Enerji-Elektrik ve Değişimlerin Dinamikleri

Barış Sanlı
www.barissanli.com

Marmara Üniversitesi
Elektrik Elektronik Mühendisliği Bölümü
20 Aralık 2017

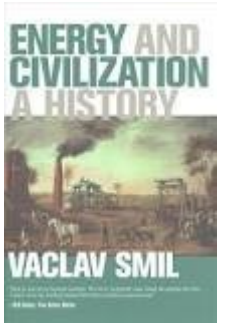
Amaç

- Daha çok elektrik ve elektronik mühendisliği öğrencilerine
  - Farklı bir enerji tarih perspektifi vermek
  - Elektrik şebekelerinin nereye evrildiğini tartışmak

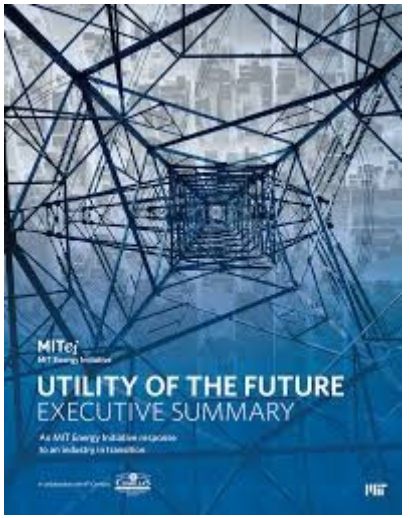
- Sunum materyalleri öğrencilerin takibi için iki ana eser üzerine kuruldu.

Kullanılan Yayınlar

- Energy and Civilization : A History
  Vaclav Smil 2017
- Utility of the Future – MIT
- İnternet kaynakları (IEA, EIA)



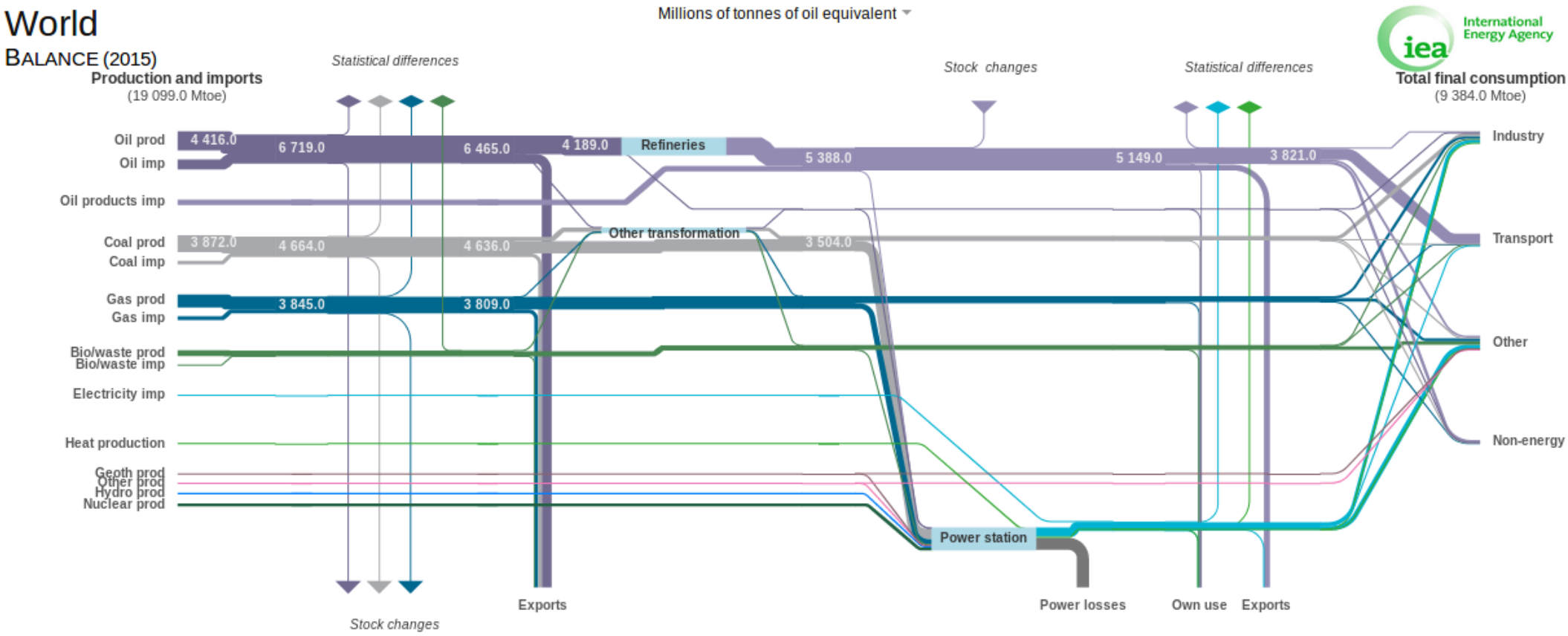
- Sunum sonrası konuların takibi kolay olsun diye sabit kaynaklardan gidildi.



İçerik

- Genel enerji girişi
- Tarihsel süreçler (Vaclav Smil)
  - İnsan-Tarım-ilkel enerji kaynakları
  - İngiltere'de kömür
  - Petrol
- MIT'nin Geleceğin Kamusal Elektrik Şirketi raporu üzerinden

Dünya Enerji Dengesi(zliği)



https://www.iea.org/Sankey/

Türkiye enerji dengesi

2016 YILI ULUSAL ENERJİ DENGE TABLOSU (15.11.2017)

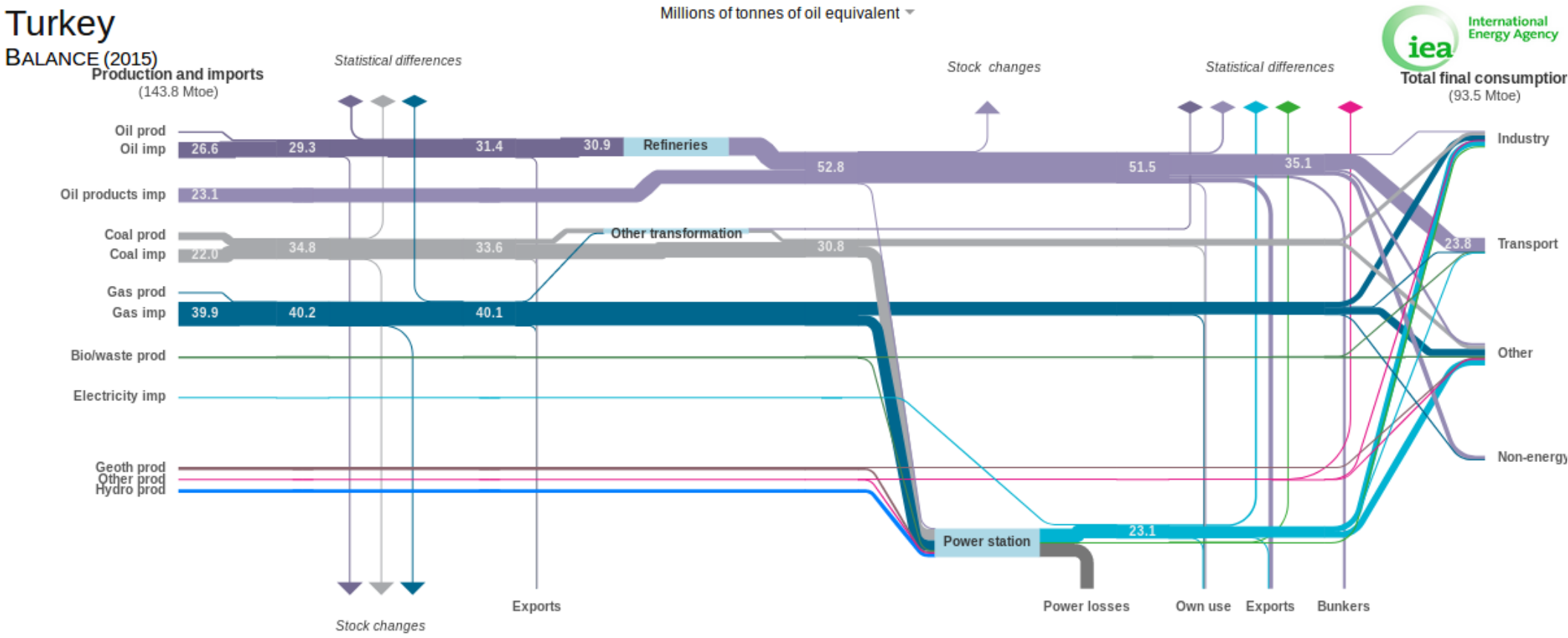
(Bin Ton Eşdeğer Petrol)

ENERJİ ARZ DAĞILIMI	Taş Kömürü	Linyit	Asfaltit	Kok	Türetilmiş Gazlar	Kömür Katranı	Ham Petrol	Petrol Ürünleri	Doğalgaz	Biyoenerji ve Atıklar	Hidrolik	Rüzgar	Elektrik	Jeo.Isı ve Diğer Is	Güneş	TOPLAM
Yerli Üretim (+)	722	14,013	725				2,702		303	2,843	5,782	1,334		6,034	917	35,374
İthalat (+)	23,178			381			26,205	24,568	38,240				544			113,117
İhracat (-)	36	0		3		117		6,411	557				125			7,250
İhrakiye (-)								4,478								4,478
Stok Değişimi (+/-)	-267	-457	52	150		16	-198	-183	352							-534
ENERJİ ÜRÜNLERİ ARZI	**23,597**	**13,556**	**778**	**527**	**0**	**-101**	**28,709**	**13,495**	**38,338**	**2,843**	**5,782**	**1,334**	**420**	**6,034**	**917**	**136,229**
--İstatistiksel Fark (+/-)--	**104**	**145**	**0**	**-64**	**1**	**0**	**0**	**-3**	**57**	**0**	**0**	**0**	**2**	**0**	**0**	
ÇEVRİM VE ENERJİ SEKTÖRÜ	**-14,834**	**-10,414**	**-661**	**2,734**	**436**	**121**	**-28,709**	**27,270**	**-16,407**	**-362**	**-5,782**	**-1,334**	**19,313**	**-2,934**	**-90**	**-31,653**
Elektrik Üretimi	-10,429	-10,138	-661		-830			-611	-14,841	-330	-5,782	-1,334	23,599	-4,143	-90	**-25,591**
Isı Üretimi	-204	-213			-47			-212	-796	-32				1,504		**0**
Kok Fırınları	-4,029			2,734	763	121										**-411**
Yüksek Fırınlar					1,420											**1,420**
Petrol Rafinerileri							-28,556	30,703	-538				-153	-295		**1,160**
İç Tüketim ve Kayıp	-171	-64			-870		-153	-2,610	-231				-4,133			**-8,231**
TOPLAM NİHAİ ENERJİ TÜKETİMİ	**8,763**	**3,141**	**116**	**3,261**	**436**	**21**	**0**	**40,765**	**21,932**	**2,480**	**0**	**0**	**19,733**	**3,100**	**827**	**104,576**
SEKTÖRLER TOPLAMI	**8,659**	**2,996**	**116**	**3,325**	**436**	**21**	**0**	**40,768**	**21,875**	**2,480**	**0**	**0**	**19,731**	**3,099**	**827**	**104,332**
SANAYİ TÜKETİMİ	**4,108**	**1,584**	**60**	**3,306**	**436**	**21**	**0**	**4,408**	**8,674**	**0**	**0**	**0**	**9,171**	**1,209**	**288**	**33,264**
Madencilik Faaliyetleri(07,08,09)	**0**	**31**						**282**	**91**				**195**			**599**
Gıda,İçicek,Tütün Ürünleri İmalatı(10,11,12)	**153**	**344**		**43**				**89**	**1,024**				**629**	**337**		**2,620**
Tekstil, Deri Ürünleri İmalatı(13,14,15)	**108**	**594**						**9**	**905**				**1,539**	**68**		**3,223**
Ağaç ve Ürünleri İmalatı(16)	**7**	**12**						**12**	**165**				**126**	**34**		**355**
Kağıt ve Ürünlerinin İmalatı(17,18)	**32**	**77**						**27**	**226**				**356**	**199**		**917**

Orjinal Birimler | Bin Ton Eşdeğer Petrol

http://www.eigm.gov.tr/tr-TR/Denge-Tablolari/Denge-Tablolari

Grafiği(2015)



https://www.iea.org/Sankey/#?c=Turkey&s=Balance

Sadeleştirilmiş Denge ve Anlattıkları

(Bin Ton Eşdeğer Petrol)

ENERJİ ARZ DAĞILIMI	Taş Kömürü	Linyit	Ham Petrol	Petrol Ürünleri[2]	Doğalgaz[3]	Hidrolik	Rüzgar	Elektrik	TOPLAM
Yerli Üretim (+)	722	14,013	2,702		303	5,782	1,334		35,374
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--İstatistiksel Fark (+/-)--	**104**	**145**	**0**	**-3**	**57**	**0**	**0**	**2**	
ÇEVRİM VE ENERJİ SEKTÖRÜ	**-14,834**	**-10,414**	**-28,709**	**27,270**	**-16,407**	**-5,782**	**-1,334**	**19,313**	**-31,653**
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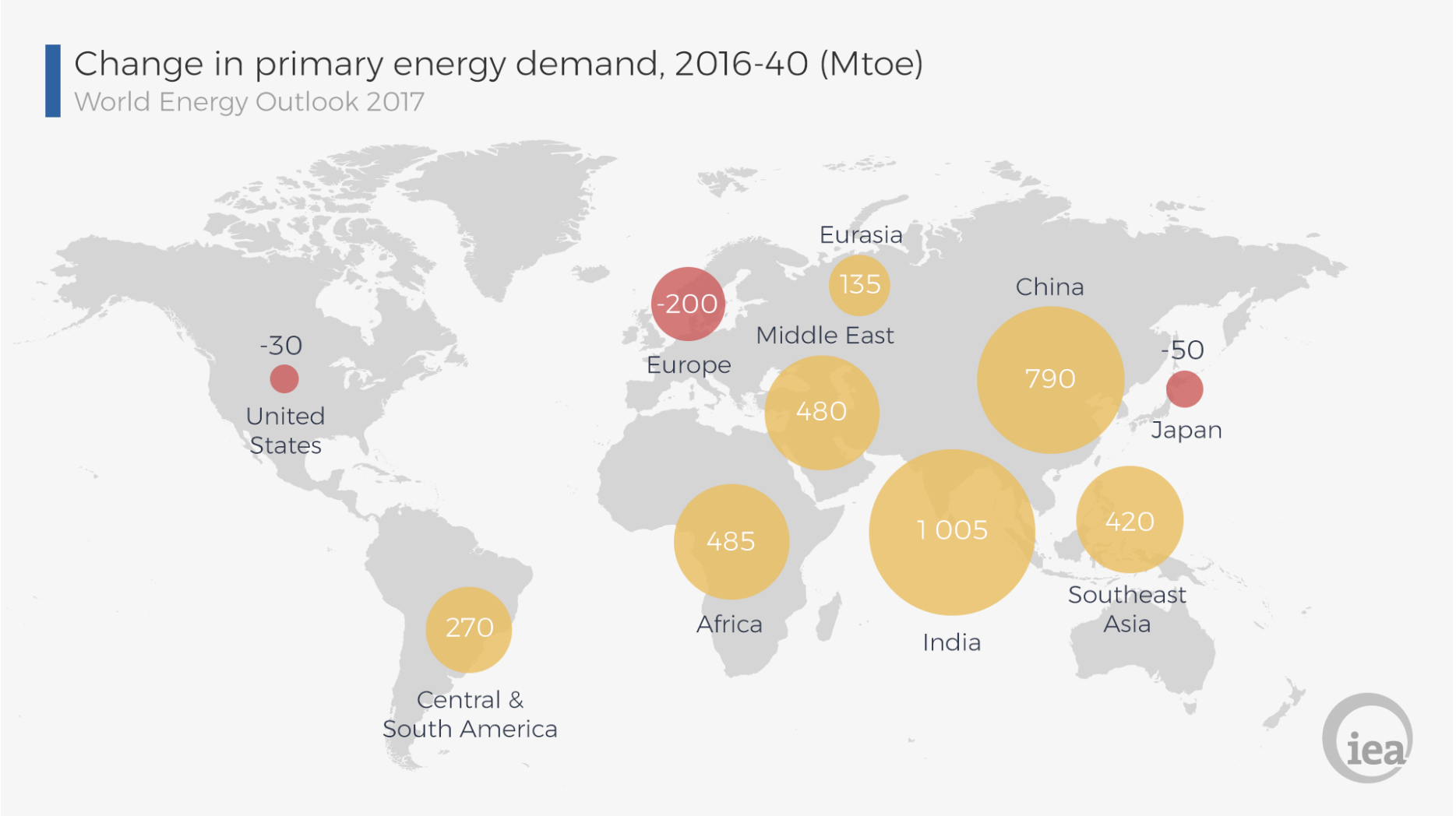
İç Tüketim ve Kayıp	-171	-64	-153	-2,610	-231			-4,133	**-8,231**
TOPLAM NİHAİ ENERJİ TÜKETİMİ	**8,763**	**3,141**	**0**	**40,765**	**21,932**	**0**	**0**	**19,733**	**104,576**
SEKTÖRLER TOPLAMI	**8,659**	**2,996**	**0**	**40,768**	**21,875**	**0**	**0**	**19,731**	**104,332**
SANAYİ TÜKETİMİ	**4,108**	**1,584**	**0**	**4,408**	**8,674**	**0**	**0**	**9,171**	**33,264**
ULAŞTIRMA	**0**	**0**	**0**	**26,269**	**327**	**0**	**0**	**42**	**26,755**
Konut	1,018	1,076		252	9,587			4,407	19,649
Ticaret ve Hizmetler	3,533	337		690	2,556			5,531	13,625
Tarım ve Hayvancılık				2,806	85			580	4,051

