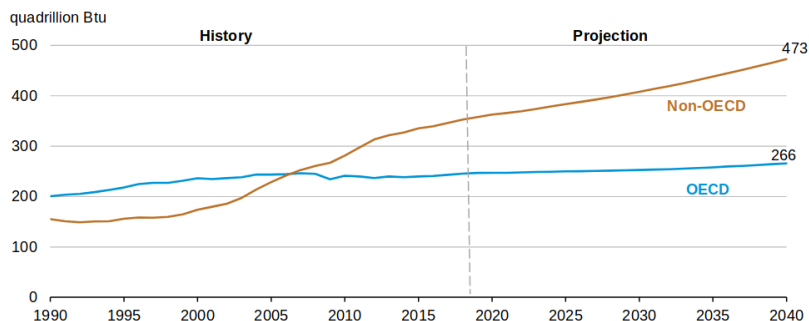


Global fuel transitions.

# Amaçlar da önemli

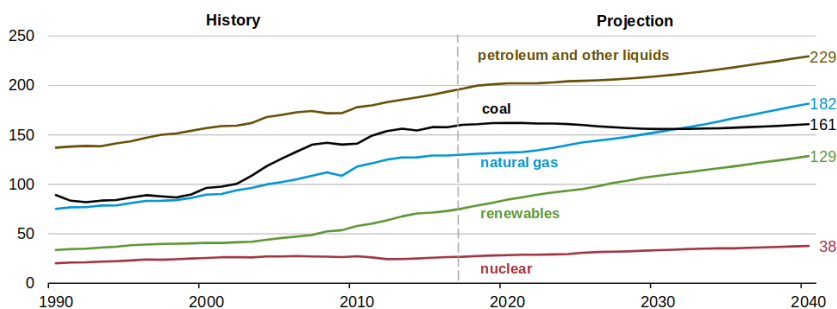
- Devlet – EIA
  - International Energy Outlook
- Uluslararası Kurumlar – IEA, IRENA
  - Future of /\* Outlook (Oil, Petrochemical
- Petrol şirketleri
  - BP, Shell, Equinor, ExxonMobil
- Danışman/ticari
  - WoodMackenzie, BNEF

# EIA International Energy Outlook



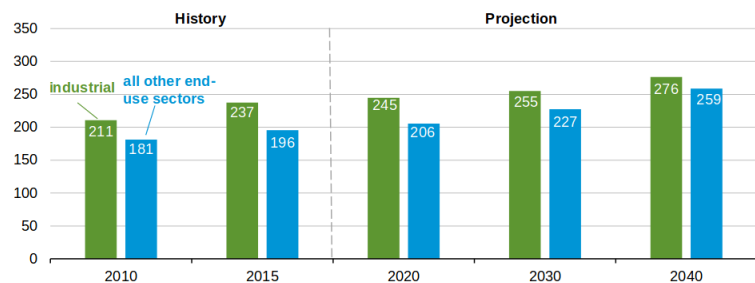
Source: EIA, International Energy Outlook 2018

**IEO2018 Reference case**  
world energy consumption by energy source  
quadrillion Btu



Source: EIA, International Energy Outlook 2018

**IEO2018 Reference case**  
world delivered energy consumption in the industrial and all other end-use sectors  
quadrillion Btu



Source: EIA, International Energy Outlook 2018

<https://www.eia.gov/outlooks/ieo/>

## Africa

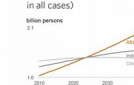
A higher economic growth case for Africa leads to more industrial sector energy use.

As of 2015...

8th largest regional energy consumer (23 quadrillion Btu)

6th largest regional GDP (\$ measured in Purchasing Power Parity (PPP))

4th largest regional population (projected to be the largest in all cases)



Source: International Energy Outlook 2018 (IEO2018)

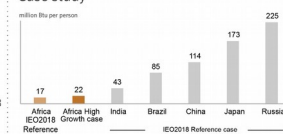
## EIA tested a case with higher economic growth

GDP (gross domestic product)

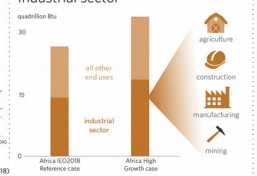
In this test case, 2040 GDP increases from US \$14 trillion to \$18 trillion PPP, which is slightly more than one-third of China's GDP.



Case study



Industrial sector



Manufacturing

African manufacturing is currently 16% of the economy, which is lower than India (33%) and China (51%).

With higher economic growth, African manufacturing increases from 19% to 24% of the economy in 2040.



## India

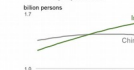
India has one of the fastest growing economies, but it is not projected to reach the level of energy consumption seen in other major economies.

As of 2015...

4th largest energy consumer (will soon become the 3rd)

3rd largest economy (measured in Purchasing Power Parity (PPP))

2nd largest population (will become the largest country by 2025)



Source: International Energy Outlook 2018 (IEO2018)

## EIA tested three high-economic growth cases

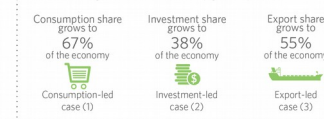
GDP (gross domestic product)

In each test case, 2040 GDP increases from US \$32 trillion to \$41 trillion PPP, exceeding that of the United States.



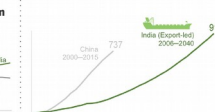
Case studies

Each case changes how India's economy grows by 2040



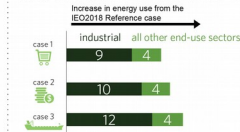
Manufacturing

Indian energy-intensive manufacturing output does not reach historical Chinese levels until after 2035



Energy use

Compared with the IEO2018 Reference case, energy use is highest in Export-led case in 2040



## China

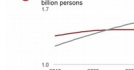
Faster economic growth in China means greater energy use, especially if it does not transition to a consumption-based economy.

As of 2015...

132 quadrillion Btu energy use (much higher than in the past 35 years)

Largest economy (\$ measured in Purchasing Power Parity (PPP))

Largest population (fourth-largest region in 2040)



Source: International Energy Outlook 2018 (IEO2018)

## EIA tested two high-economic growth cases

GDP (gross domestic product)

In each test case, 2040 GDP increases from US \$54 trillion to \$73 trillion PPP, which is double the U.S. GDP.