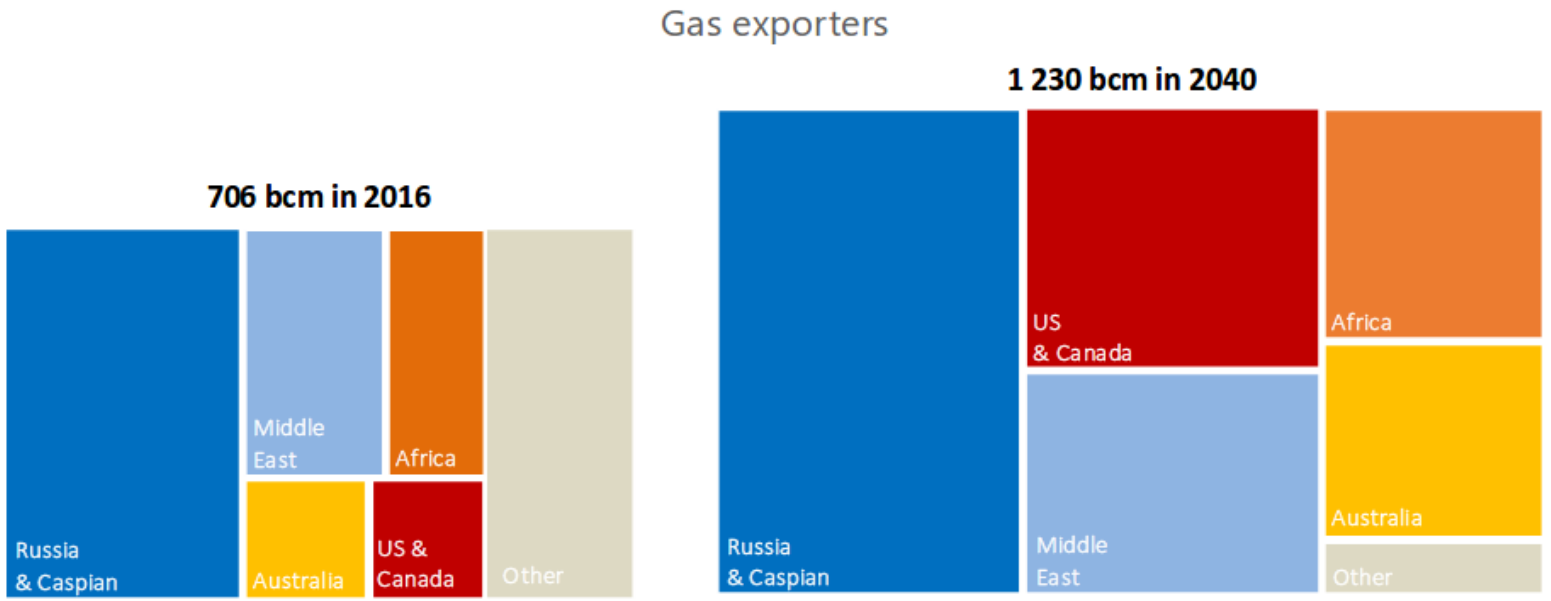
Dünya Enerji Talebi



https://www.iea.org/weo2017/

20.yüzyıl petrol yüzyılı mıydı

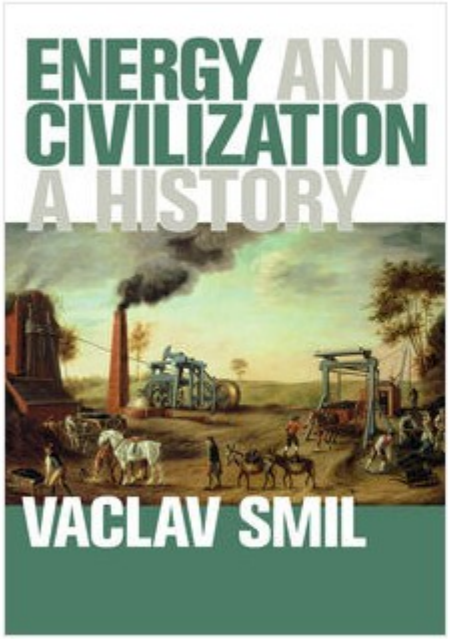
- 1950'lere kadar kömür
- Sonra petrol
- 2030 sonrası da doğalgaz mı?
  - Yoksa yenilenebilir mi? (Belki 2.-3. yenilenebilir



https://www.iea.org/media/publications/weo/WEO2017launchpresentationprint.pd

Energy and Civilization

ENVIRONMENT AND URBAN STUDIES → ENERGY AND CIVILIZATION



Energy and Civilization

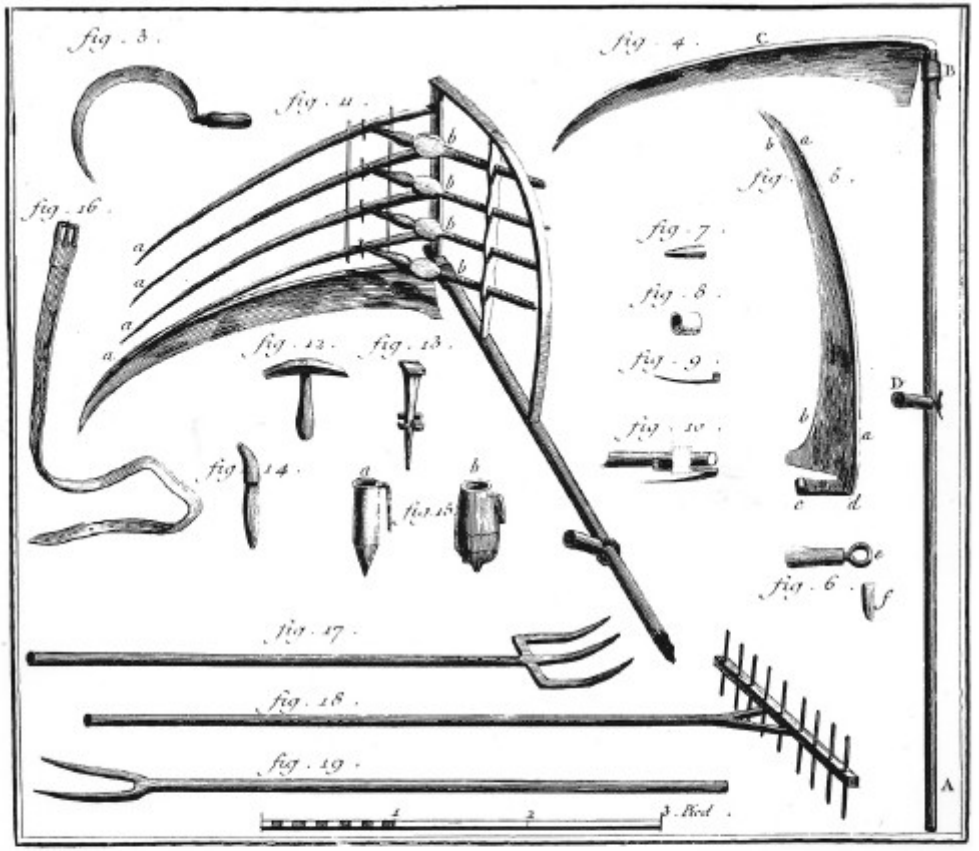
A History

By Vaclav Smil

Overview

Energy is the only universal currency; it is necessary for getting anything done. The conversion of energy on Earth ranges from terra-forming forces of plate tectonics to cumulative erosive effects of raindrops. Life on Earth depends on the photosynthetic conversion of solar energy into plant biomass. Humans have come to rely on many more energy flows—ranging from fossil fuels to photovoltaic generation of electricity—for their civilized existence. In this monumental history, Vaclav Smil provides a comprehensive account of how energy has shaped society, from pre-agricultural foraging societies through today's fossil fuel–driven civilization.

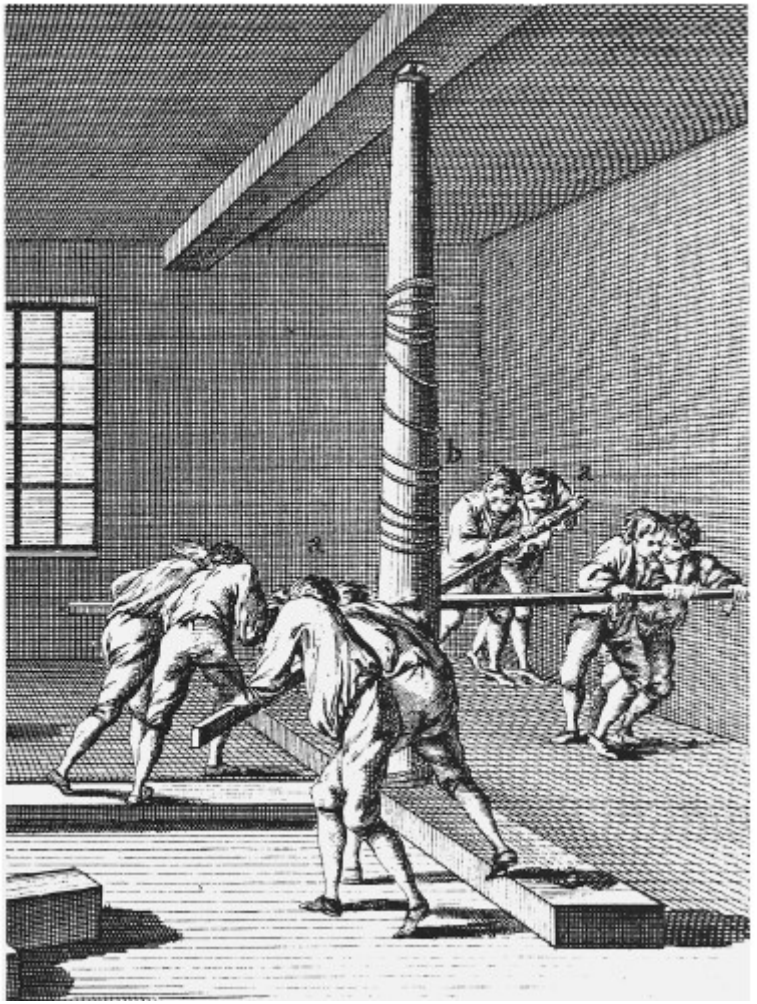
İnsan başına tarım

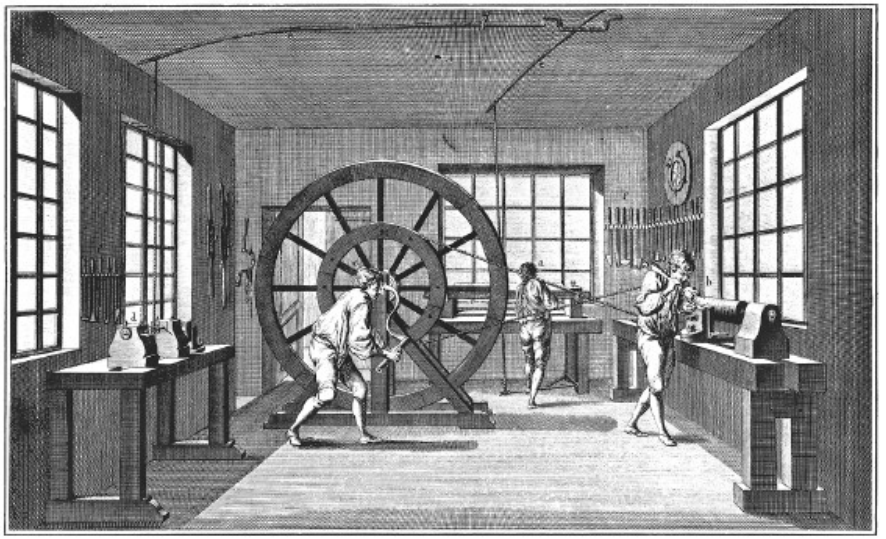


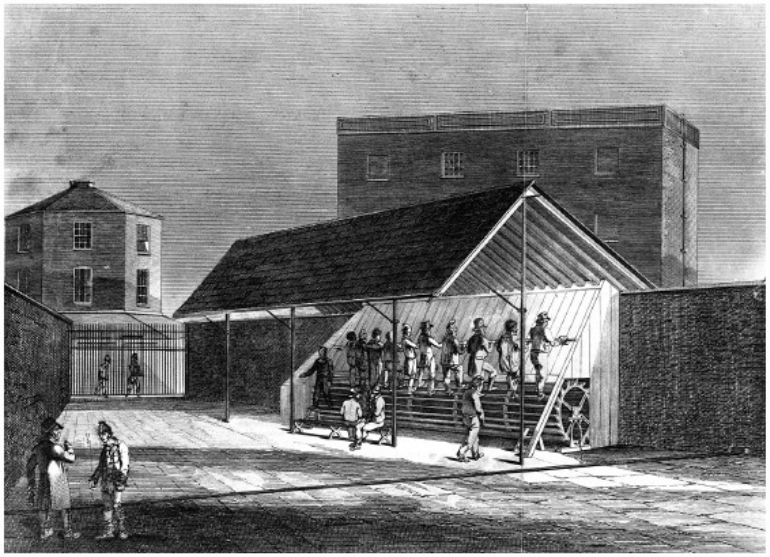
Tarım öğrencilikten zor

Tasks	People/Animals	Hours per hectare	Energy cost
Hoeing			M–H
General	1/—	100–120	M–H
Wet soil	1/—	150–180	H
Plowing			M–H
Wooden plow	1/1	30–50	H
Wooden plow	1/2	20–30	H
Steel plow	1/2	10–15	M
Harrowing	1 /2	3–10	M
Sowing			L–M
Broadcasting	1/—	2–4	M
Seed drills	1/2	3–4	L
Weeding	1/—	150–300	M–H
Harvesting			M–H
Sickle (wheat)	1/—	30–55	H
Sickle (rice)	1/—	90–110	H
Cradle	1/—	8–25	H
Binding sheaves	1/—	8–12	M–H
Shocking	1/—	2–3	H
Reaper	1/2	1–3	M
Binder	1/3	1–2	M
Combine	4/20	2	M
Threshing			L–H
Treading	1/4	10–30	L
Flailing	1/—	30–100	H
Threshers	7/8	6–8	M

Enerji kaynağı : İnsan

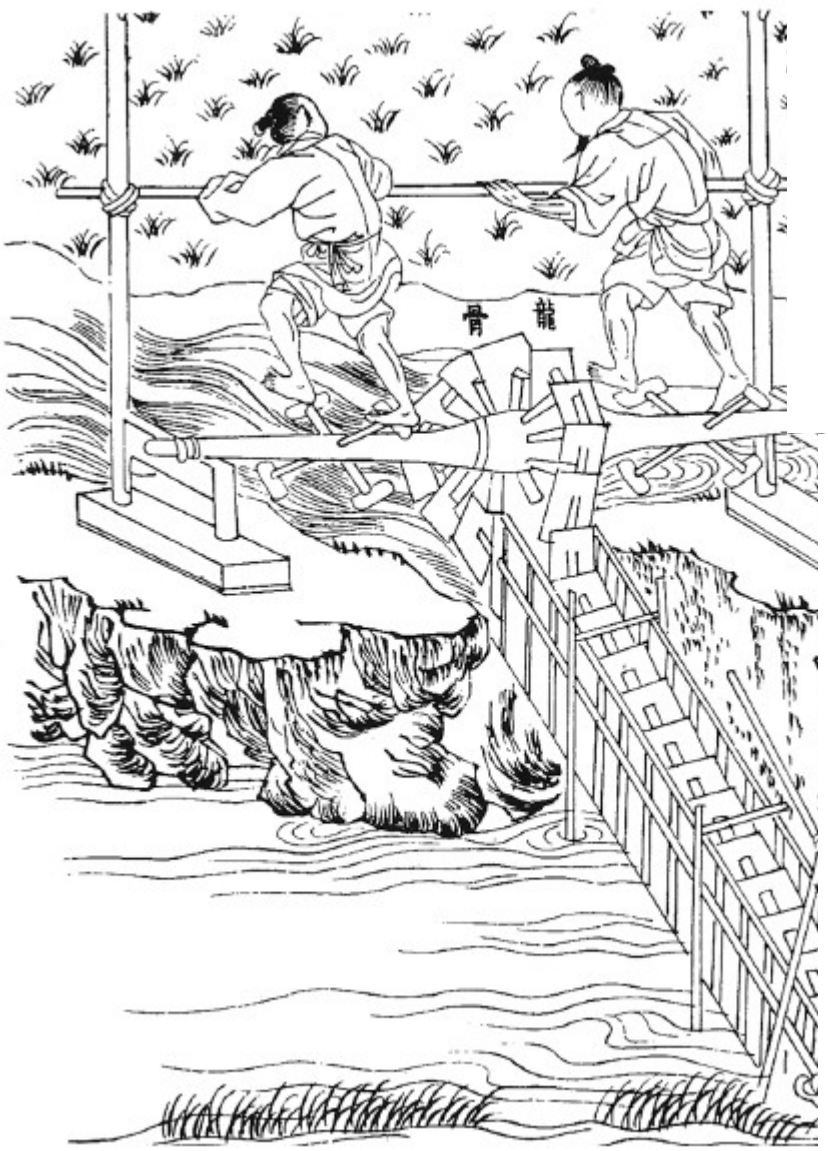




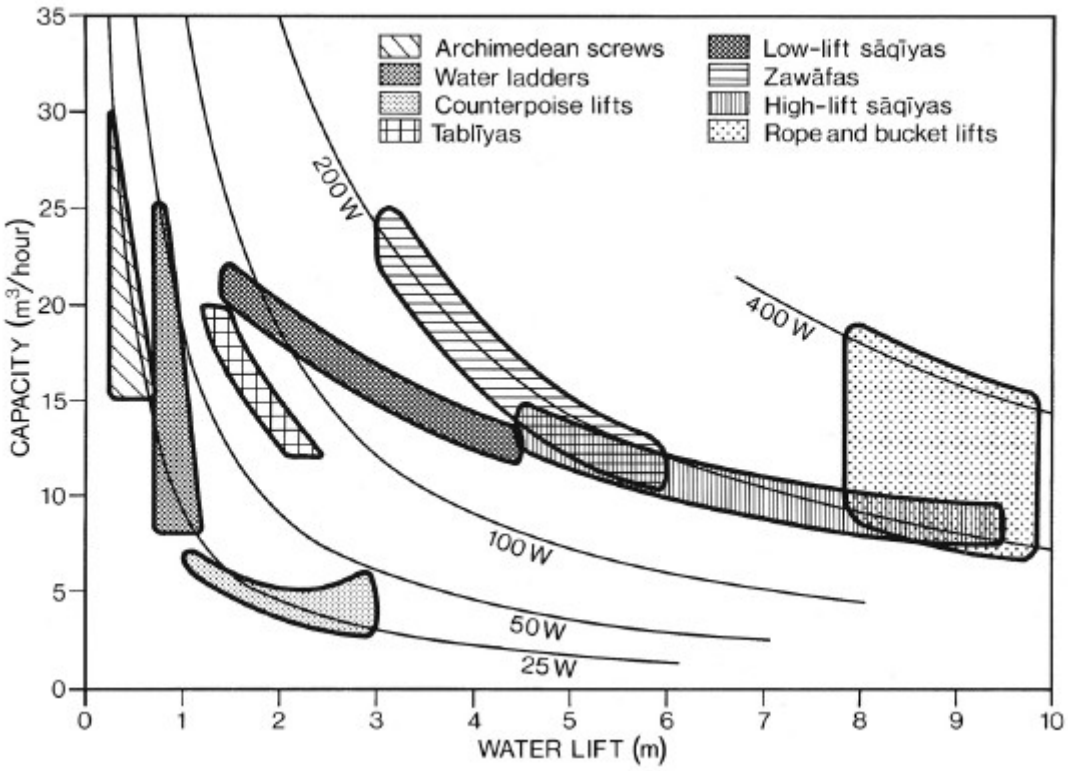


at the Brixton House of Correction (Corbis).