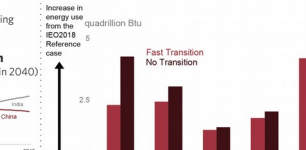
Case studies

Each case changes China's transition to a consumption-led economy by 2040



Energy use

Supply chain links lead to changes in other countries



Trade

Higher growth in China results in more Chinese trade

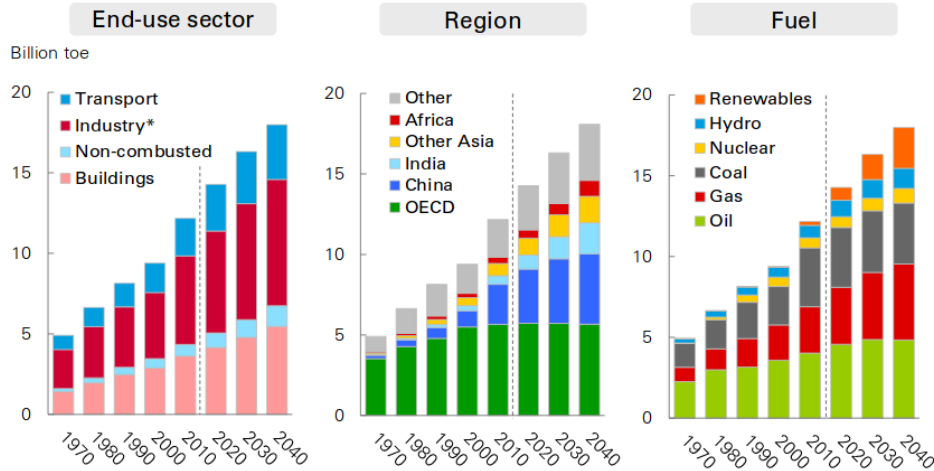


20



# BP Energy Outlook

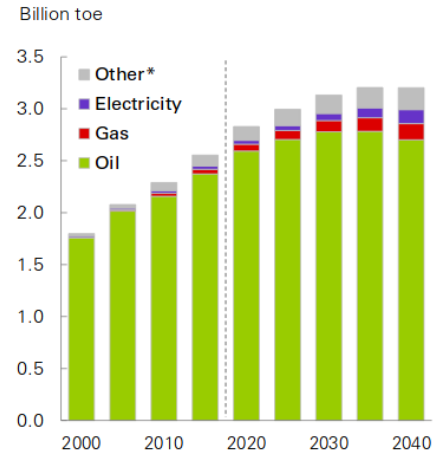
Primary energy demand



\*Industry excludes non-combusted use of fuels

2018 BP Energy Outlook

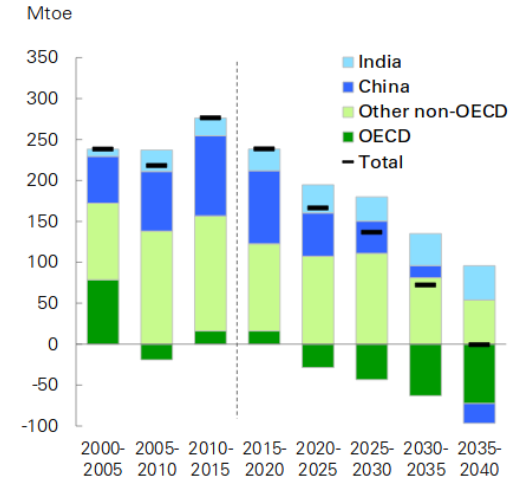
Transport energy consumption by fuel type



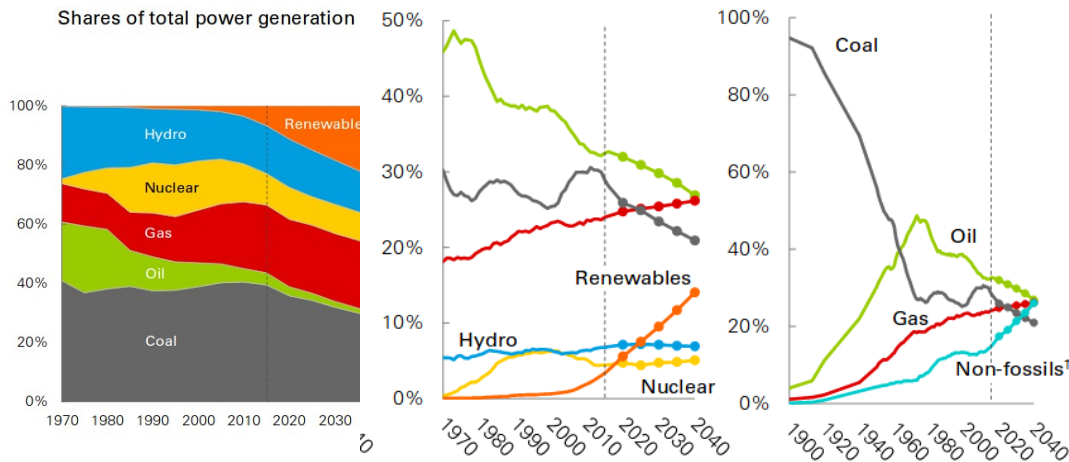
\*Other includes biofuels, gas-to-liquids, coal-to-liquids, hydrogen

2018 BP Energy Outlook

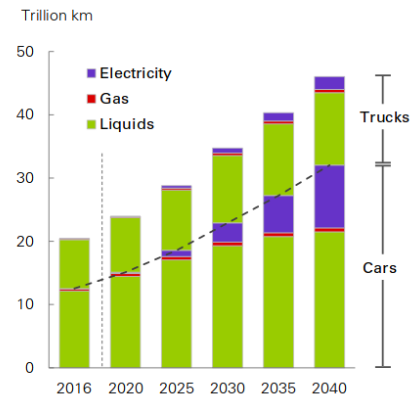
Transport energy consumption growth by region