Sulama



Devices	People/ Animals	Lift (m)	Capacity (m^3/h)	Work (kJ)	Input (kJ)	Efficiency (%)
Scoops	2/—	0.6	5	30	440	7
Suspended scoops	2/—	1	8	80	440	18
Shaduf	1/—	2.5	3	75	220	34
Archimedean screw	2/—	0.7	15	100	440	23
Paddle wheel	1/—	0.5	12	60	220	27
Water ladder	2/—	0.7	9	60	440	14
Rope and bucket	3/4	9	17	1500	5,690	26
Saqiya	1/2	6	8	470	2,740	17
Zawafa	1/2	6	12	710	2,740	26
Noria high lift	1/2	9	9	790	2,740	29
Noria low lift	1/1	1.5	22	325	1,480	22
Tabliya	1/1	2.5	12	295	1,480	20



Ne kadar insan zamanı gidiyor

Tasks	People/Animals	Hours per hectare	Energy cost
Hoeing			M–H
General	1/—	100–120	M–H
Wet soil	1/—	150–180	H
Plowing			M–H
Wooden plow	1/1	30–50	H
Wooden plow	1/2	20–30	H
Steel plow	1/2	10–15	M
Harrowing	1 /2	3–10	M
Sowing			L–M
Broadcasting	1/—	2–4	M
Seed drills	1/2	3–4	L
Weeding	1/—	150–300	M–H
Harvesting			M–H
Sickle (wheat)	1/—	30–55	H
Sickle (rice)	1/—	90–110	H
Cradle	1/—	8–25	H
Binding sheaves	1/—	8–12	M–H
Shocking	1/—	2–3	H
Reaper	1/2	1–3	M
Binder	1/3	1–2	M
Combine	4/20	2	M
Threshing			L–H
Treading	1/4	10–30	L
Flailing	1/—	30–100	H
Threshers	7/8	6–8	M

1 Beygir kaç beygir

Animals	Weights (kg)		Typical draft (kg)	Usual speed (m/s)	Power (W)
	Common range	Large sizes			
Horses	350–700	800–1000	50–80	0.9–1.1	500–850
Mules	350–500	500–600	50–60	0.9–1.0	500–600
Oxen	350–700	800–950	40–70	0.6–0.8	250–550
Cows	200–400	500–600	20–40	0.6–0.7	100–300
Buffaloes	300–600	600–700	30–60	0.8–0.9	250–550
Donkeys	200–300	300–350	15–30	0.6–0.7	100–200

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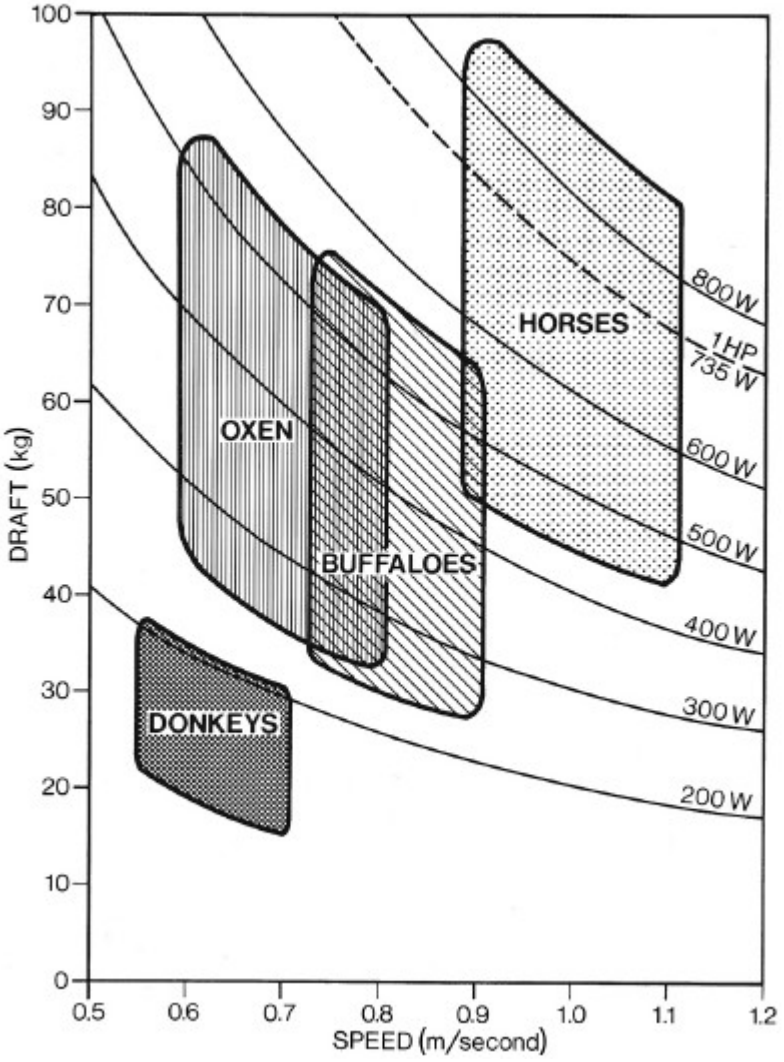
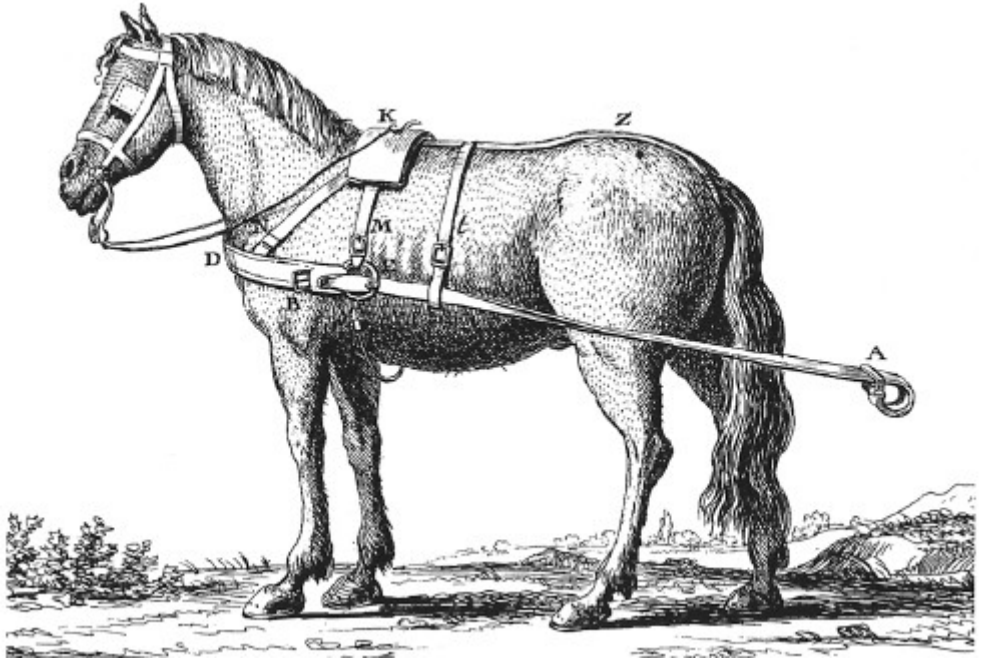
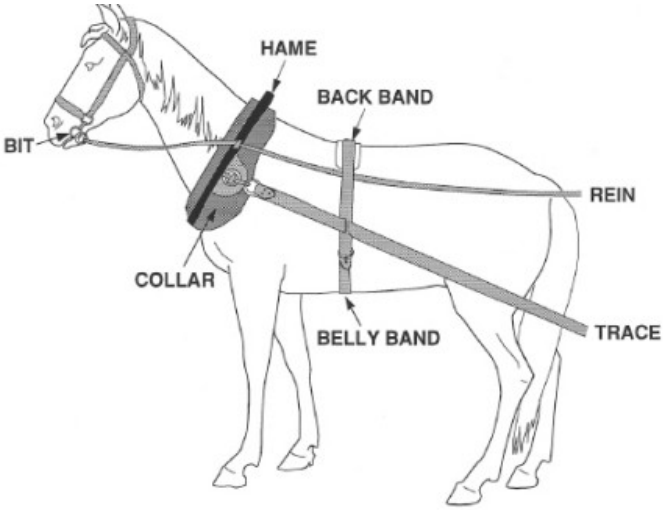
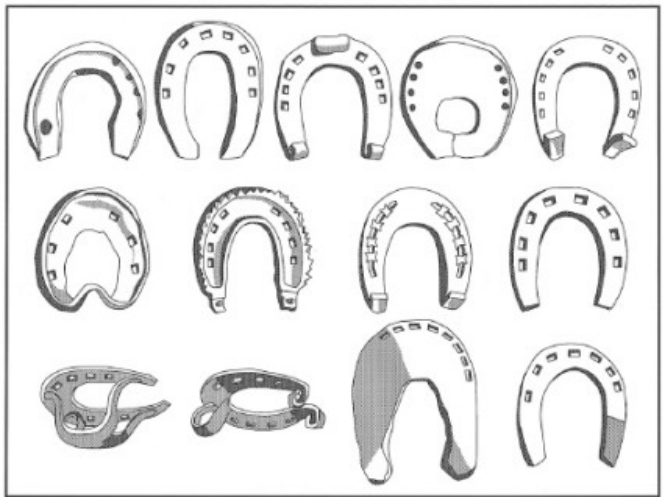


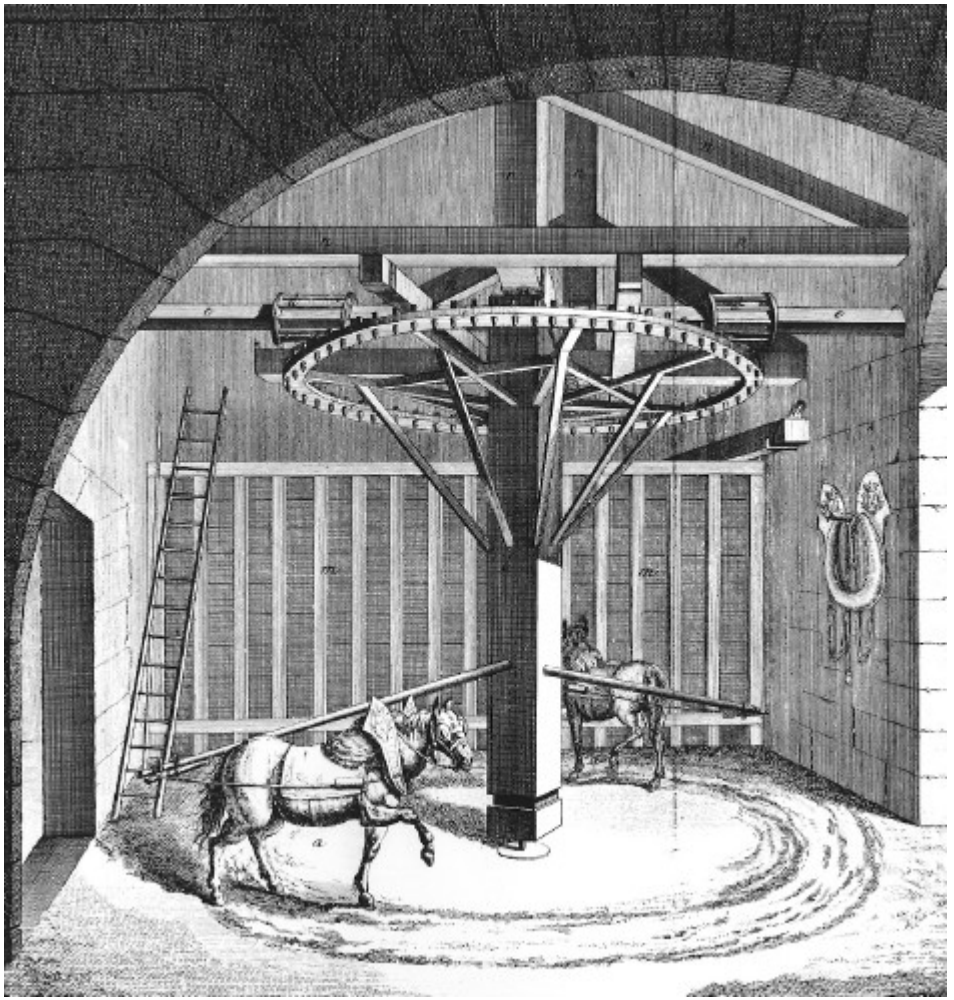
Attan güç almak için araçlar







Buhar öncesi



Labor requirements of European wheat harvests, 200–1800

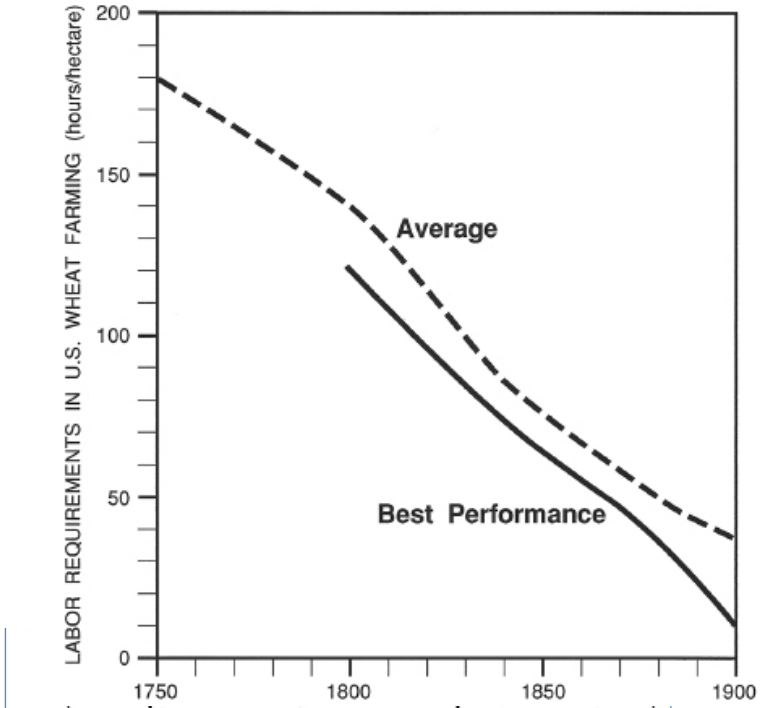
	Hours of labor (people/animals)/ha of wheat		
Tasks	Italy, 200	England, 1200	Netherlands, 1800
Plowing			
Oxen	37/74	25/150	
Horses			15/30
Harrowing	8/16	7/14	5/10
Sowing			
Broadcasting	4/—	4/—	
Seed drill			3/6
Manuring			40/60
Harvesting			
Sickle	50/—	50/—	
Cradle			24/—
Hauling	15/30	10/20	7/14
Threshing			
Treading (oxen)	30/60		
Flailing		30/—	33/—
Winnowing	25/—	25/—	30/—
Measuring, sacking	8/—	7/—	10/—

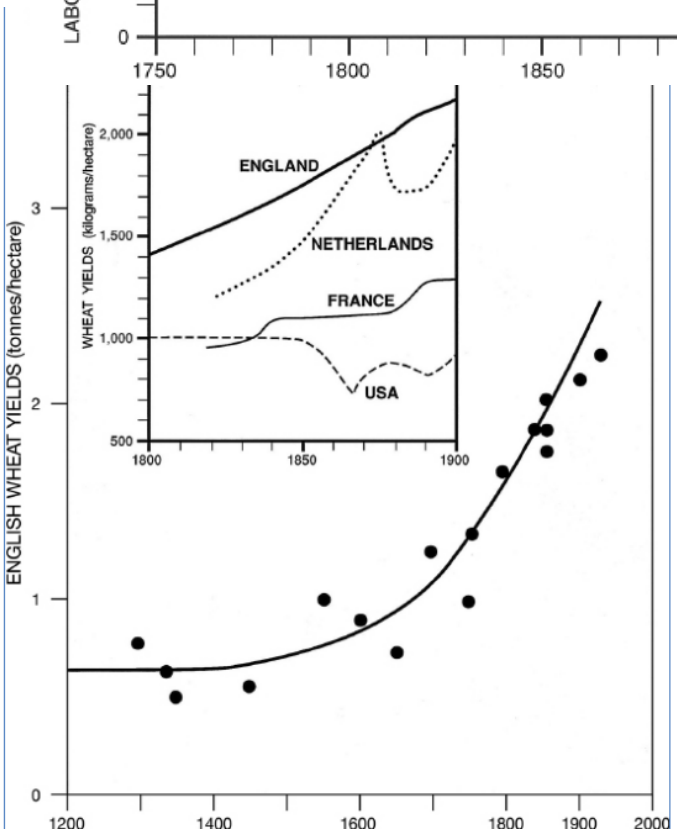
ulations are based on information in Baars (1973), Seebohm (1927), White (1970), and

	Energy costs and returns of wheat farming		
	Italy, 200	England, 1200	Netherlands, 1800
Hours of labor	177	158	167
Energy cost (MJ)	142	126	134
Grain yield (t/ha)	0.4	0.5	2.0
Food yield (GJ)	3.3	4.9	22.2
Net energy return	23	39	166
Hours of animal work	180	184	120

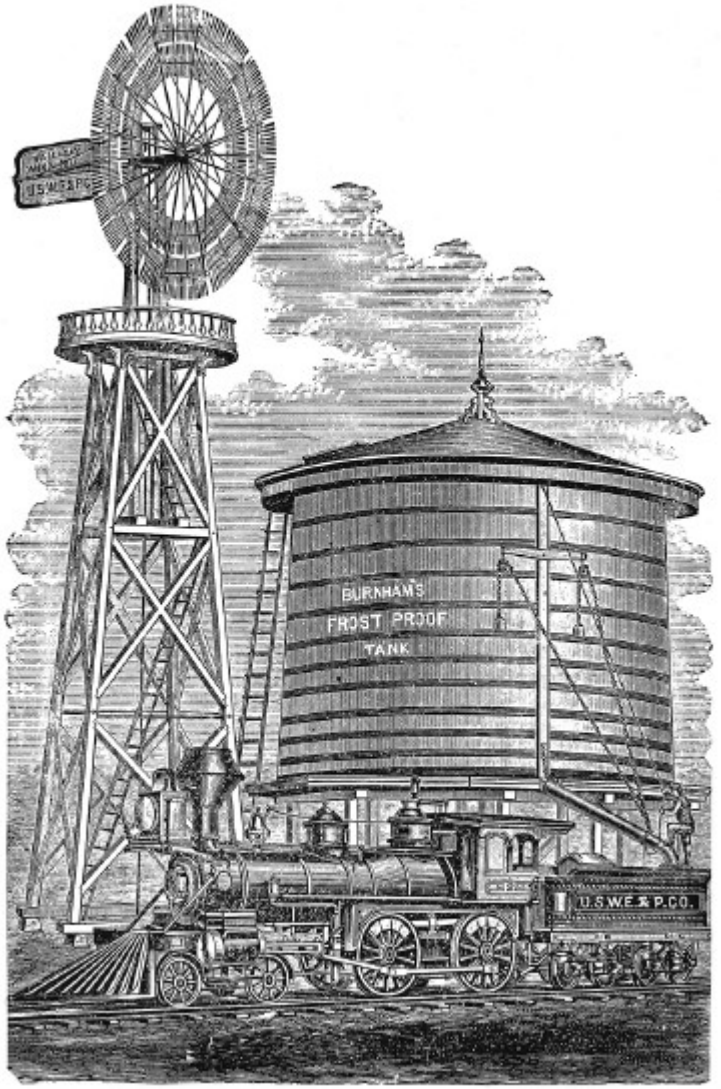
American wheat, 1800–1900

Tasks	1800	1850	1875	1900
Plowing				
Wooden plow	20/40			
Cast-iron plow		15/30		
Steel plow			8/24	
Steel gang plow				3/30
Harrowing				
Brush harrow	7/14			
Tooth harrow		5/10	5/15	1/4
Seeding				
Broadcasting	3/—			
Drilling		3/6	3/9	1/2
Harvesting				
Sickle	49/—			
Cradle		25/—		
Binder			11/6	
Combine				3/17
Hauling	10/10	8/8	5/5	2/10
Threshing				
Flailing	33/—			
Threshers		10/10	8/8	
Winnowing	40/—			
Hours of labor	162	66	40	9
Energy cost (MJ)	145	56	32	7
Gross food energy return	129	335	586	2680
Net food energy return	90	270	500	2400
Labor productivity (min/kg of grain)	7.2	2.9	1.8	0.4

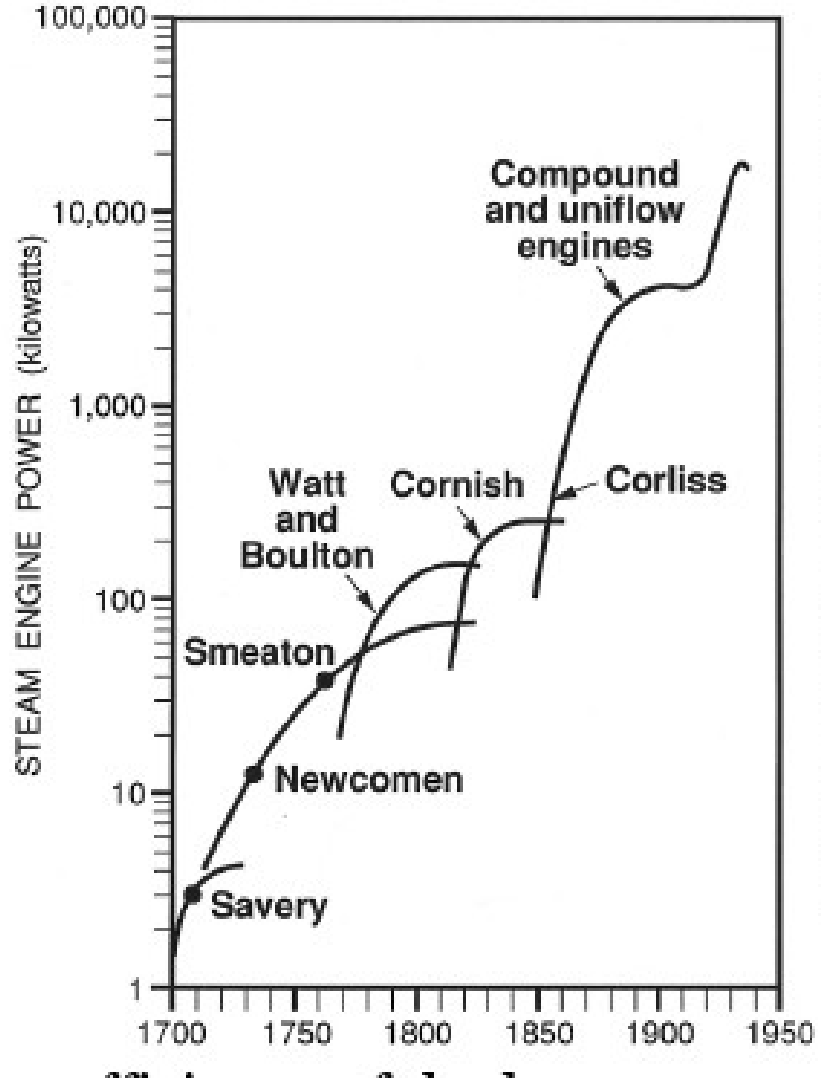


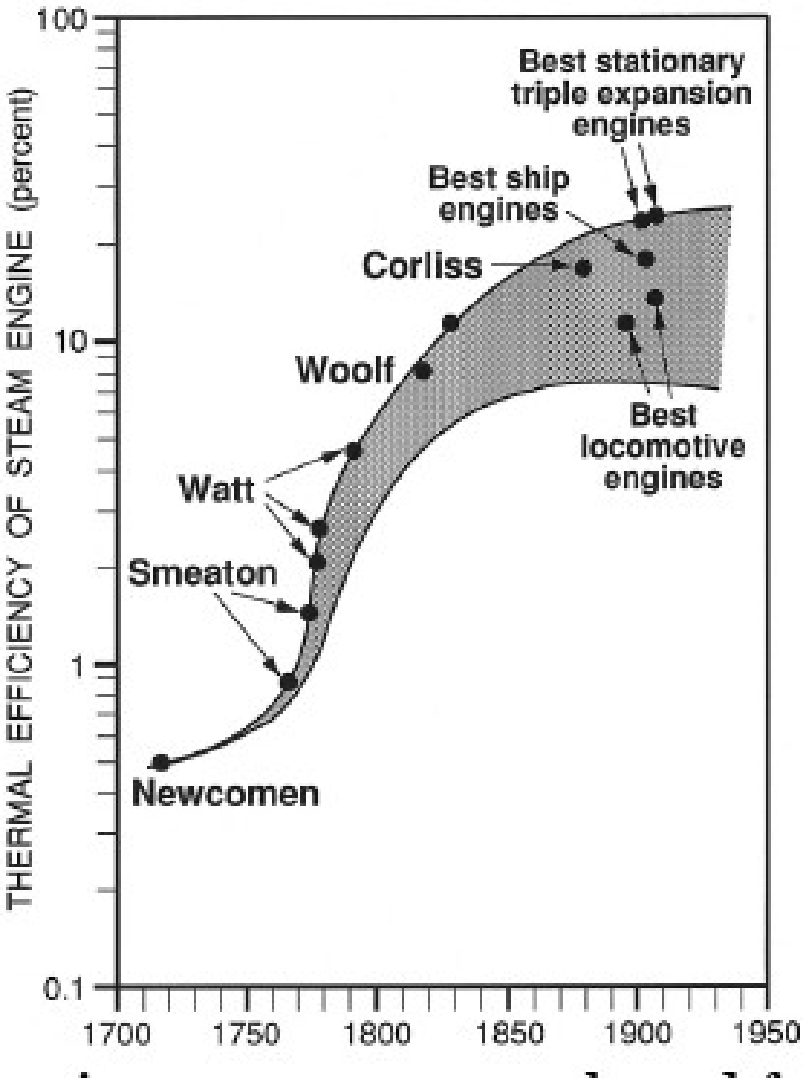


Rüzgar - Su

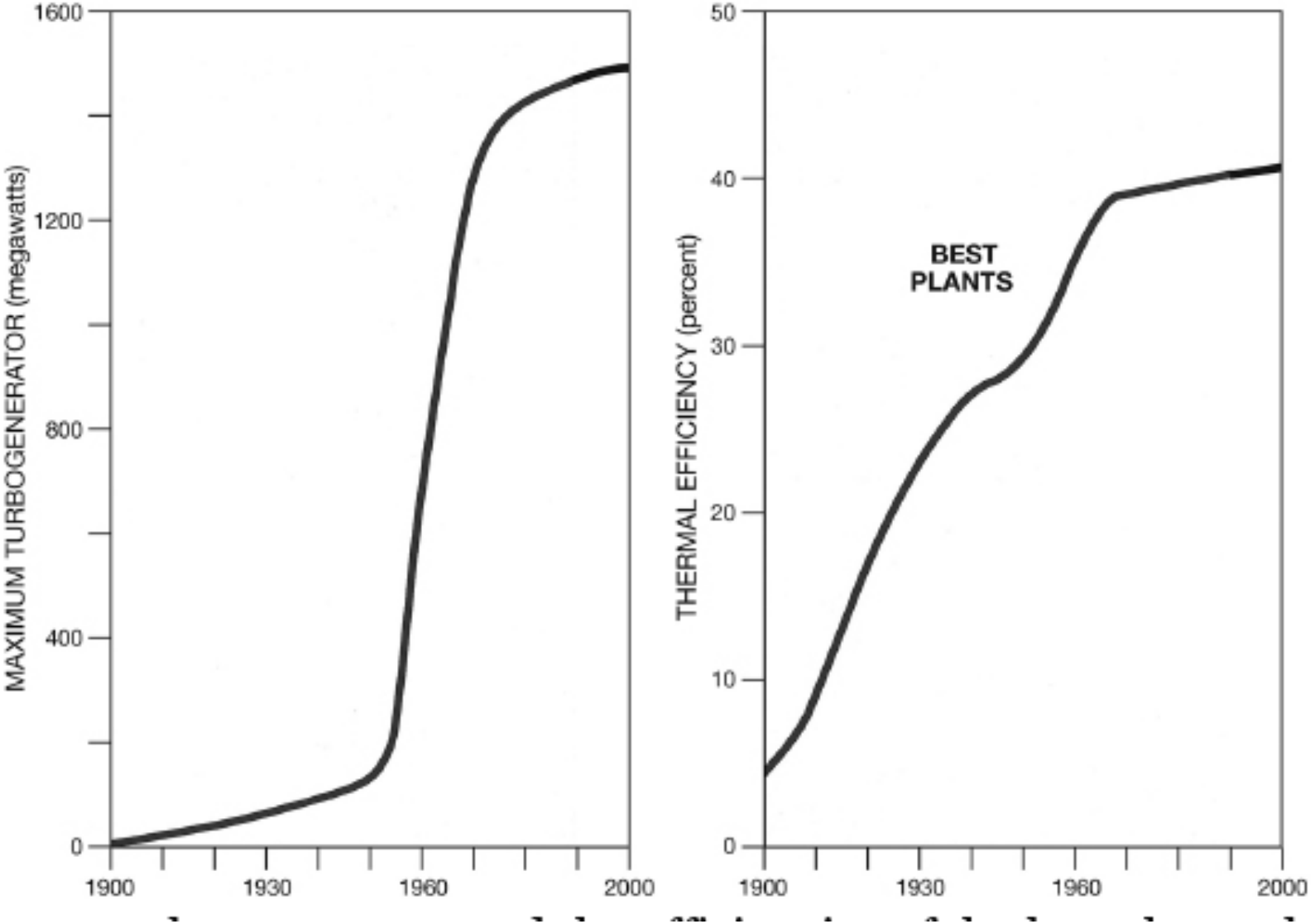


Termik verimler

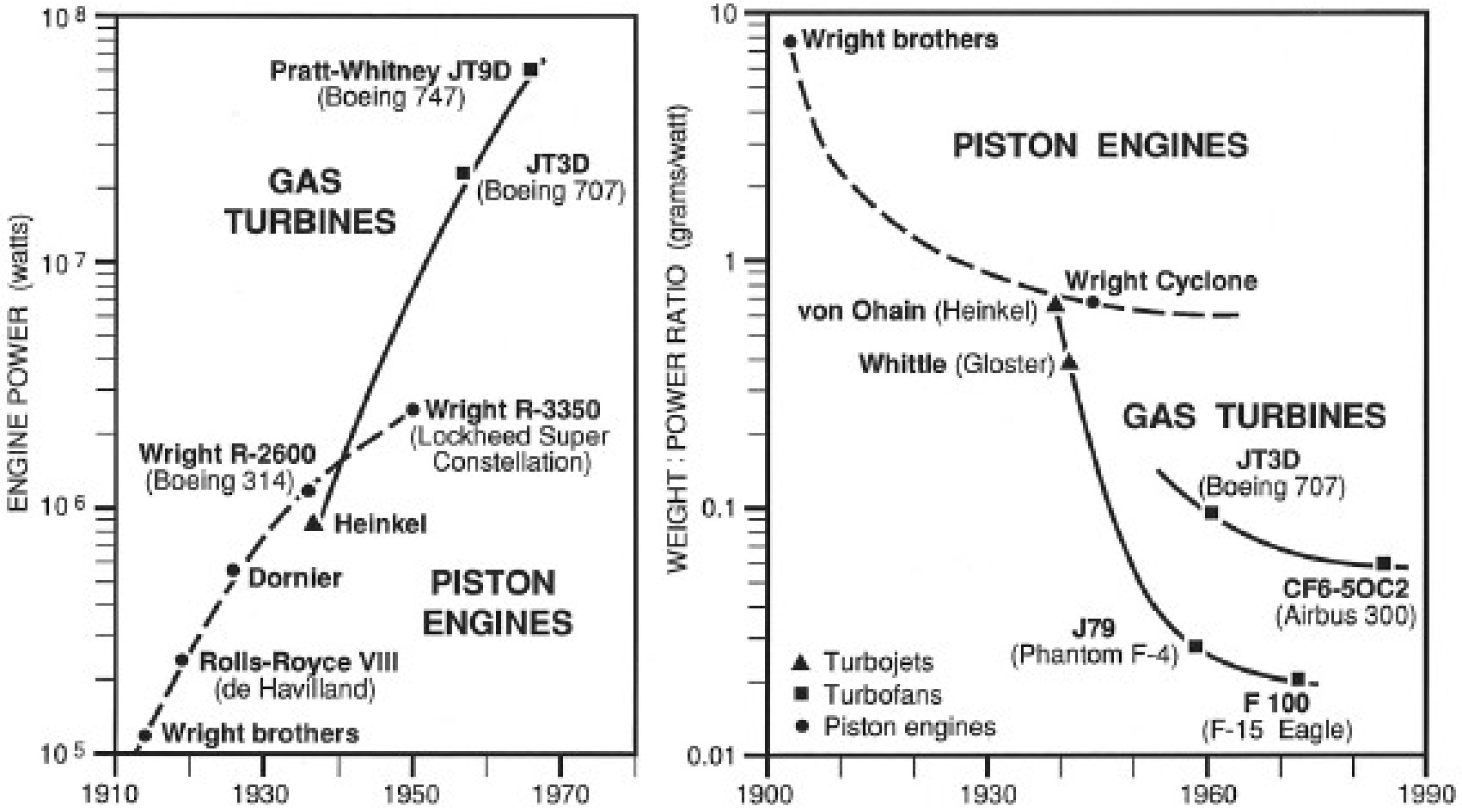




Verimlilikler



Verimlilik ve watt/gram



İngiltere'de kömür devrimi nasıl başladı?

- 1533'de 8. Henry ilk hanımını boşuyor
- Katolik kilisesinden ayrılınca, kilise sahalarını devletleştiriyor
- Kuzey İngiltere'deki kömür alanlarını kar amaçlı kişilere veriyor.
- 1620'de İngiltere enerjisinin yarısı kömürden.

https://www.nature.com/articles/d41586-017-07506-z

İngiltere de Ağaç kıtlığı

- İskoçya'da zaten çok ağaç yok
- 1550-1700 nüfus ana karada 2 misline çıktı
- Şehirleşme: Londra 8 misline
- 12.yy dan beri Avrupa'da kömür yakılıyor.
- 1550-1700 arası Newcastle'dan kömür kargoları 20 kat arttı.
- Kömür o kadar başarılı oldu ki 17.yy'da odun fiyat artışı durdu.

https://nature.berkeley.edu/er100/readings/Nef_1977.pdf

Odun yeter derken....

- Pirotechnia – Vannoccio Biringuccio (1540)
  - "Büyük ormanlar her yerde"
- De re metallica – Georgius Agricola(1556)
  - madencilik
- Adam Smith(1776) – "İskoçya'da bir tek İskoç odunu yok"

https://nature.berkeley.edu/er100/readings/Nef_1977.pdf

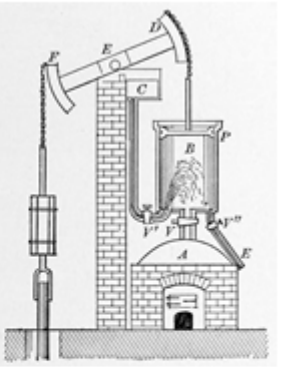
Adam Smith'de Türk madenciler

than that of the latter. The Hungarian mines, it is remarked by Mr. Monteſquieu, though not richer, have always been wrought with leſs expenſe, and therefore with more profit, than the Turkiſh mines in their neighbourhood. The Turkiſh mines are wrought by ſlaves; and the arms of thoſe ſlaves are the only machines which the Turks have ever thought of employing. The Hungarian mines are wrought by freemen, who employ a great deal of machinery, by which they facilitate and abridge their own labor. From the very little

https://books.google.com.tr/books?id=vQxKAAAAcAAJ&lpg=PA304&ots=2AwbVpnJIl&dq=adam%20smith%20wealth%20of%20nations%20turkish%20miners%20hungarian&pg=PA304#v=onepage&q&f=false

Herşey Kömür için

it preserved the limited timber growth. The hungry market required a solution to a problem that challenged the British mining industry. This solution was Thomas Newcomen's 1712 invention of a simple single-piston pump, the first machine to successfully direct steam to produce work. Newcomen engines were quickly put to use all over England to pump out the water that regularly flooded the coal mines. In allowing coal mines to delve deeper into the ground, the Newcomen caused an expansion in England's coal industry.



https://www.theguardian.com/environment/gallery/2015/dec/18/coal-mining-britain-brief-history-in-pictures

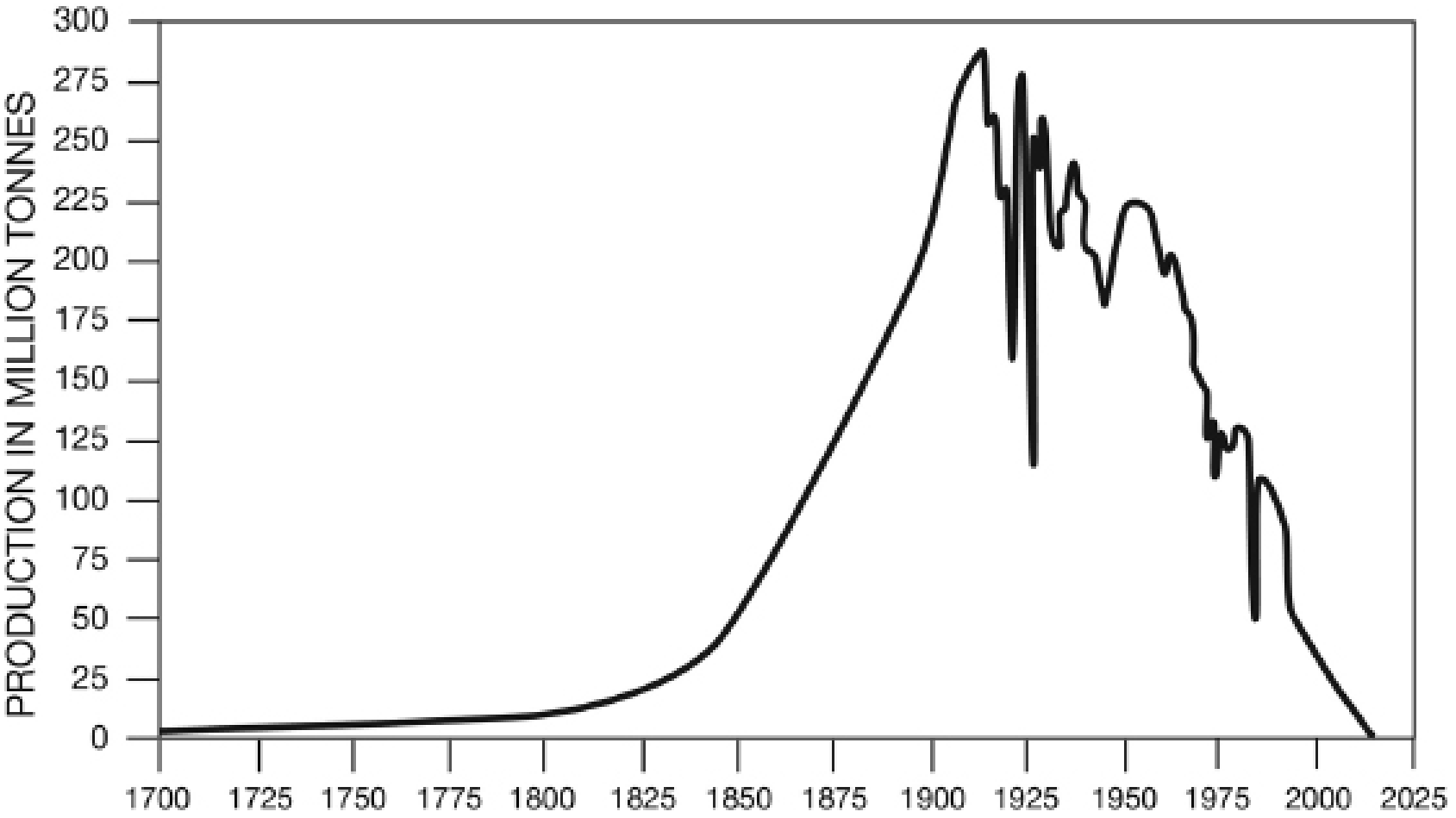
http://history.alberta.ca/energyheritage/coal/early-coal-history-to-1900/the-steam-engine-the-industrial-revolution-and-coal.aspx

Vaclav Smil'den

solution: almost all of the country's coalfields were opened up between 1540 and 1640.

By 1650 annual English coal output had passed 2 Mt; 3 Mt/year were extracted in the early eighteenth century and more than 10 Mt/year by its end. The rising use of coal required solving many technical and organizational problems connected with its mining, transport, and combustion. The depletion of outcropping seams led to the development of deeper pits. While the pits were rarely more than 50 m deep during the late seventeenth century, the deepest shafts surpassed 100 m shortly after 1700, 200 m by 1765, and 300 m after 1830. By that time daily production was between 20 and 40 t per mine, compared to just a few tonnes a century earlier. Deeper pits required more water pumping, and more energy was also needed for mine ventilation, for hoisting the coal from deeper shafts, and for its distribution. Waterwheels, windmills, and horses powered these needs. Coal mining itself was energized by heavy human labor.

İngiltere kömür üretimi



ABD tarafından

- Büyük odun kıtlığı (6 Ocak 1905)

FEARS A TIMBER FAMINE.

"If the present rate of forest destruction is allowed to continue, a timber famine is obviously inevitable. Fire, wasteful and destructive forms of lumbering, and legitimate use, are together destroying our forest resources far more rapidly than they are being replaced.