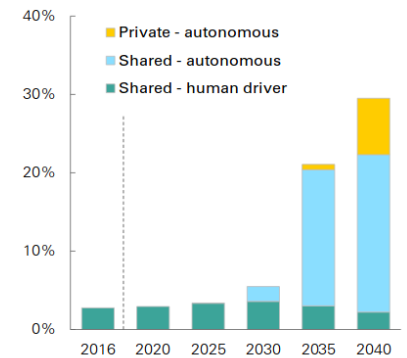
Shares of total power generation



Vehicle kilometres (Vkm) by fuel type

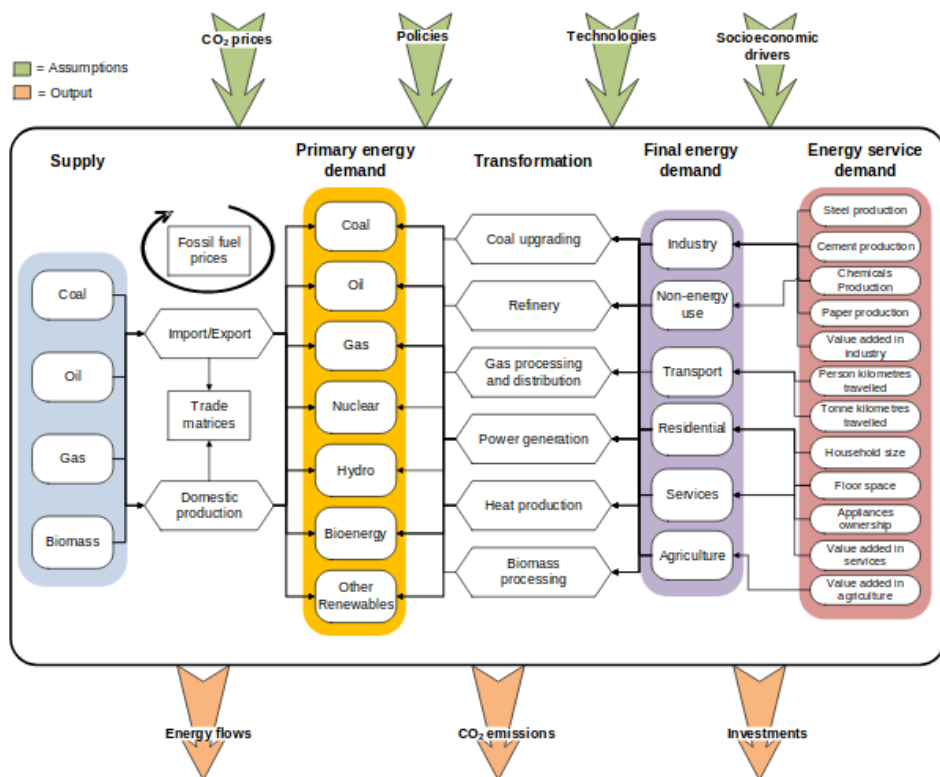


New mobility share of total Vkm

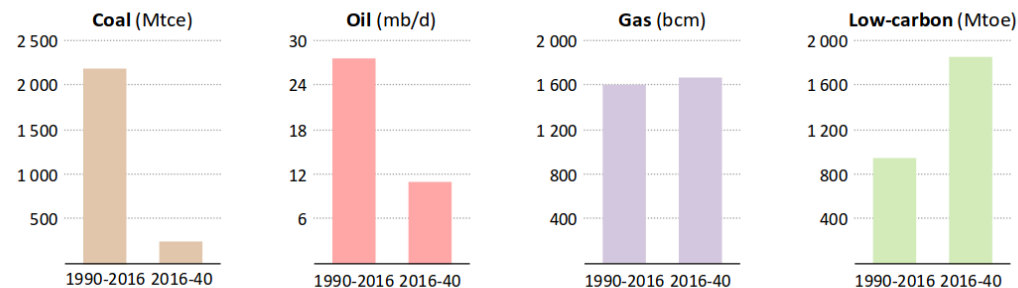


# IEA World Energy Outlook

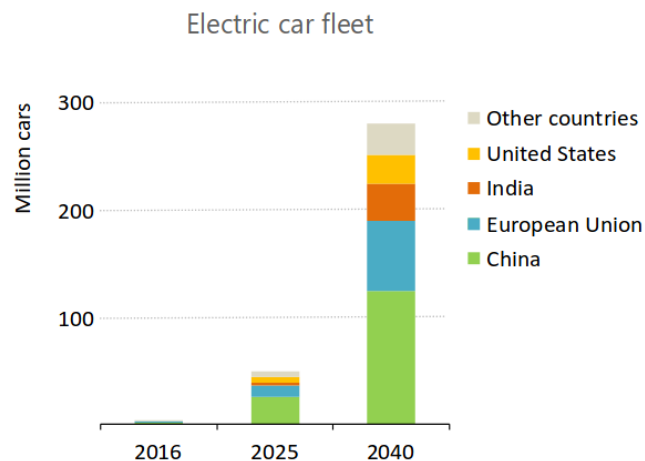
Figure 1: World Energy Model Overview



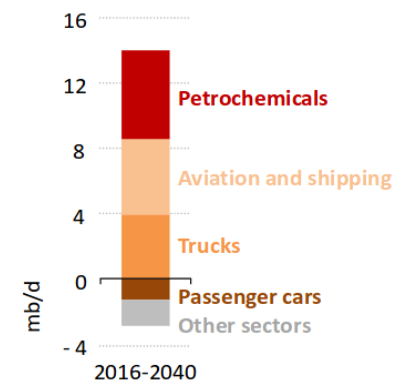
Change in world energy demand by fuel



Low-carbon sources & natural gas meet 85% of the increase in global demand:



Change in global oil demand



# IEA Future of Cooling

Map 2.1 • CDDs across the world, mean annual average 2007-17

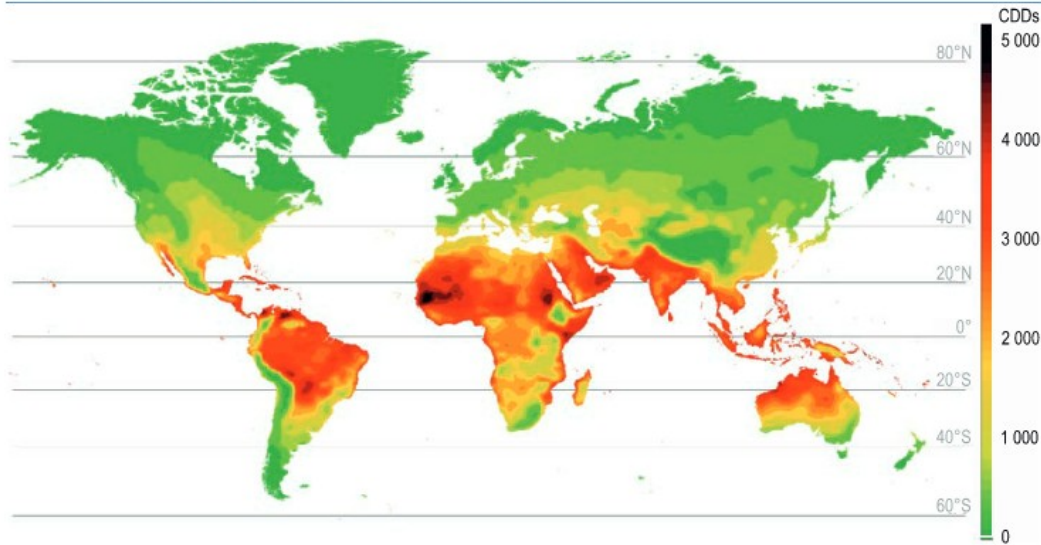
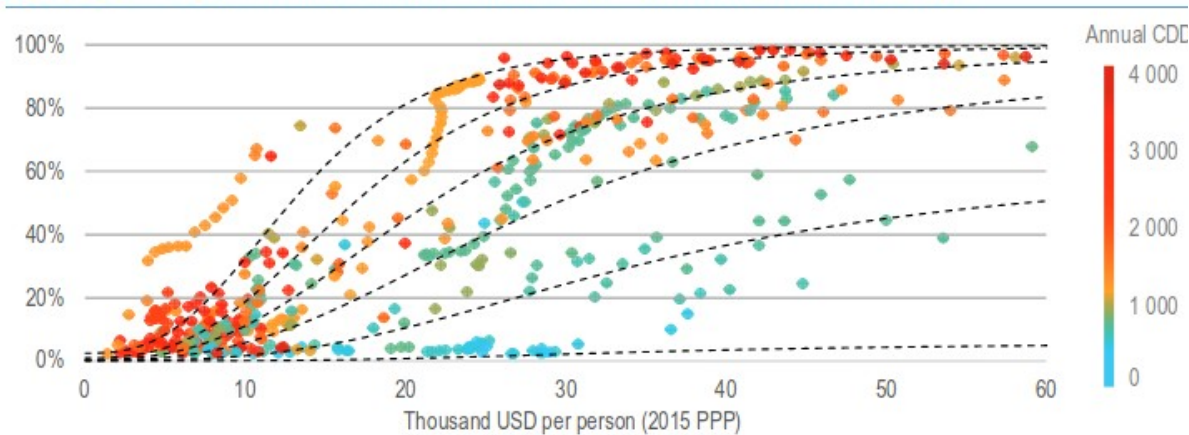
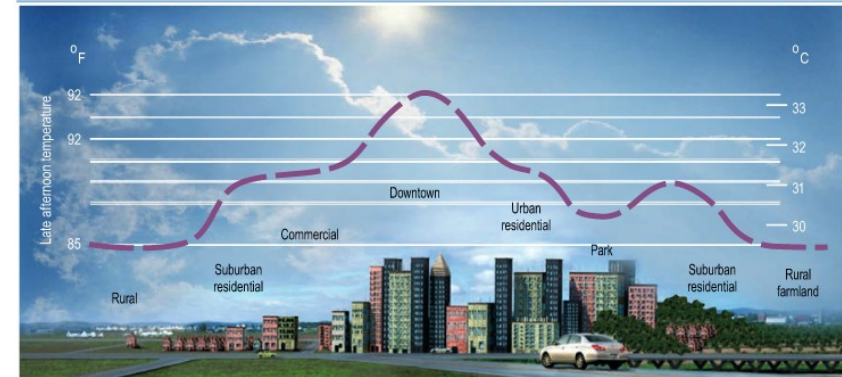


Figure 2.1 • Per-capita income and rate of household ownership of air conditioners



Notes: The dotted lines shown here are illustrative pathways for a typical place or country according to CDDs adjusted for relative humidity (see Box 2.1 for an explanation of how the heat index is calculated); PPP = purchasing power parity.

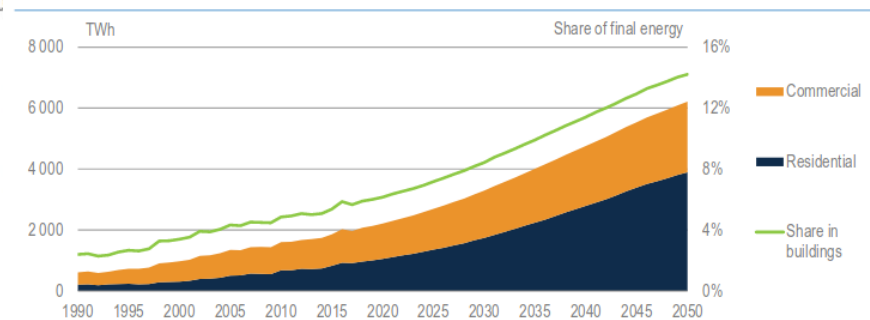
Figure 2.2 • Illustration of the heat island effect



Source: LBNL (2013), Heat Island Group, <http://heatisland.lbl.gov/>.

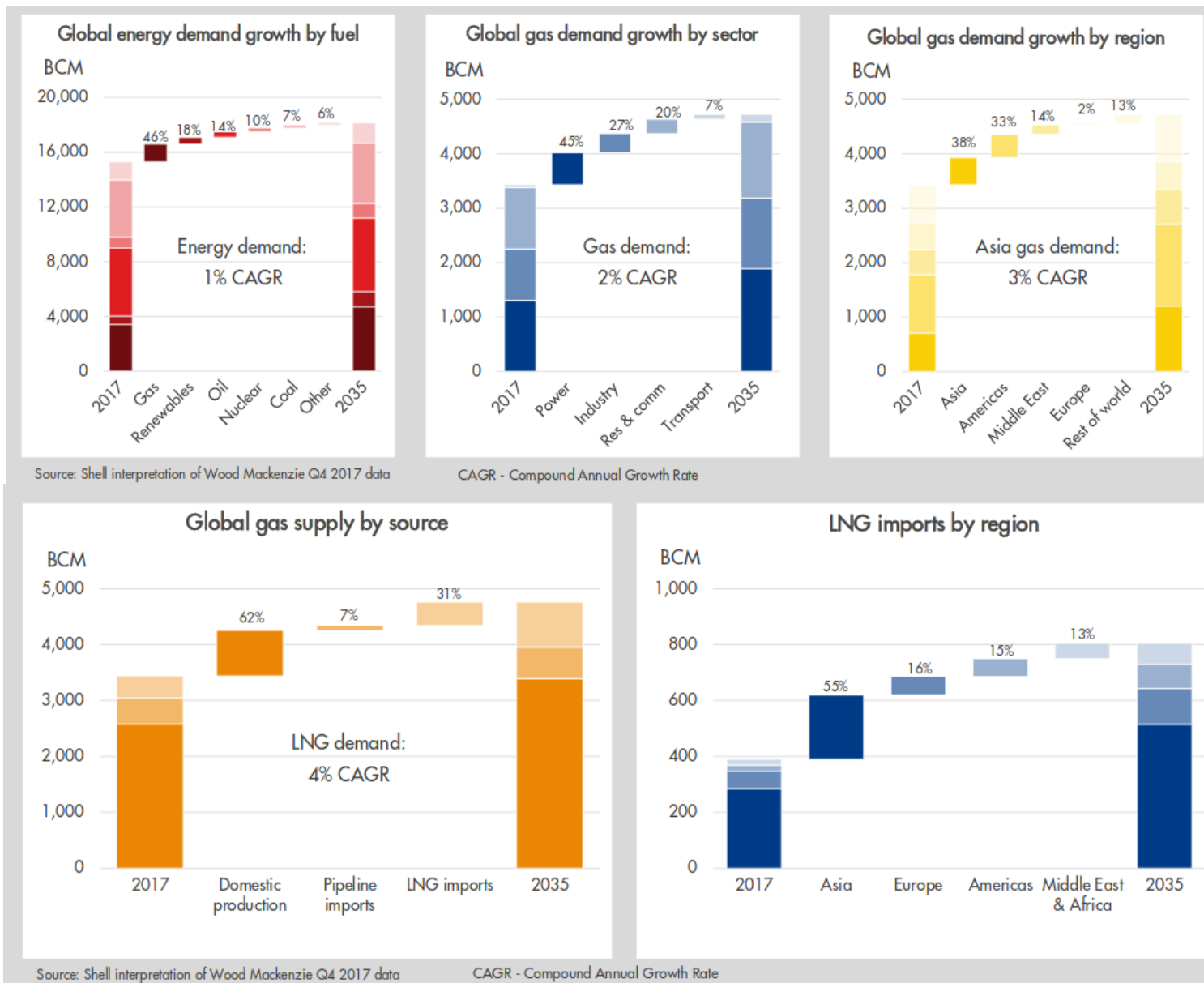
**Key message** • Cooling is one of several contributors to the heat island effect, which creates a need for more cooling in a classic feedback loop.