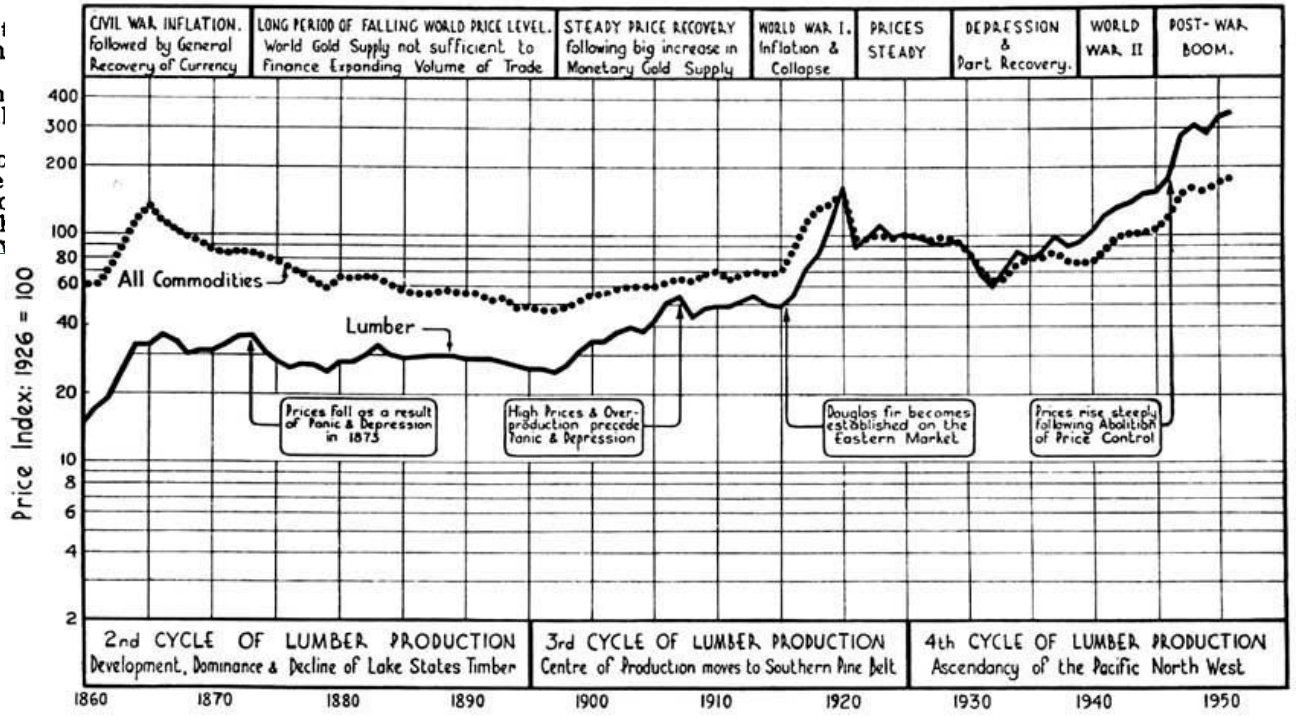
"What such a famine would mean to each of the industries of the United States it is scarcely possible to imagine. And the period of recovery from the juries which a timber famine would ent would be measured by the slow growth the trees themselves.

"Fortunately, the remedy is a sim one, and your presence here is proof t it is being applied.

"It is only as the producing and co mercial interests of the country come realize that they need to have trees gro ing up in the forest not less than t need the product of the trees cut do

CIVILIZATION'S NEED OF WOOD.

"Wood is an indispensabe part of the material structure upon which civilization rests, and civilized life makes continually greater demands upon the forest. We use not less wood, but more.



http://www.fao.org/docrep/x5397e/x5397e07.htm

http://query.nytimes.com/mem/archive-free/pdf?res=940DE4DE133AE733A25755C0A9679C946497D6CF

Elektrikli araba benzinliden önce mi icat edildi?

- İskoçyalı Robert Anderson, 1834-1835'de elektrikli ilk taşımayı icat etti
- 1842'de şarj edilemeyen
- 1865 Fransız Gaston Plante kurşun-asit pil
- İlk benzin motoru Carl Benz – 1879
- Ford (11 Ocak 1914):

> Within a year, I hope, we shall begin the manufacture of an electric automobile. I don't like to talk about things which are a year ahead, but I am willing to tell you something of my plans.
>
> The fact is that Mr. Edison and I have been working for some years on an electric automobile which would be cheap and practicable. Cars have been built for experimental purposes, and we are satisfied now that the way is clear to success. The problem so far has been to build a storage battery of light weight which would operate for long distances without recharging. Mr. Edison has been experimenting with such a battery for some time.

https://energy.gov/articles/history-electric-car

http://www.automostory.com/first-electric-car.htm

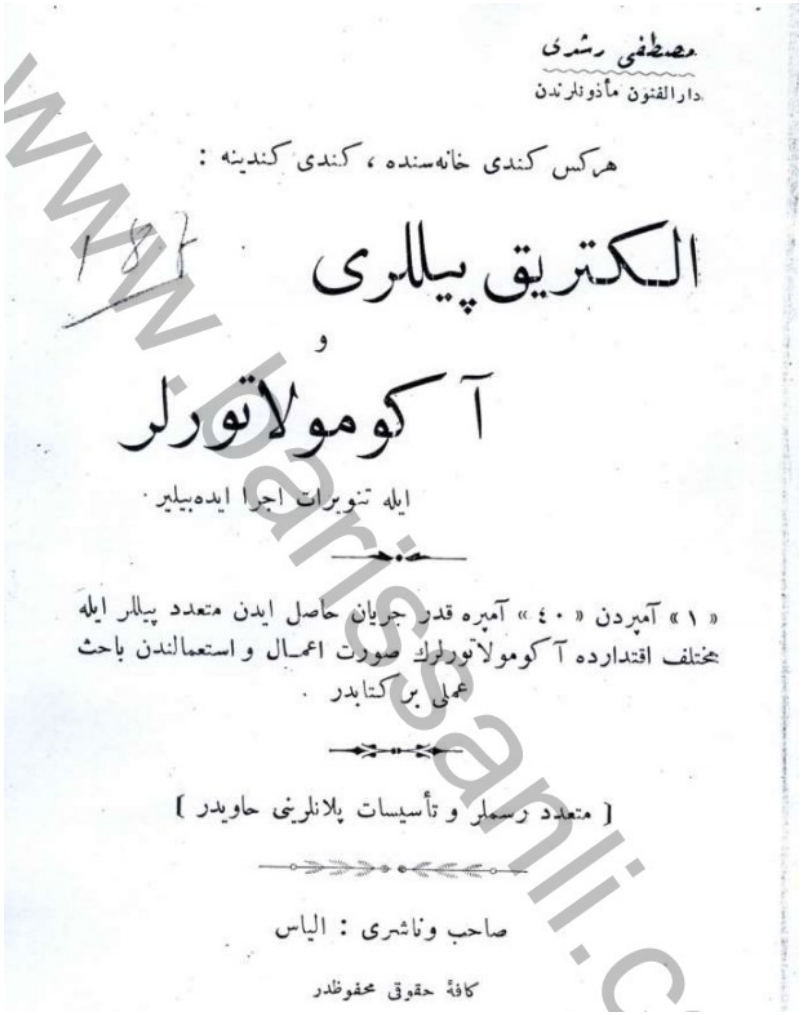
https://jalopnik.com/5564999/the-failed-electric-car-of-henry-ford-and-thomas-edison

Elektrikli aydınlatmayı kim icat etti

- Humphry Davy, Volta pillerini kömür elektrotlara
- 1802 – "Ark lambaları"
- 1878 Swan İngiltere'de patent aldı
- Edison 1879
- Sonra Edison-Swan United kurdular

https://www.livescience.com/43424-who-invented-the-light-bulb.html

1915 – Osmanlıca Elektrik pilleri kitabı



مصطفى رشدى

دارالفنون مأذونلرندن

هركس كندى خانه‌سنده ، كندى كندينه :

الكتريق پيللرى

و

آكومولاتورلر

ايله تنويرات اجرا ايده‌بيلير .

« ١ » آمپردن « ٤٠ » آمپره قدر جريان حاصل ايدن متعدد پيللر ايله مختلف اقتداردە آكومولاتورلرك صورت اعمال و استعمالندن باحث عملى بر كتابدر .

[متعدد رسملر و تأسيسات پلانلرينى حاويدر]

صاحب وناشرى : الياس

كافة حقوق محفوظدر

١٧ الكتريق پيللرى

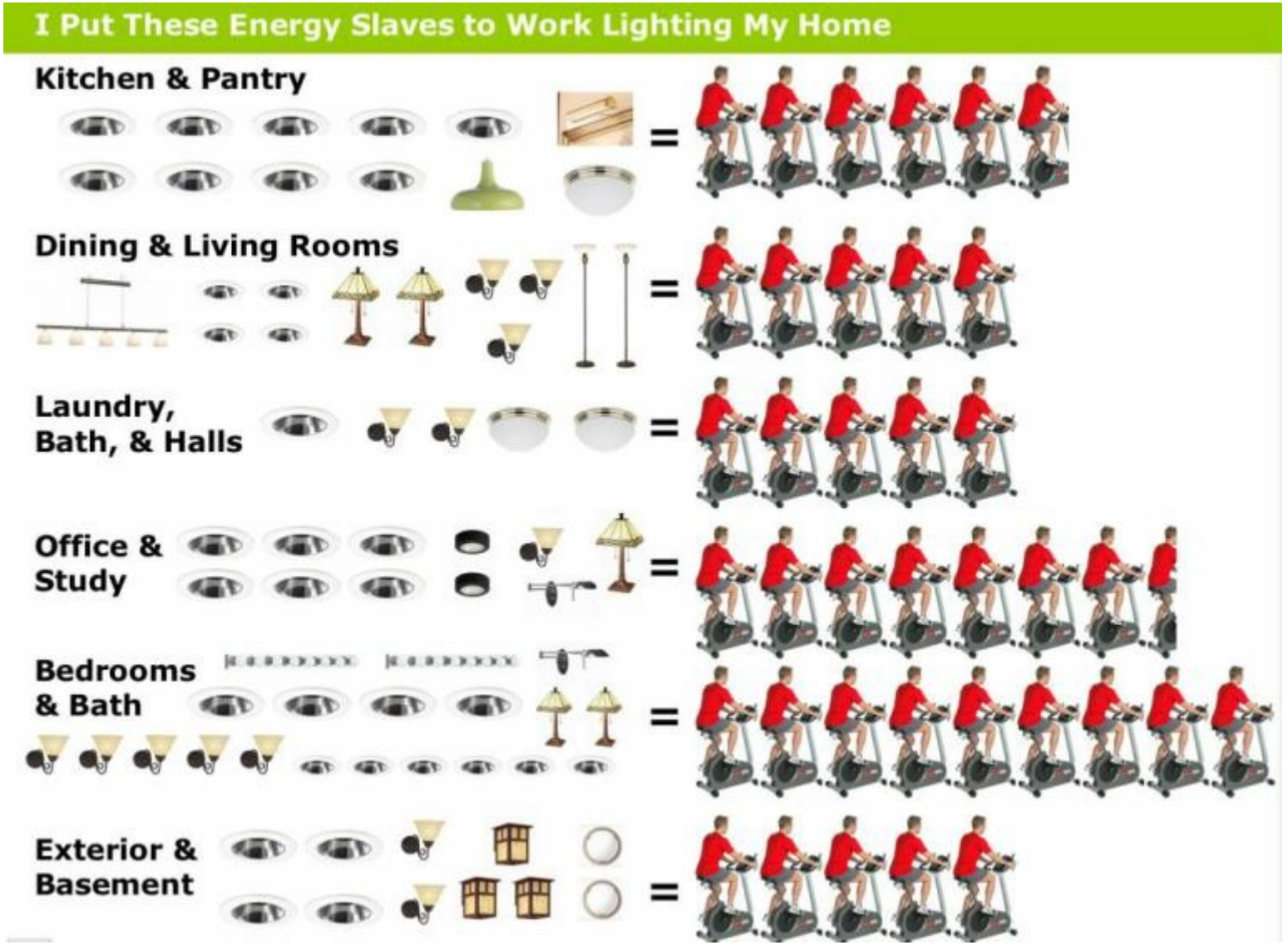
برتبدل يوقدر. آنجق برشى‌وارکه اوده مانع استقطاب ماده دها كثير مقداردە بولنيوردە مدت دوام تزايد ايدييور . بو پيلك فيآتى‌ده فابريقه‌سنده ايكى فرانقدر . مدت دوامنك چوقلغى حسبيله متقطع صورتده ضيااستحصالنده فائده‌بحشدر. (٨—١٠) دقيقه ظرفنده اينجه تللى لامبه‌لرله پك كوزل وپازلاق ضيا حاصل ايده‌بيلير. مخترع (موسيوونسان) بوپيله (Simplex) نامنى ويرمشدر .

2 Jahre Garantie!

(شكل ٨)طوربه‌لى پيل (شكل ٧)طوربه‌لى پيلك قطبلرى

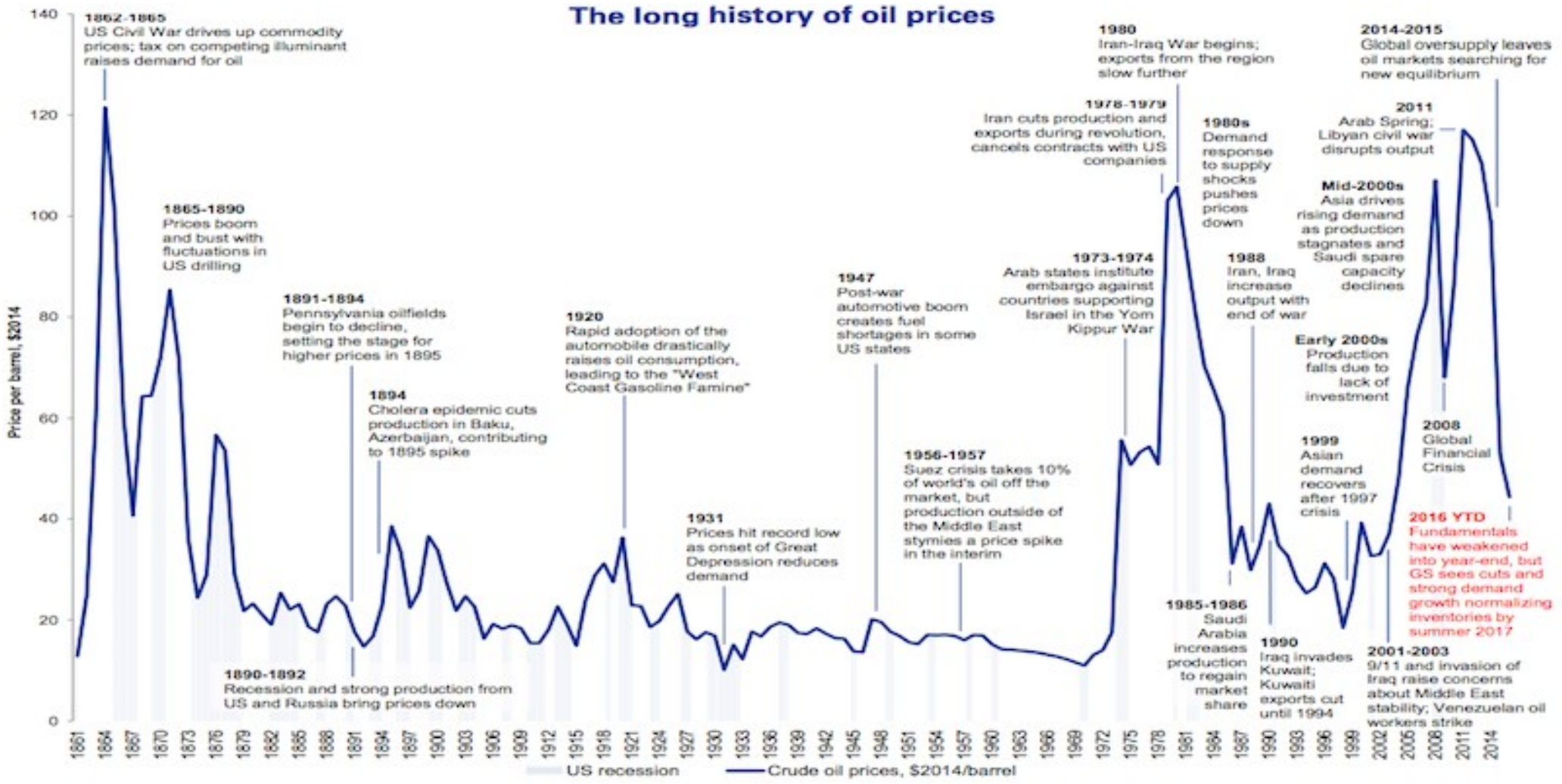
http://www.barissanli.com/calismalar/tarih/elektrikpilleri-1915-