Figure 3.5 • World energy use for space cooling by subsector in the Baseline Scenario



**Key message** • On current trends, energy needs for space cooling – almost entirely in the form of electricity – will more than triple between 2016 and 2050, driven mainly by the residential sector.

# Shell LNG Outlook



Source: Shell interpretation of Wood Mackenzie Q4 2017 data

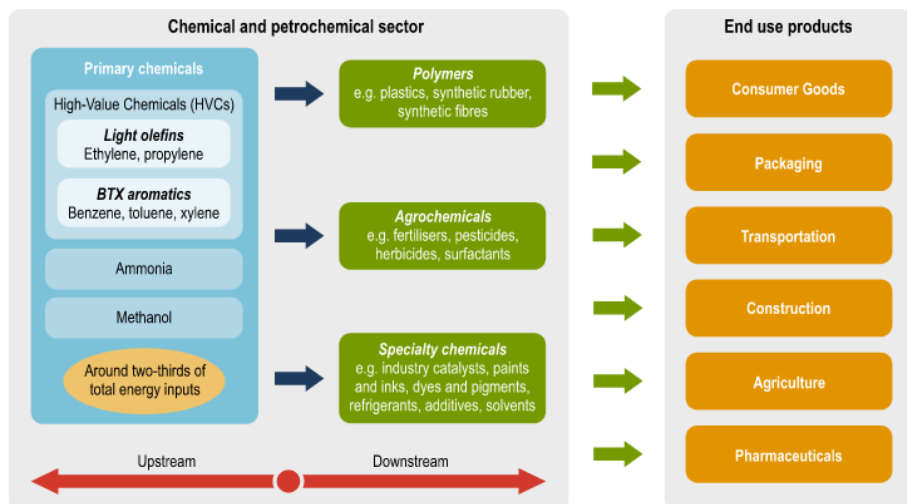
CAGR - Compound Annual Growth Rate

Source: Shell interpretation of Wood Mackenzie Q4 2017 data

CAGR - Compound Annual Growth Rate

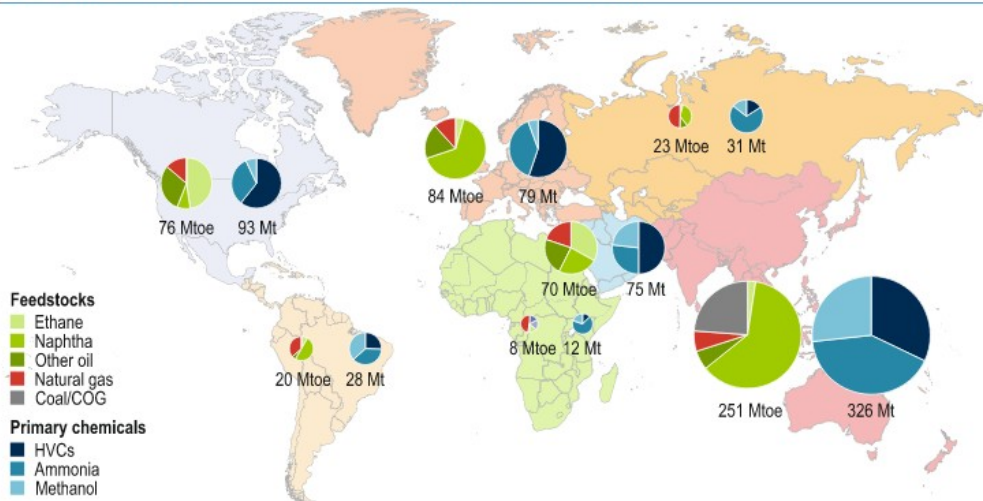
# IEA – The Future of Petrochemicals

Figure 1.7 • Primary chemicals in context



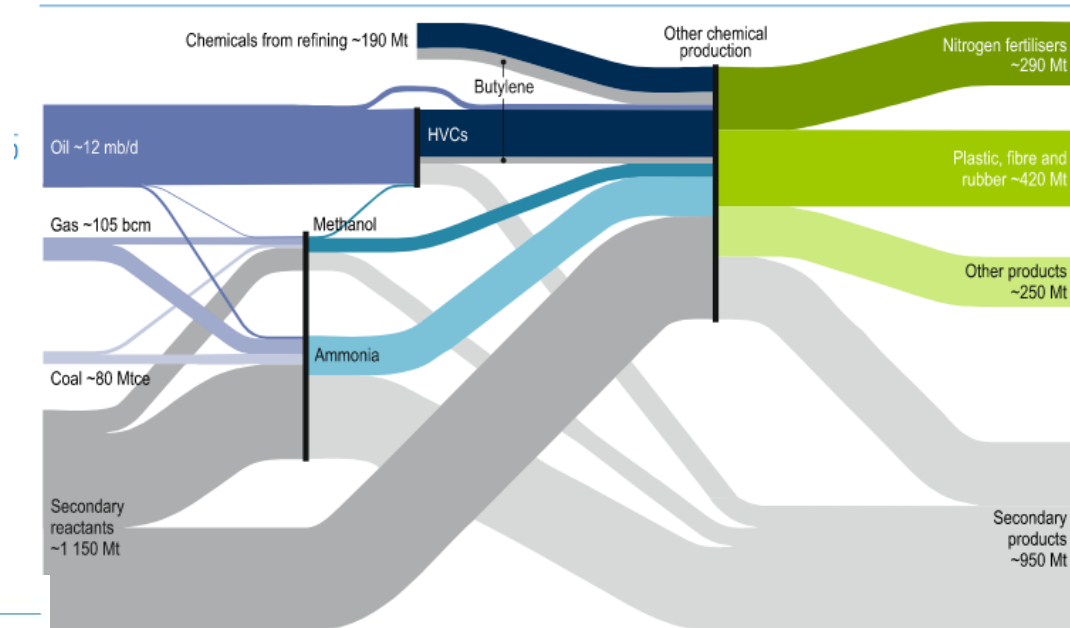
**Key message** • While most energy consumption in the chemical sector takes place upstream, a host of transformations, intermediates, and end-use sectors lie downstream from primary chemicals.

Figure 2.7 • Primary feedstock use and chemical production by region



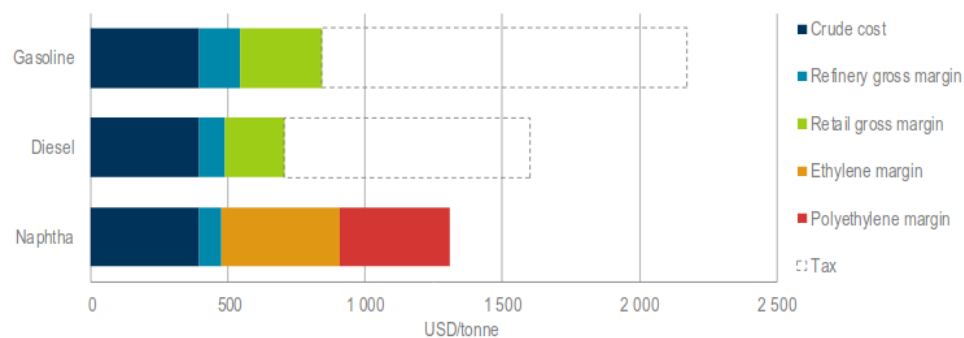
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

Figure 2.3 • Passage of fossil fuel feedstock through the chemical industry in 2017



Notes: All flows in the diagram are sized on a mass basis. Secondary reactants and products are the compounds specified within chemical reactions that do not form part of the feedstock or main products. Key examples include water, CO<sub>2</sub>, oxygen, nitrogen and chlorine. Some of the secondary products entering the sector on the left of the figure may well coincide with those leaving it on the right – CO<sub>2</sub> emitted from ammonia facilities and utilised in urea production is a key example. Mtce = Million tonnes of coal-equivalent.

Figure 2.12 • Indicative economics for fuels and petrochemicals in Europe



# BP Technology Outlook

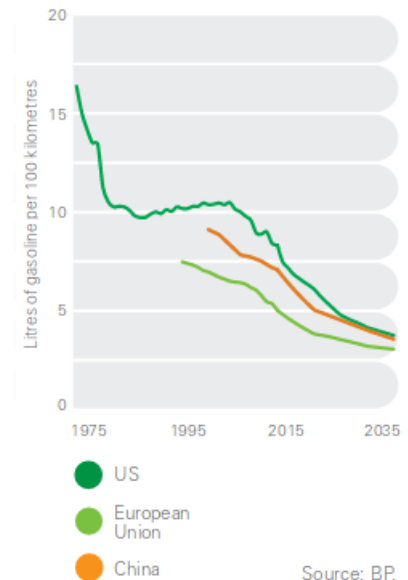
## Emerging technologies

Time range from commercialization to significant impact.

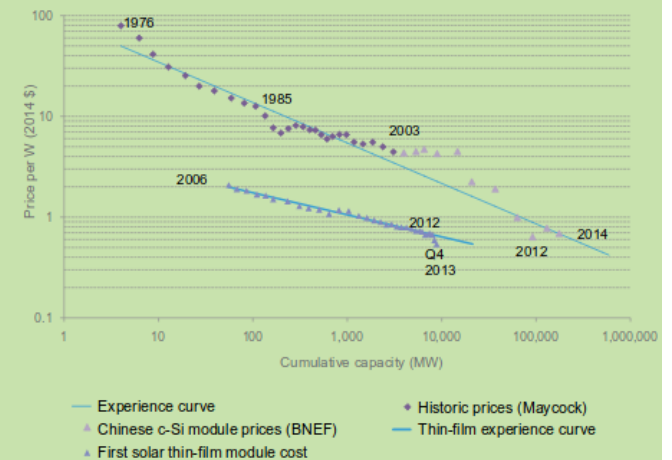


Source: BP.

## Fuel economy of new car fleet



## The silicon PV experience curve

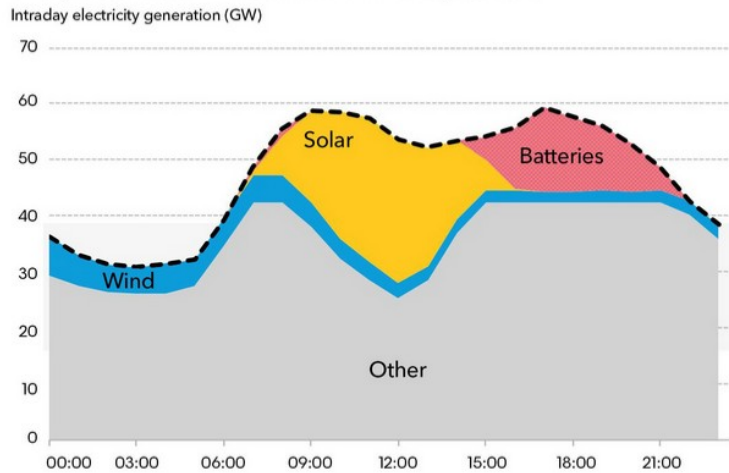


Source: Maycock, Bloomberg New Energy Finance.

# BNEF New Energy Outlook 2018

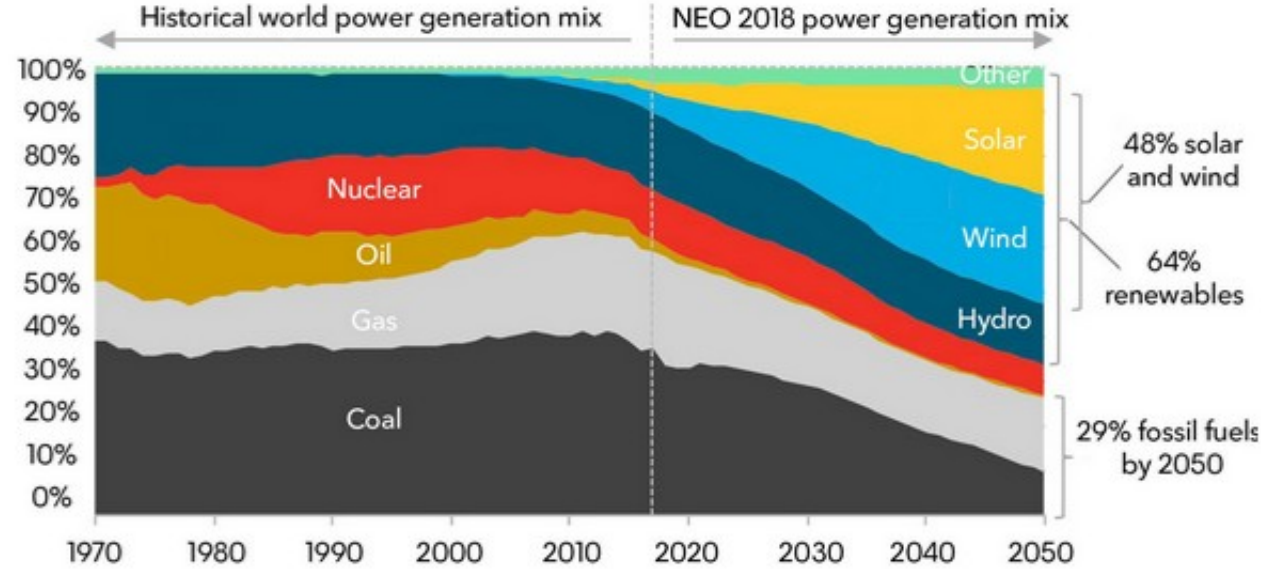
- 2050'de %50 elektrik rüzgar-güneş
- 2050'ye
  - Güneş %71
  - Rüzgar %58 fiyat düşüşü
- Gaz çok artmaz
- Elektrik arabaların elektrik talebi %9