Enerji köleleri



http://energyskeptic.com/2014/energy-slaves/

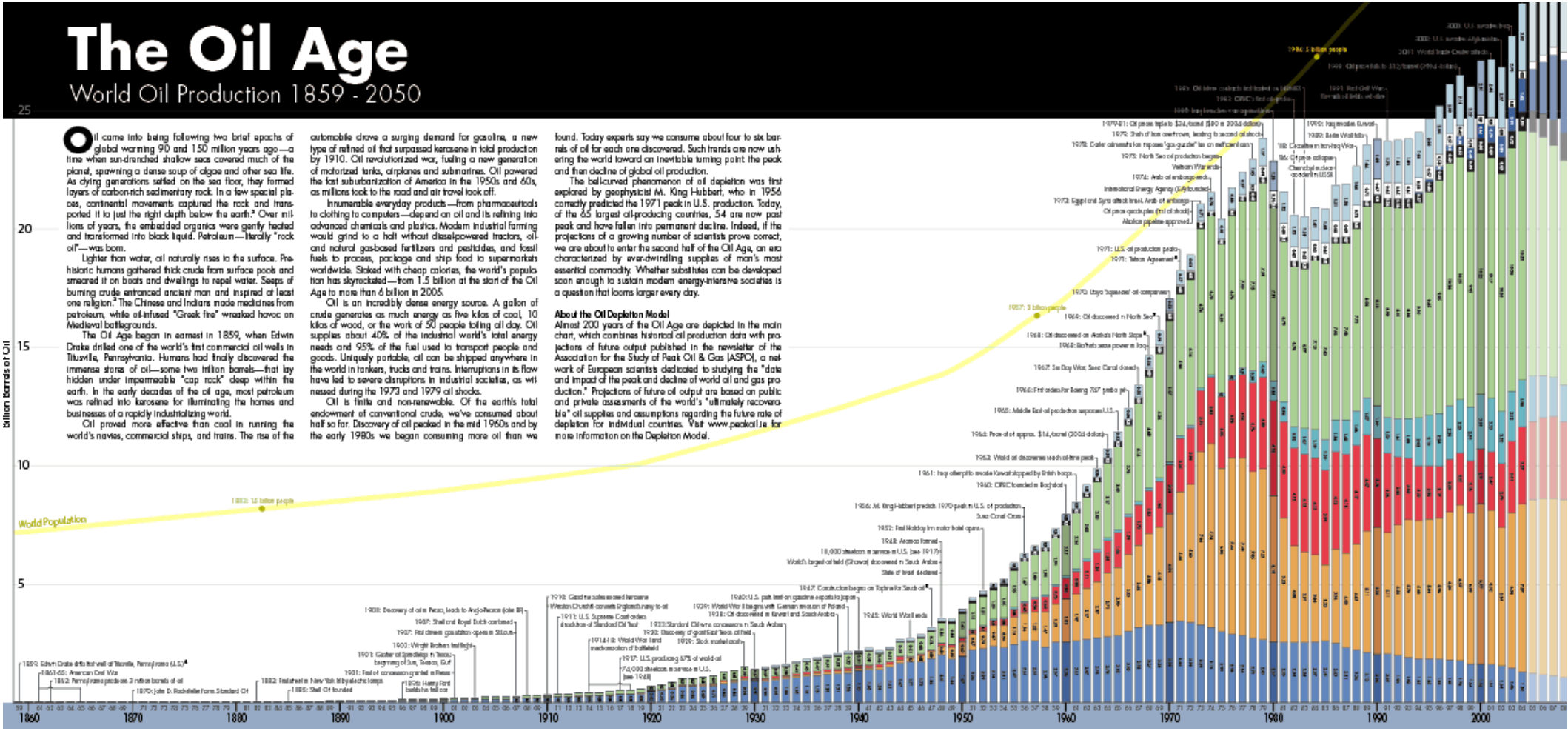
Petrol fiyatları = Petrol tarihi



http://www.businessinsider.com/timeline-155-year-history-of-oil-prices-2016-12

Petrol üretimi

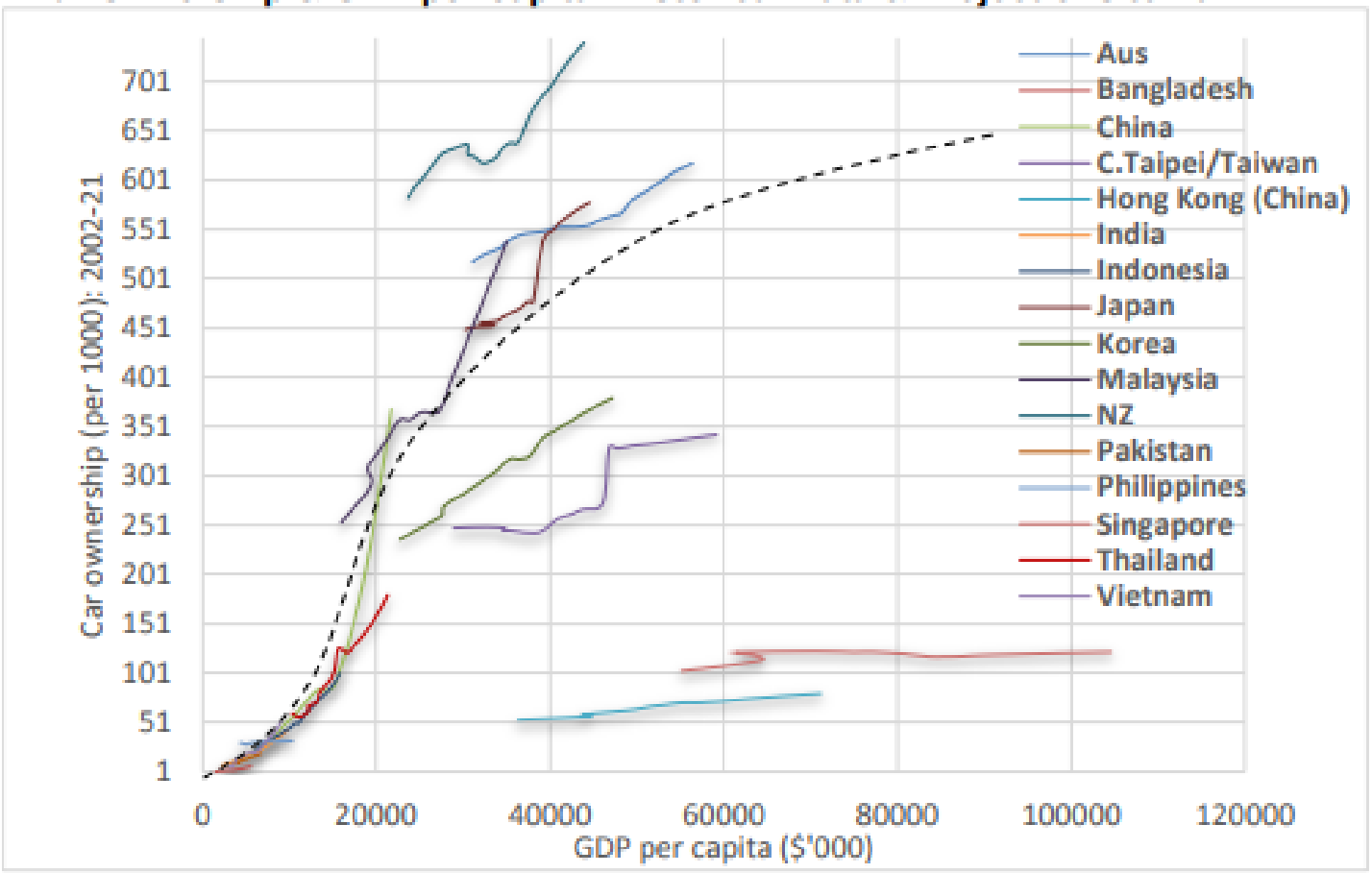
1 litre = 10kWh = 125 saat insan enerjisi



https://backspace.com/notes/2006/04/san-francisco-passes-peak-oil-resolution.php

Talep dinamikleri - Araba sahipliği Asya tahmini

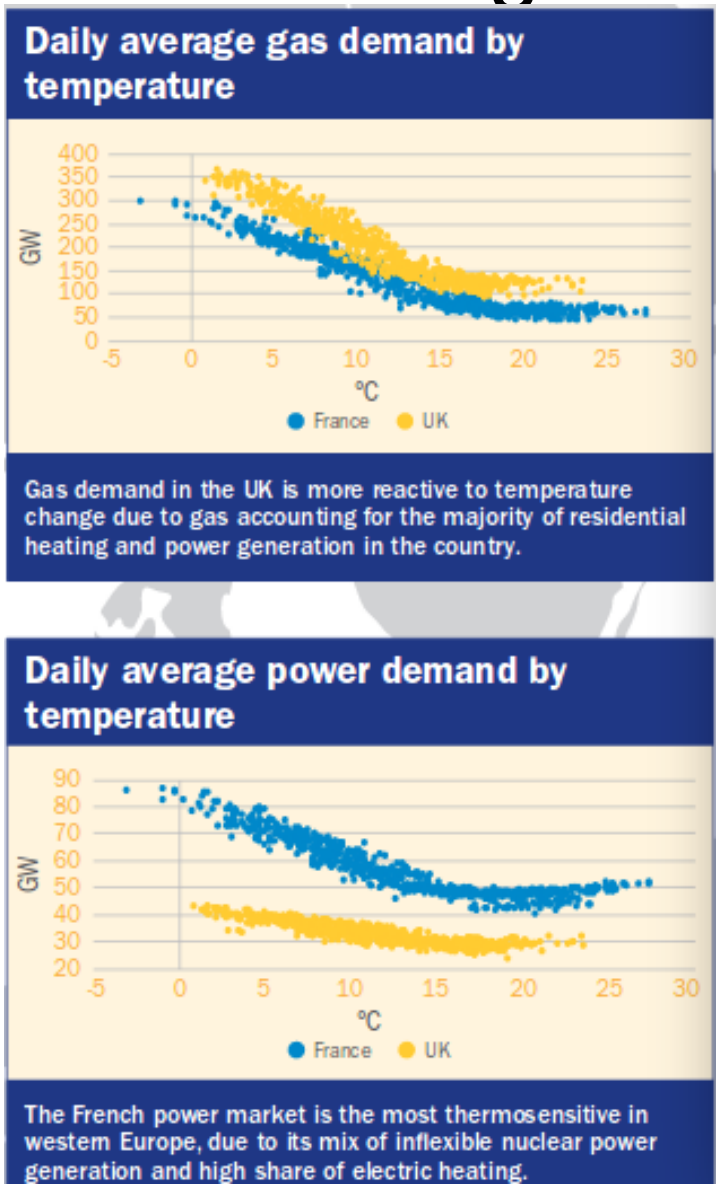
Figure 3: Car Ownership & GDP per capita: Historical Data & Projections to 2021



Source: Authors

https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/11/Gasoline-Demand-in-Transport-in-Non-OECD-Asia-Insight-22.pdf

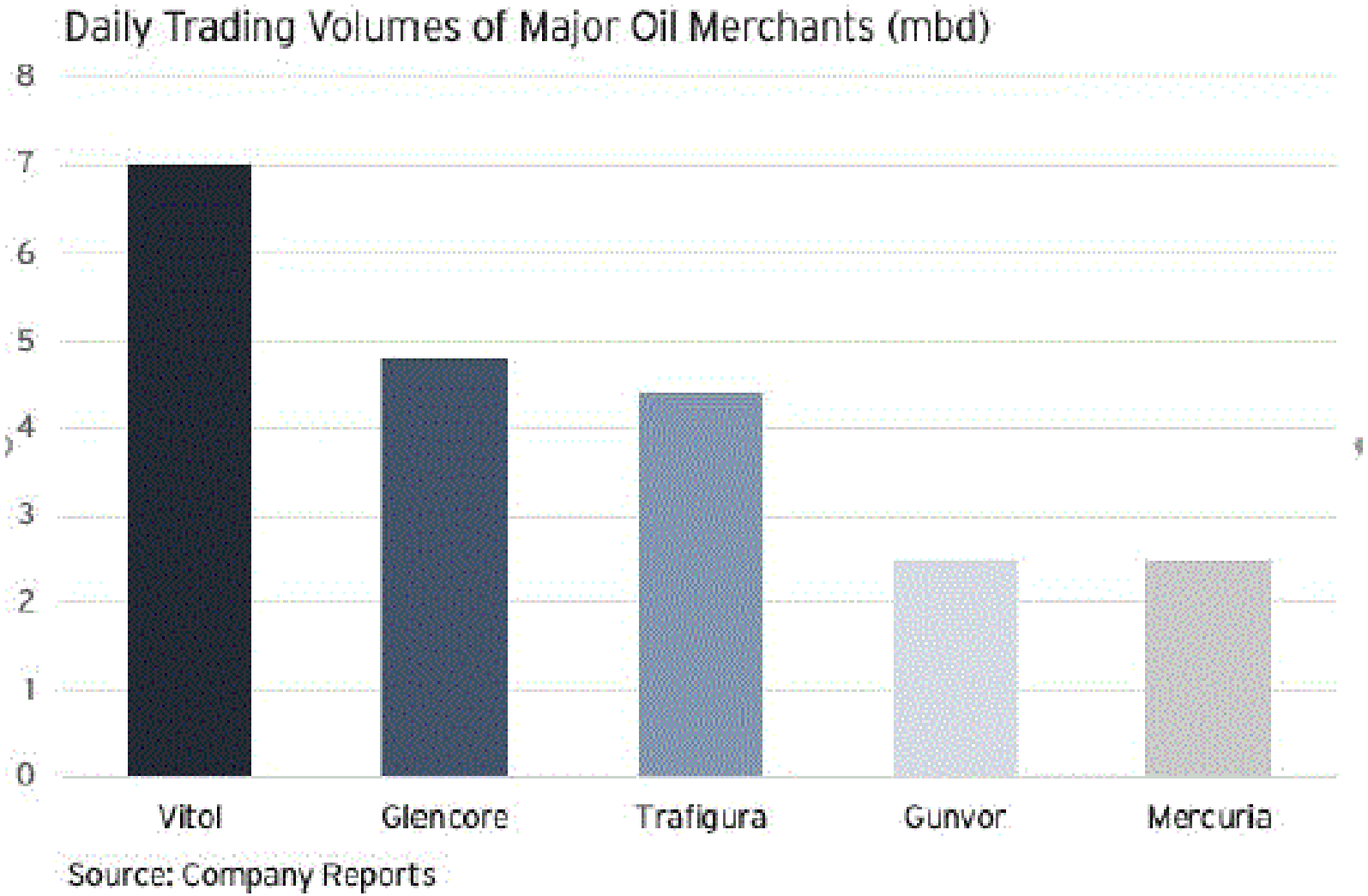
Talep dinamikleri – sıcaklık esnekliği
(Sadece konfor değil - iklim&teknoloji)



https://www.icis.com/globalassets/documents/forms/ppf-pdf/energy-demand-temperature_infog.pdf

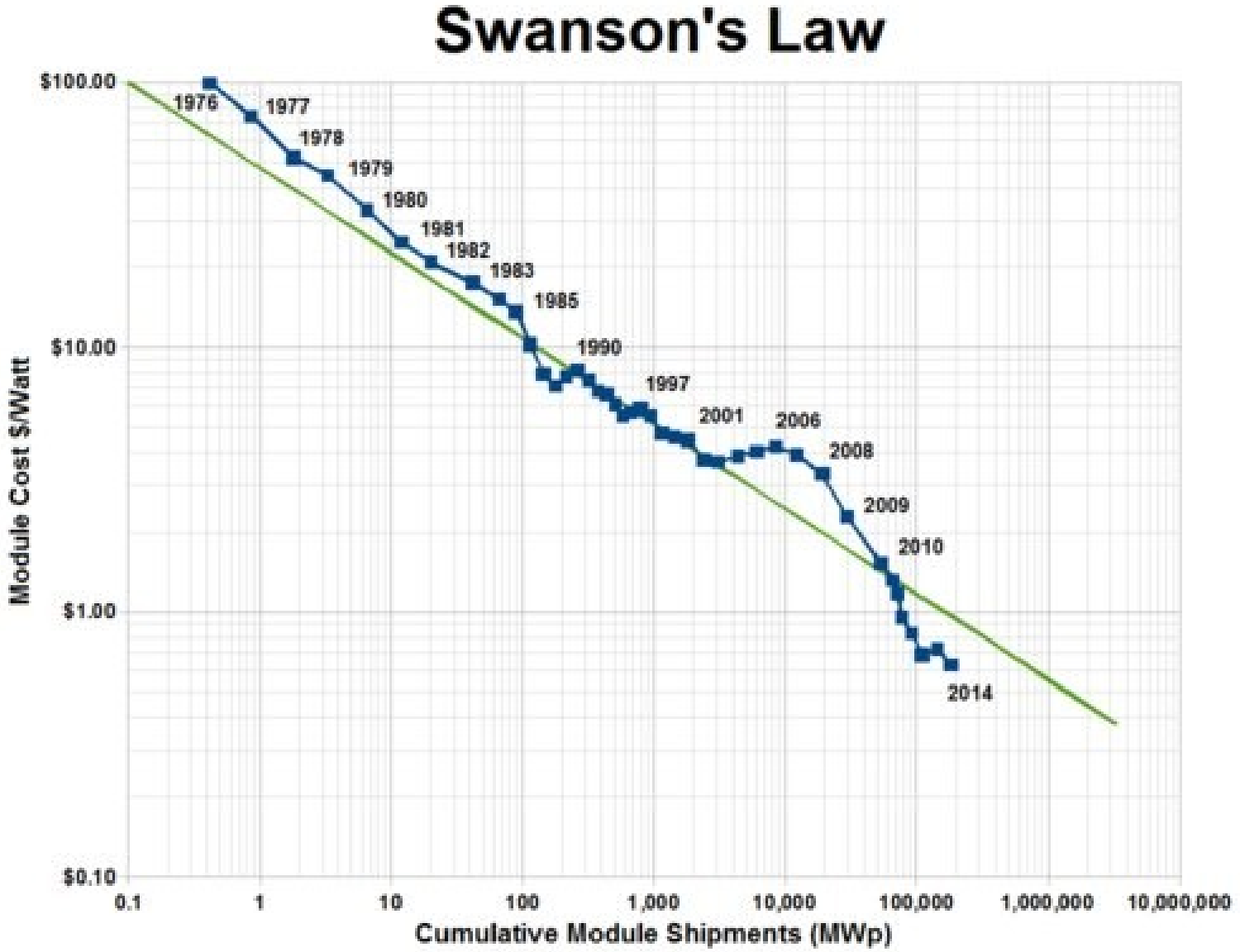
Dünyanın önemli petrol tacirleri

Tanıdık var mı?



http://energyfuse.org/nigerias-prepayment-deal-traders-necessary-support-economic-goals/

Güneş - Swanson yasası



IEEE

Derli toplu bir şebeke geleceği

https://energy.mit.edu/wp-content/uploads/2016/12/Utility-of-the-Future-Full-Report.pdf

Fred Scweppe – "Homeostatic"

IEEE Transactions on Power Apparatus and Systems, Vol. PAS-99,No. 3 May/June 1980

HOMEOSTATIC UTILITY CONTROL

Fred C. Schweppe, Fellow IEEE
Richard D. Tabors, Member IEEE
James L. Kirtley, Jr., Member IEEE
Hugh R. Outhred*, Member IEEE
Frederick H. Pickel, Student Member IEEE
Alan J. Cox

Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Abstract - Distribution Automation and Control (DAC) systems have potentially major effects on costs, social impacts, and even on the nature of the power system itself, especially as dispersed storage, generation, and customer interaction become more prevalent. However, at the present time, it is not clear which particular modes of control will best exploit the capabilities of DAC. Homeostatic Utility Control is an overall concept which tries to maintain an internal equilibrium between supply and demand. Equilibrating forces are obtained over longer time scales (5 minutes and up) by economic principles through an Energy Marketplace using time-varying spot prices. Faster supply-demand balancing is obtained by employing "governor-type" action on certain types of loads using a Frequency Adaptive Power Energy Rescheduler (FAPER) to

- Finally, government regulation plays a mixed role; customers are isolated from changes in real cost while utilities are isolated from the effects of competition.