Cheap batteries can make solar and wind dispatchable



Source: Bloomberg NEF

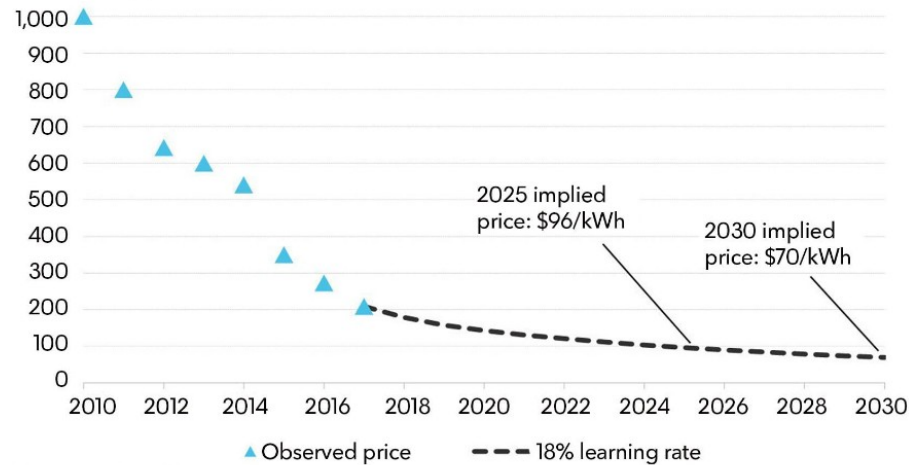
## Power generation mix



Source:

## Lithium-ion battery price, historical and forecast

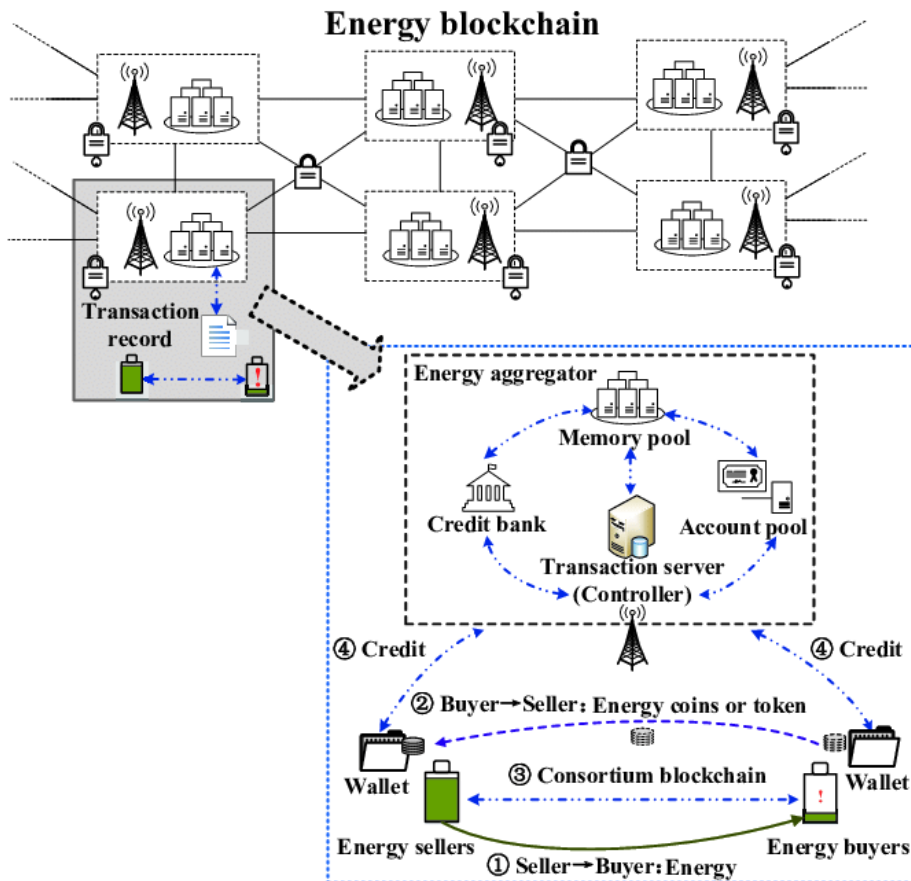
Li-ion battery price (\$/kWh, 2017 real)



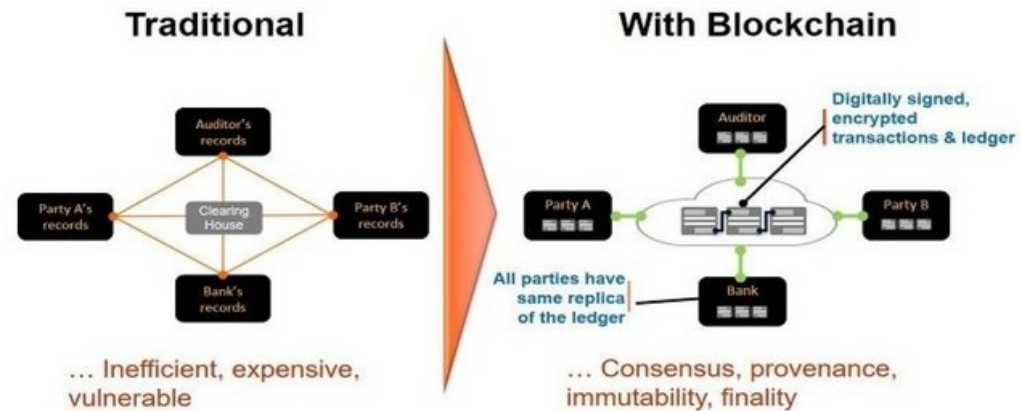
Source: Bloomberg NEF



# Kayitinciri - Blockchain



## Basic change to business processes



# Dağıtık enerji

FROST & SULLIVAN

## 2016 GLOBAL DISTRIBUTED ENERGY OUTLOOK

THE 'NEW NORMAL' OF THE ENERGY LANDSCAPE TO EXPERIENCE ACCELERATED GLOBAL GROWTH

### KEY DISTRIBUTED ENERGY MARKET TRENDS FOR 2016

- DERMS** (Distributed Energy Resource Management Systems) will see industry consolidation in 2016.
- PROSUMERS** will gain momentum, moving the industry to a self-generation model.
- ENERGY STORAGE** systems will show strong growth from 2016 for commercial and residential applications.
- COMBINED HEAT & POWER** investments will remain strong, helped by lower technology costs, government-mandated targets, and preferential grid access.
- MICRO GRIDS** combined with renewable energy sources will gain market growth in 2016; focus will remain on power supply security and reduced carbon footprint.
- DEMAND RESPONSE** technology innovation will be in demand with France opening its capacity markets and the UK getting active DR management.
- GENSETS** market to slowdown due to low oil prices; oil to remain at the \$30 per barrel mark in 2016 due to geopolitics tensions and weaker economic growth.
- DISTRIBUTED SOLAR PV** will represent the largest market contributing 75% of the installed distributed energy capacity of \$42 Billion in 2016.

### ONE TECHNOLOGY TREND

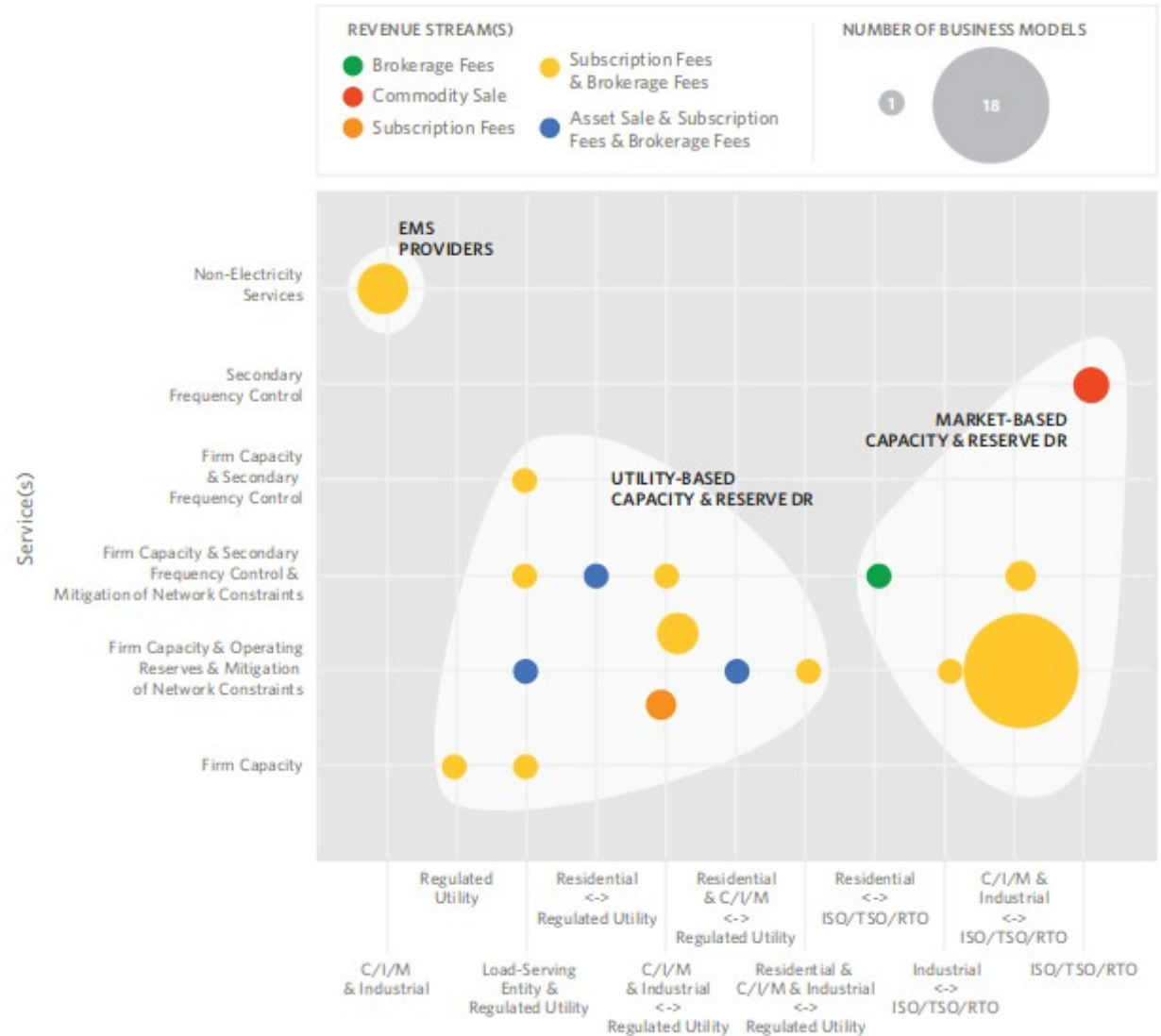
- Distributed energy investments will lead to increased spending in:
  - Transmission and distribution (T&D)
  - Energy storage
  - Newer utilities business models
  - Creating exciting opportunities for demand response programmes

### KEY CONCLUSIONS

- Distributed energy sources will play a key role in strengthening energy security and reliability by integrating multiple power generation sources.
- Coueneration and distributed storage solutions will gain momentum in 2016** with increasing investments in supportive subsidies and commercialisation.
- Distributed energy resource management will grow substantially with technology companies investing in R&D for **enhanced data integration and onsite/offsite technology support**.
- In 2016, **further disruptions to the utility business models** is expected with energy suppliers actively participating in the prosumer-led energy models.
- While regulatory regression will slow down investments in renewable technologies in the developed markets, **the demand supply gap in the emerging markets will drive growth in 2016**.

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Figure B.1: Business Model Taxonomy for Demand Response and Energy Management Systems



# Diğer teknolojiler

- Gaz hidratlar
- Yüzen offshore
- Perovskit güneş
- SMR (Small modular reactor)
- Füzyon
- CO2 yakalama sıkıştırma
- Jeotermal
- Yapay zeka, büyük veri

# Talep tarafında

- Verimlilik
- IoT
- Yapay zeka
- Akıllı sistemler
- Otonom araçlar
- Araç paylaşımı



# Özet ve Sorular