This paper introduces a basic philosophy in which the supply (generation) and demand (load) respond to each other in a cooperative fashion and are in a state of continuous equilibrium. Homeostasis is a biological term referring to the "existence of a state of equilibrium...between the interdependent elements of an organism." It is appropriate to apply this concept to an electric power system in which the supply systems and demand systems work together to provide a natural state of continuous equilibrium to the benefit of both the utilities and their customers. A set of interrelated physical and economic forces maintains the

Enerji Piyasa alanı

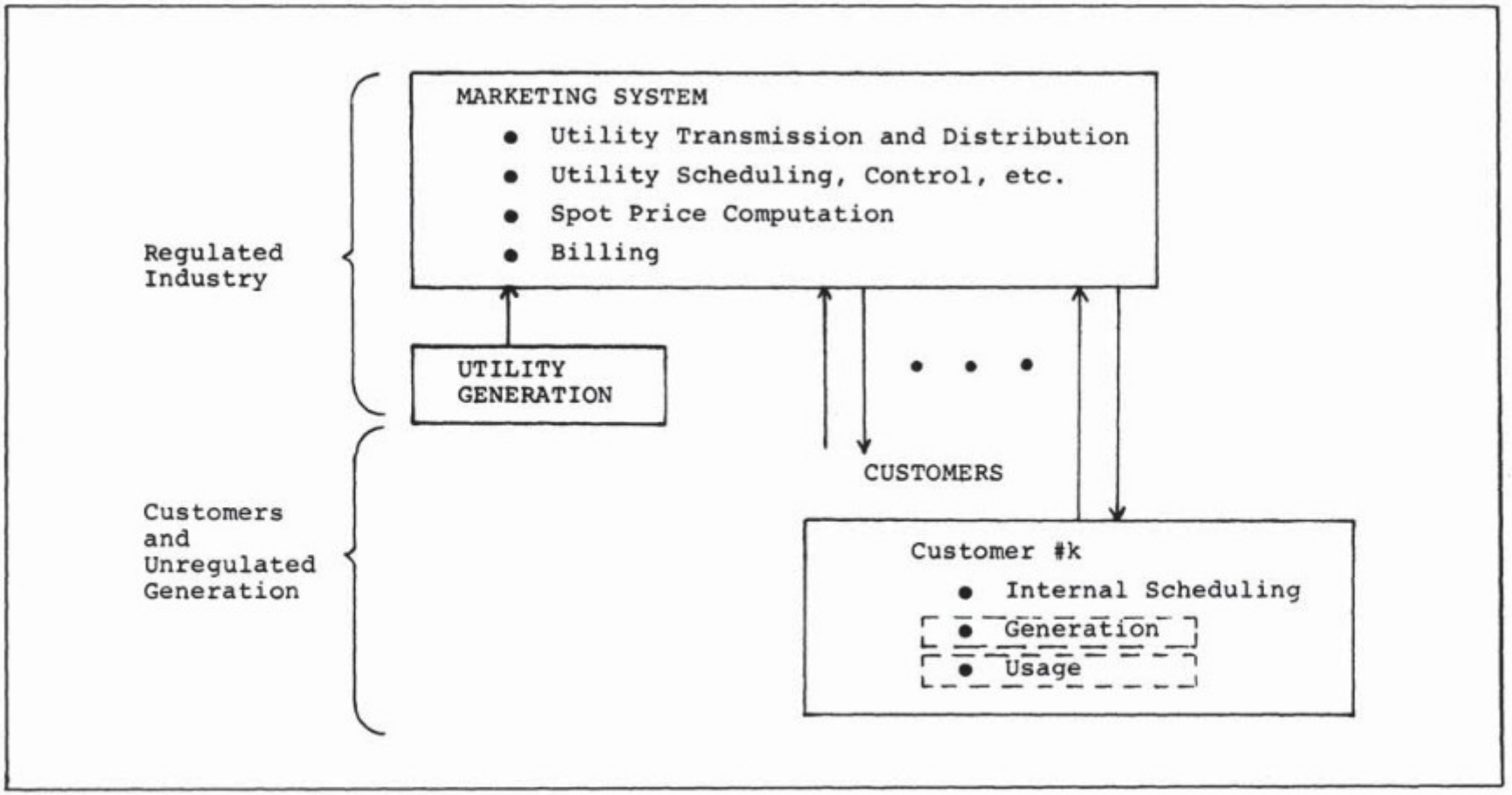
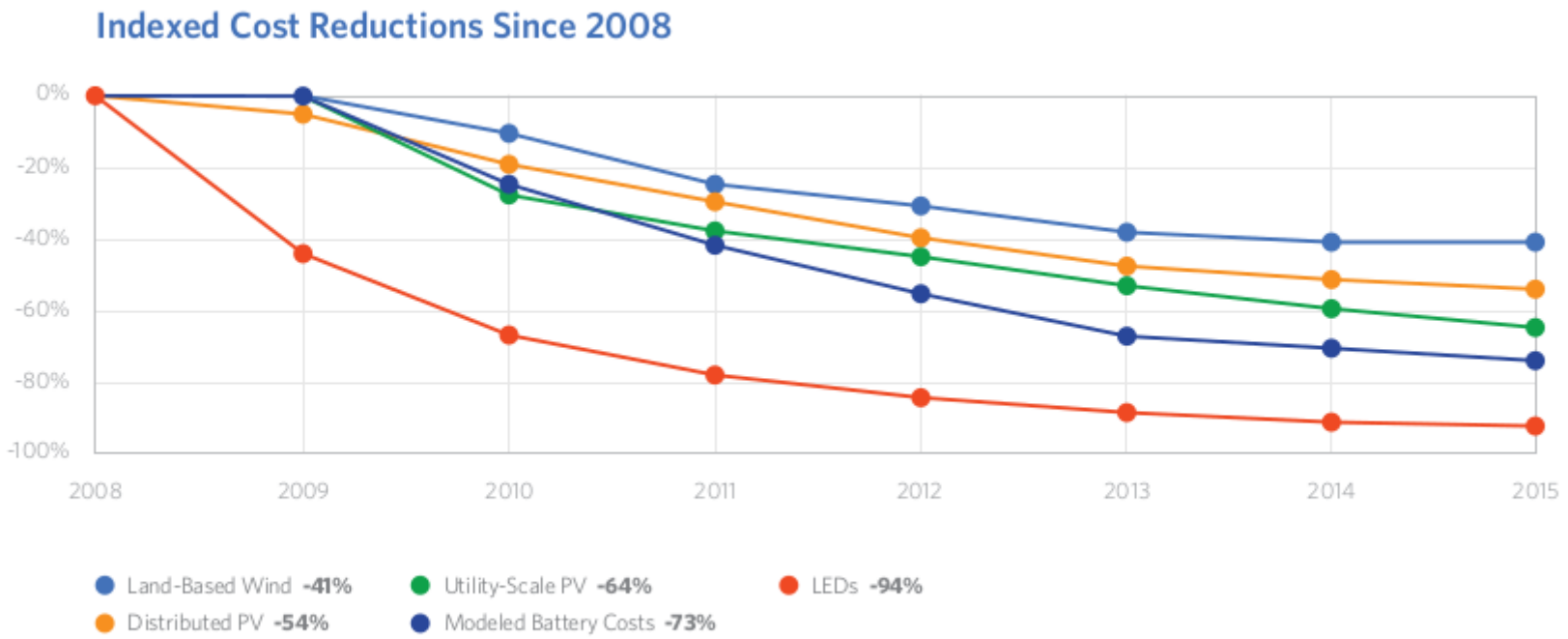


FIGURE 1: The Energy Marketplace

Dünyada Yenilenebilir

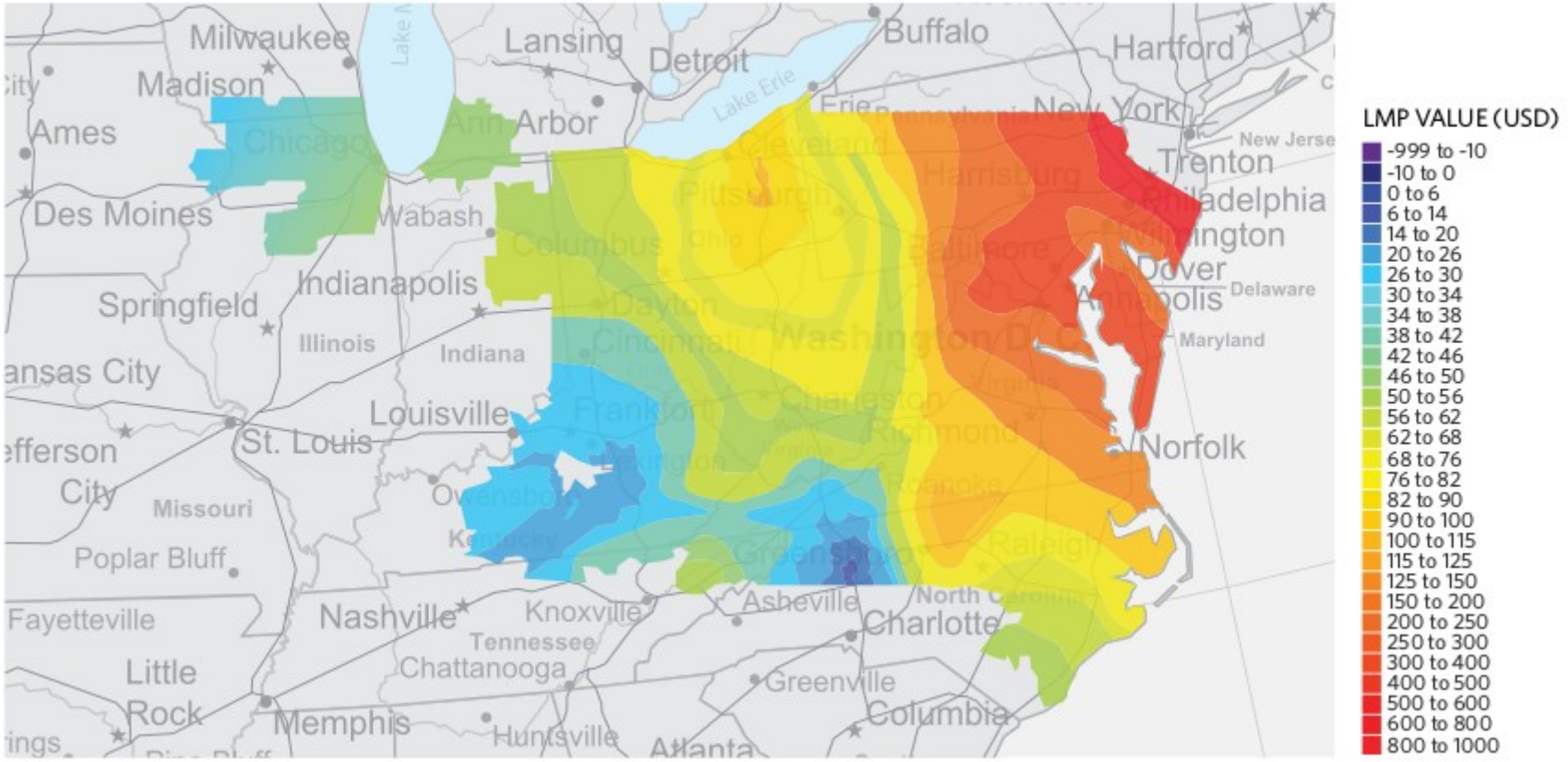
Figure 1.4: Cost Declines in Key Technologies, 2008–2014



Source: US DOE 2016

Elektriğin mekansal değeri

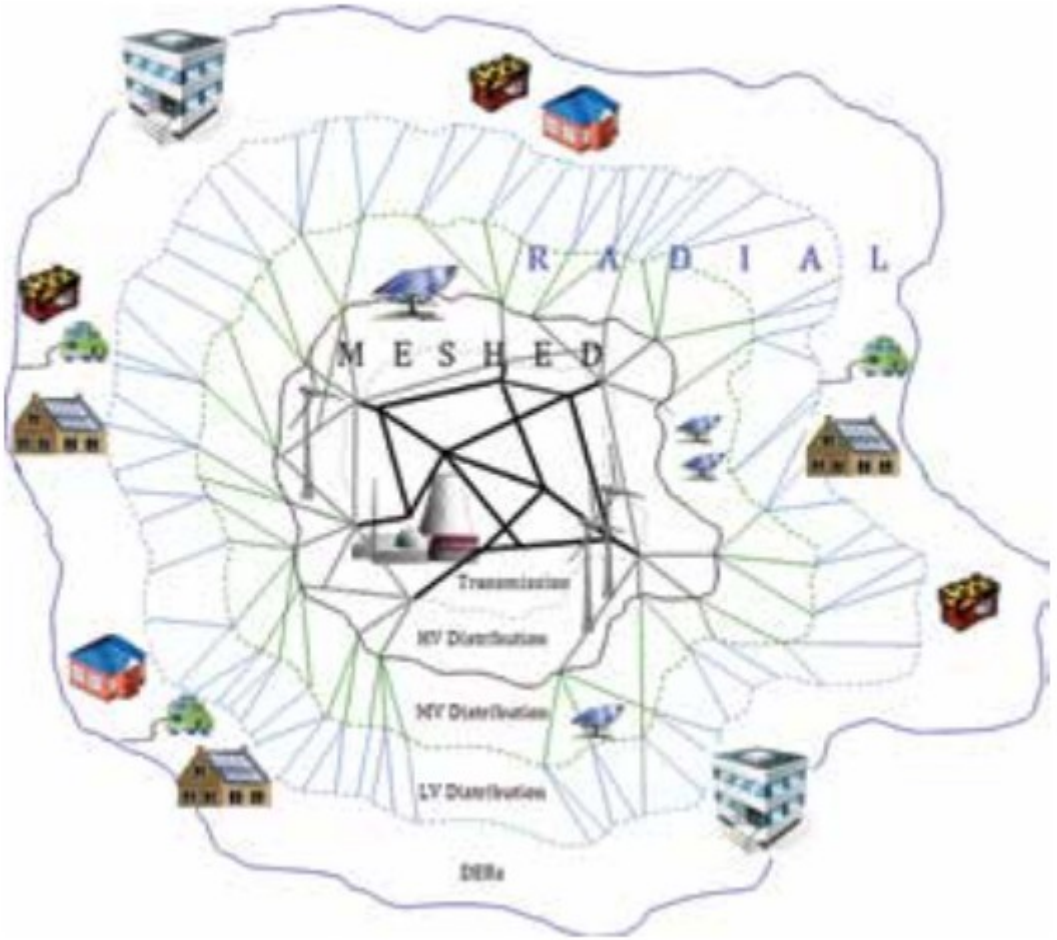
Figure 2.4: Contour Map of PJM Nodal Prices on July 19, 2013, at 4:05 p.m. ET



Source: PJM

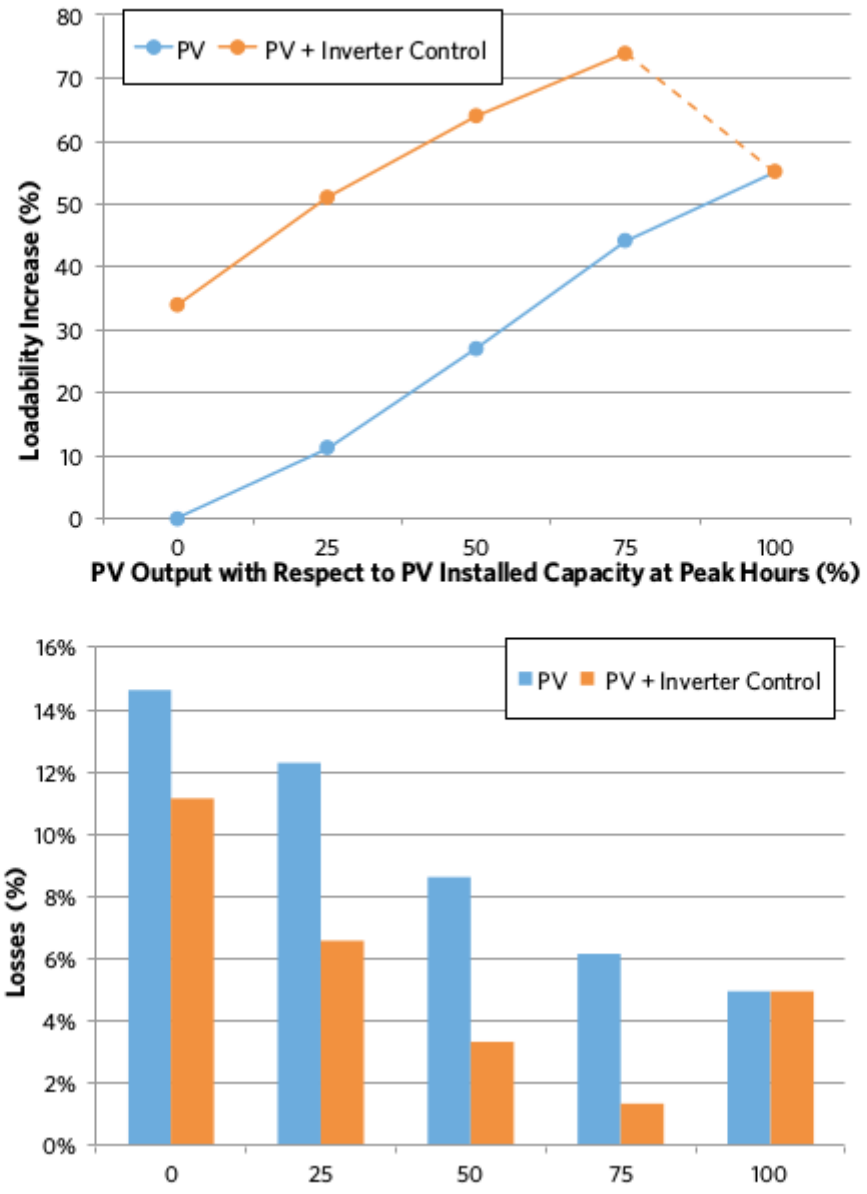
İletim neydi dağıtım neydi

Figure 3.1: Beyond the "Top-Down" Paradigm



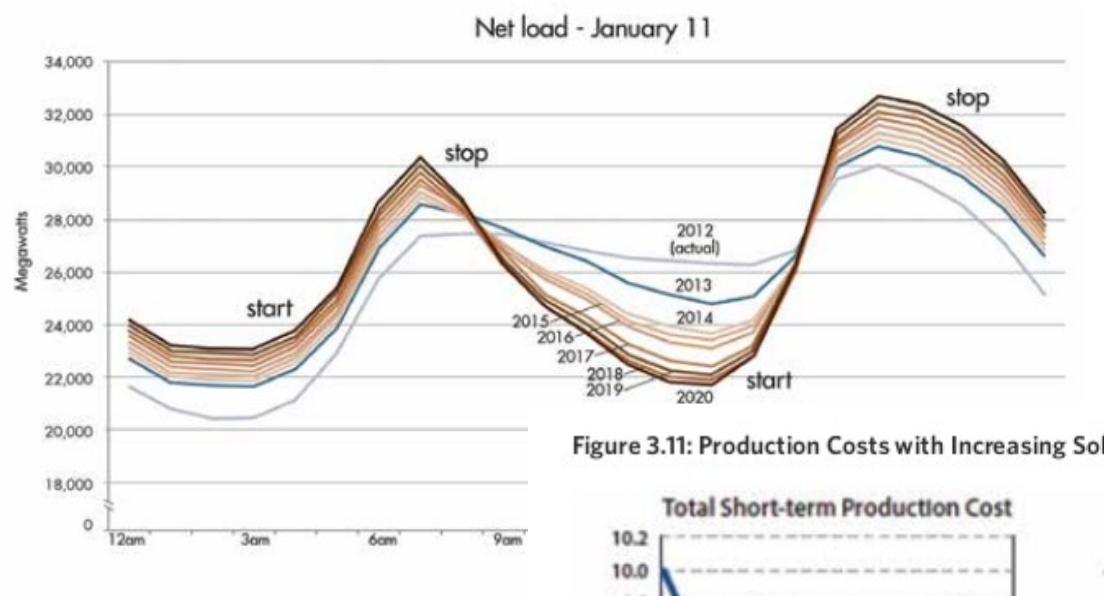
Dönen Kütlelerden Katı hal cihazlara

Figure 3.9: Network Loadability and Losses with Solar PV



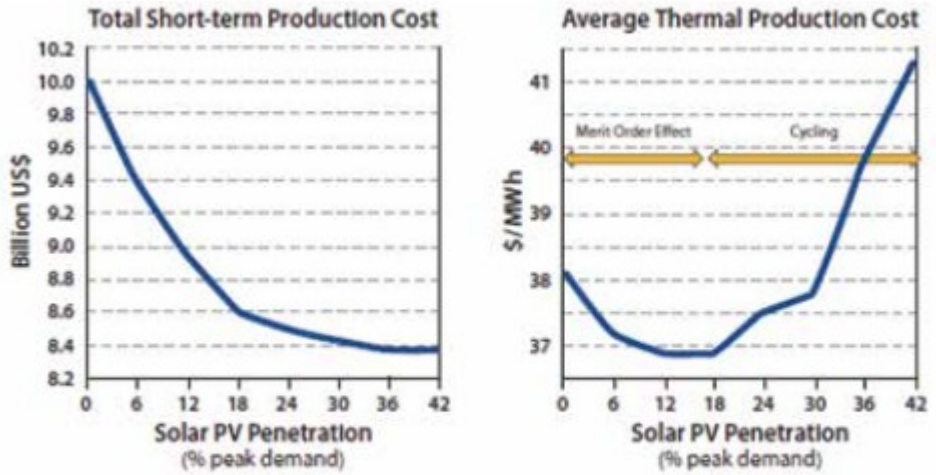
Meşhur Ördek Eğrisi

Figure 3.10: Duck Curve



Source: CAISO (2013)

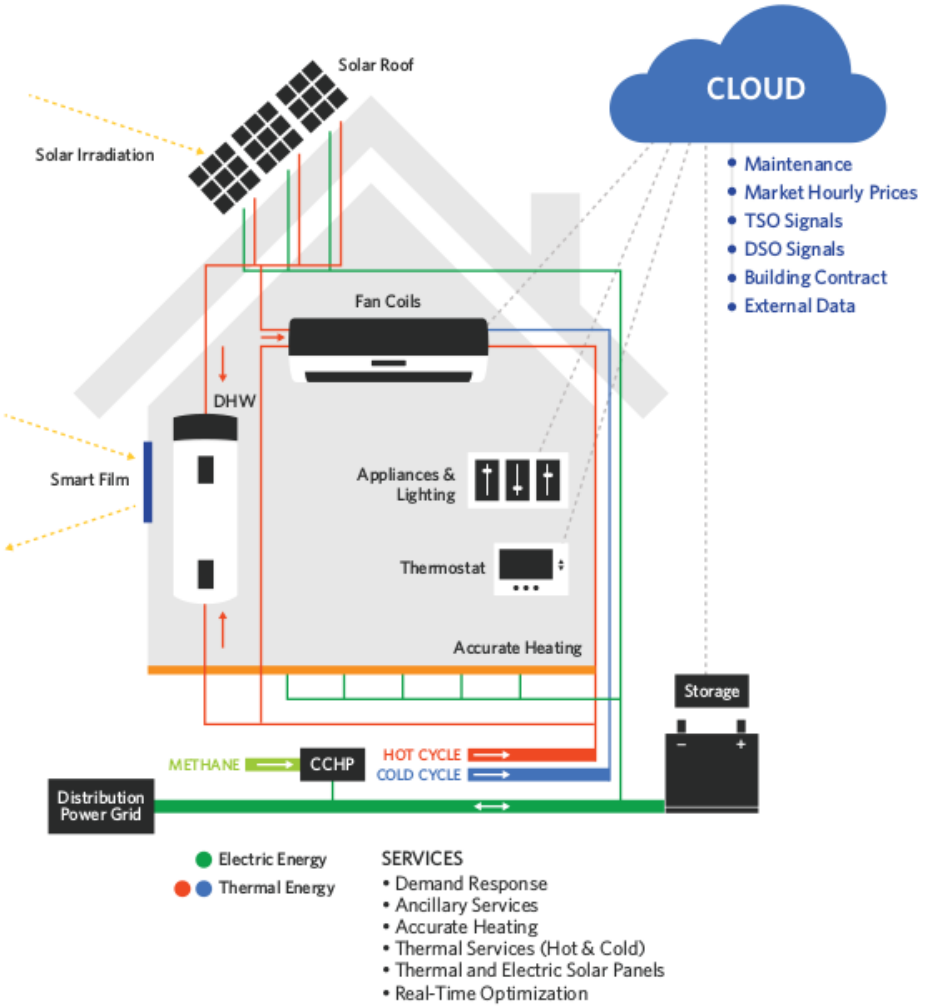
Figure 3.11: Production Costs with Increasing Solar Penetration in ERCOT



Note: The figure shows total short-term production cost and average short-term production cost for thermal genera with increasing solar penetrations in ERCOT, a thermal-dominated system. (MIT 2015)

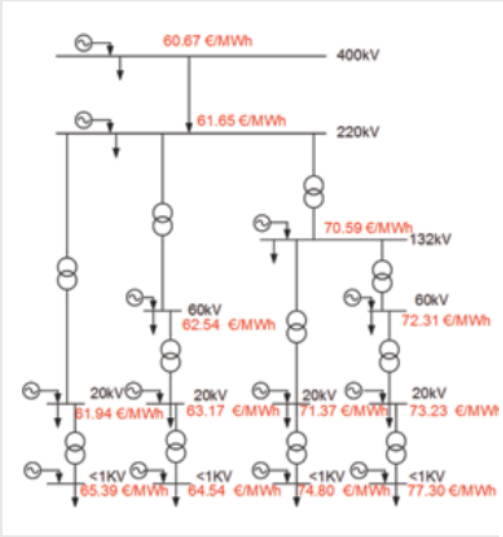
Aklı bulutta Ev

Figure 3.14: Example of a Smart Home with Several DERs Connected to Cloud-Based Data Management and Computation Systems

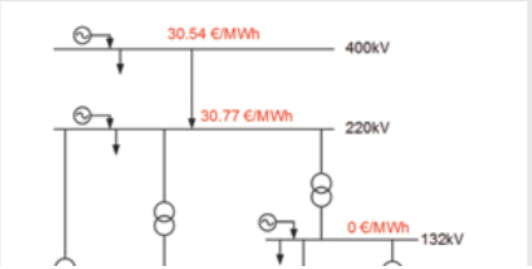


Her noktada fiyat

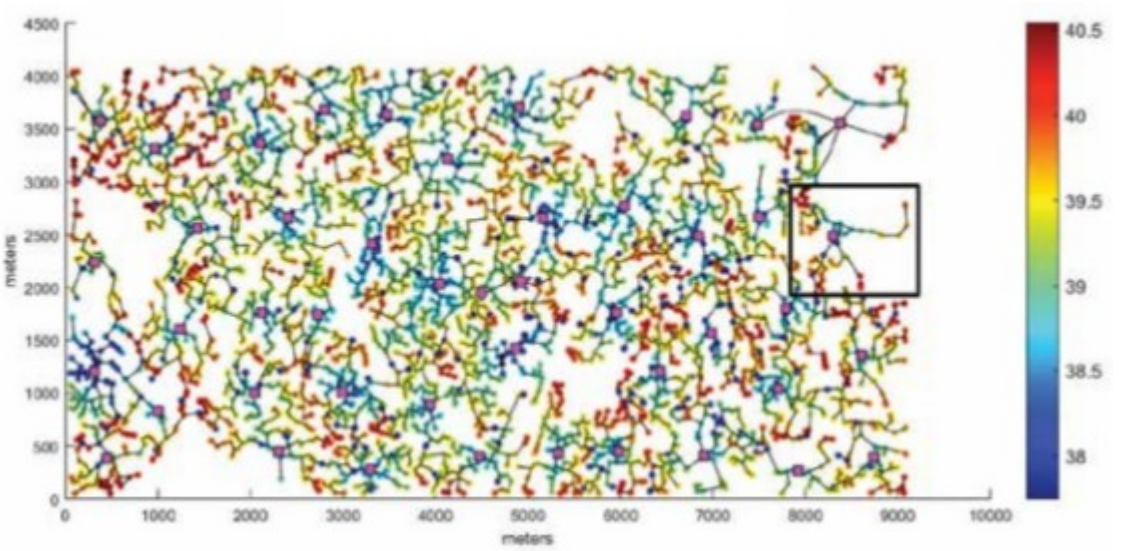
4.9a: Yearly average prices for the current Spanish system



4.9b: Marginal prices for 9 a.m. during a day in April when the Spanish system had a penetration level of solar PV connected at low voltage (under 1 kV) providing 35 percent of total generation capacity

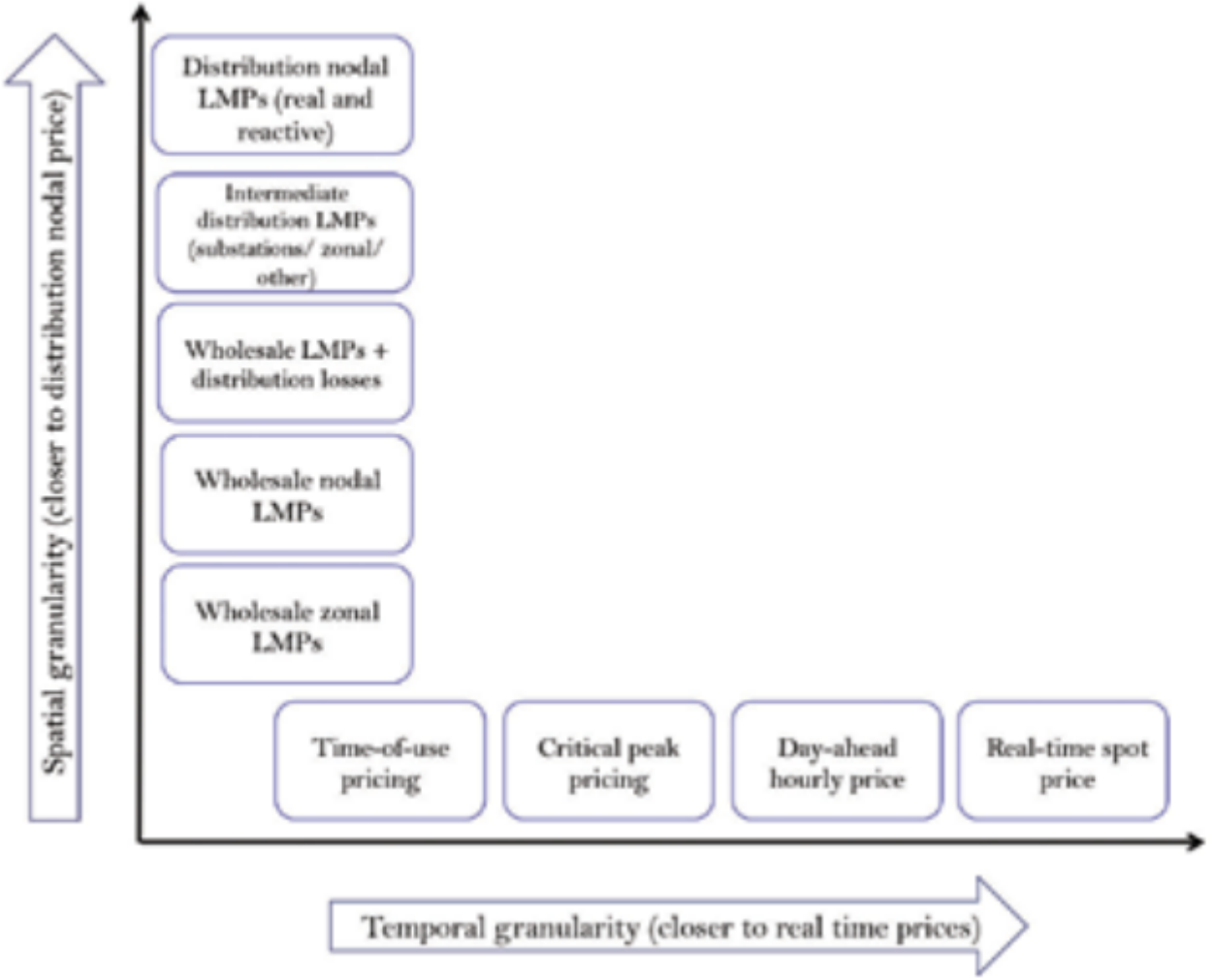


4.11a: Distribution-level active power nodal prices (in $/MWh) across the entire considered network during a single hour



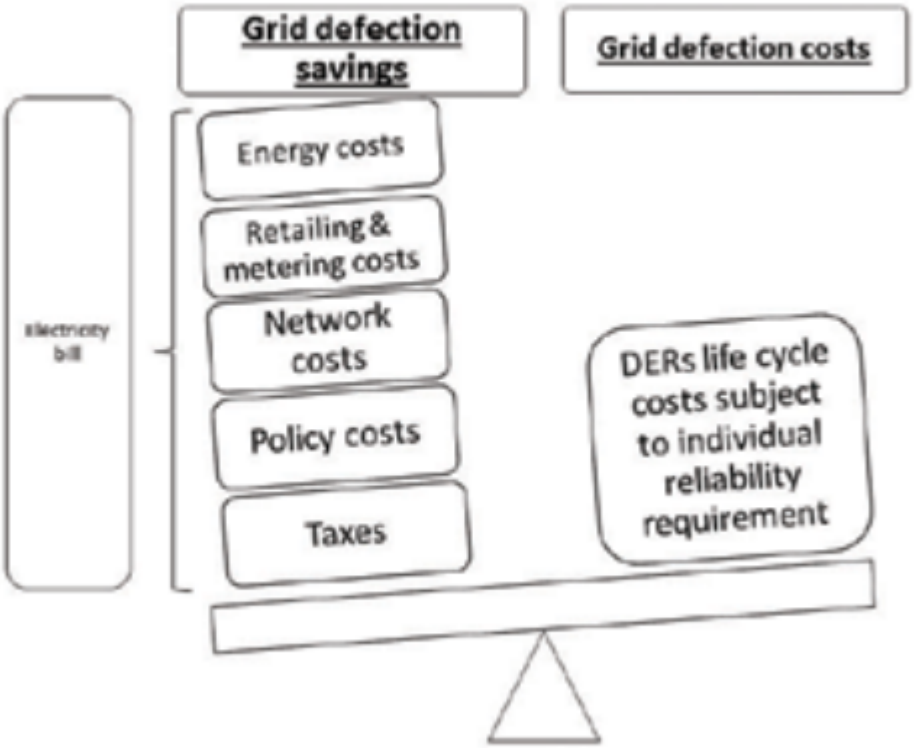
Fiyat: Elektrikçilere kalsa atom fiziği

Figure 4.14: Choices in the Adoption of Temporal and Spatial Granularity in Energy Pricing

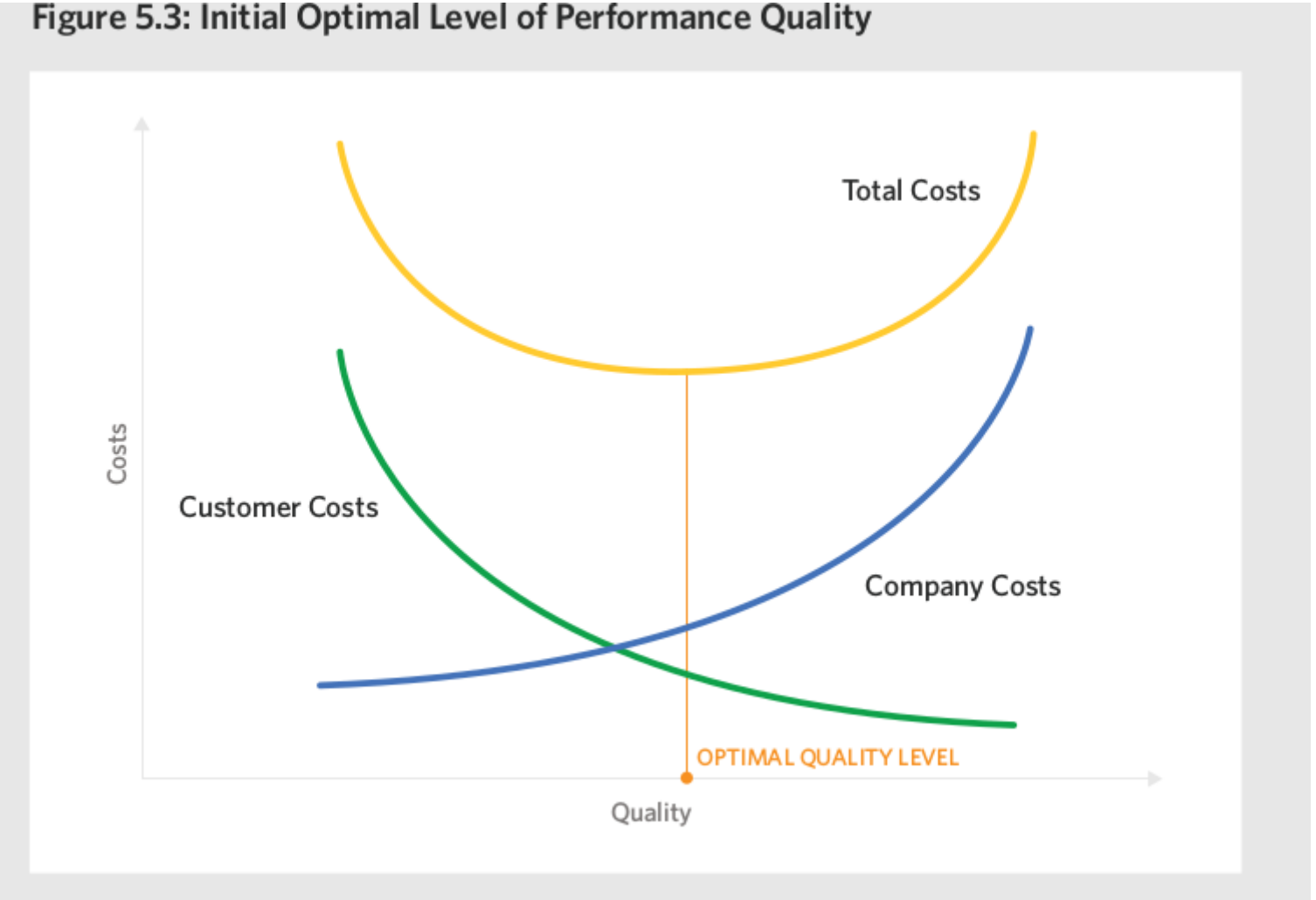


Sabit hat kullanan var mı?

Figure 4.19: Costs and Benefits of Grid Defection from the Customer Viewpoint

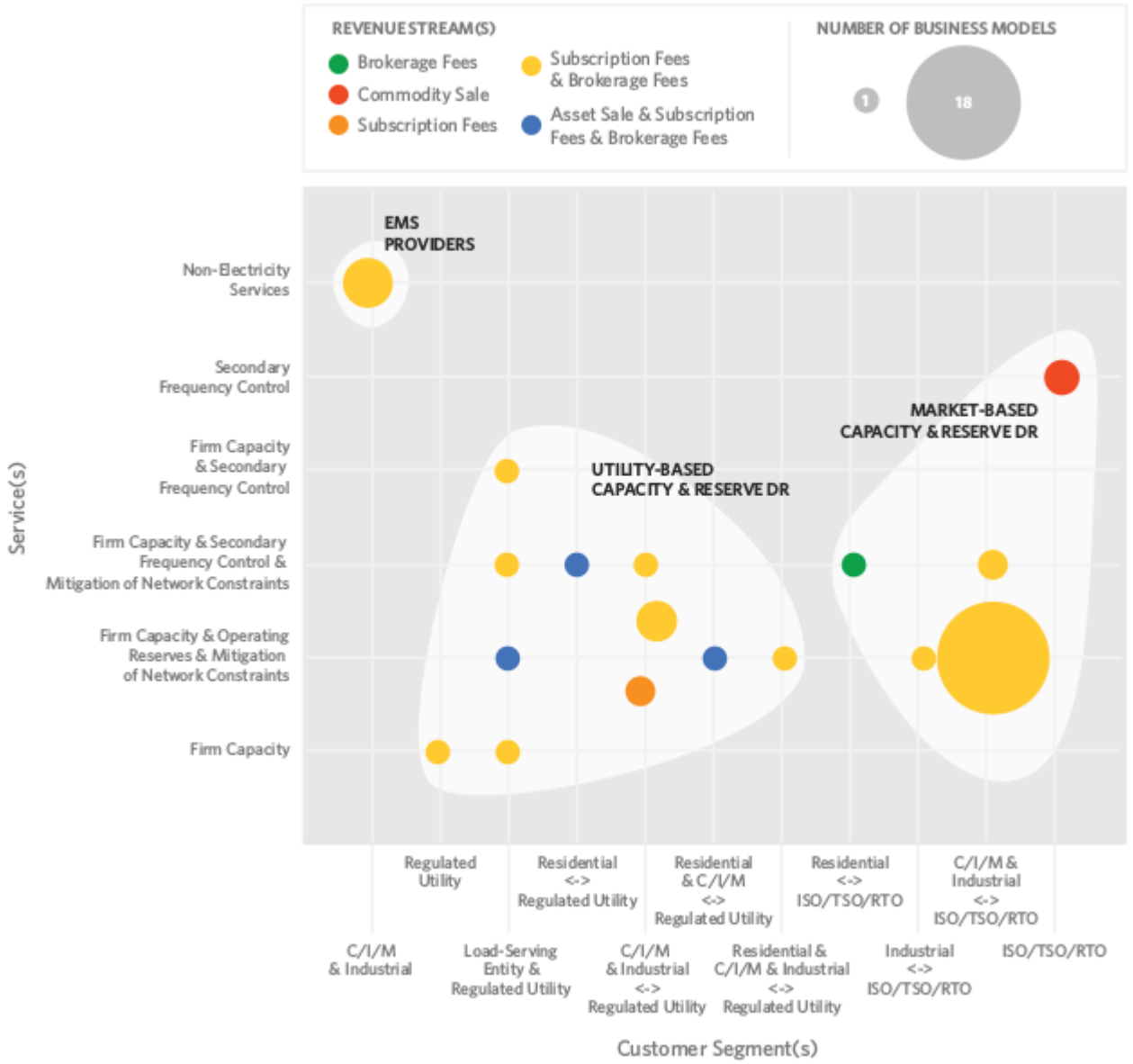


kesilmeyen elektrik = her trafoya iki jeneratör (kim daha çok ödemek ister)



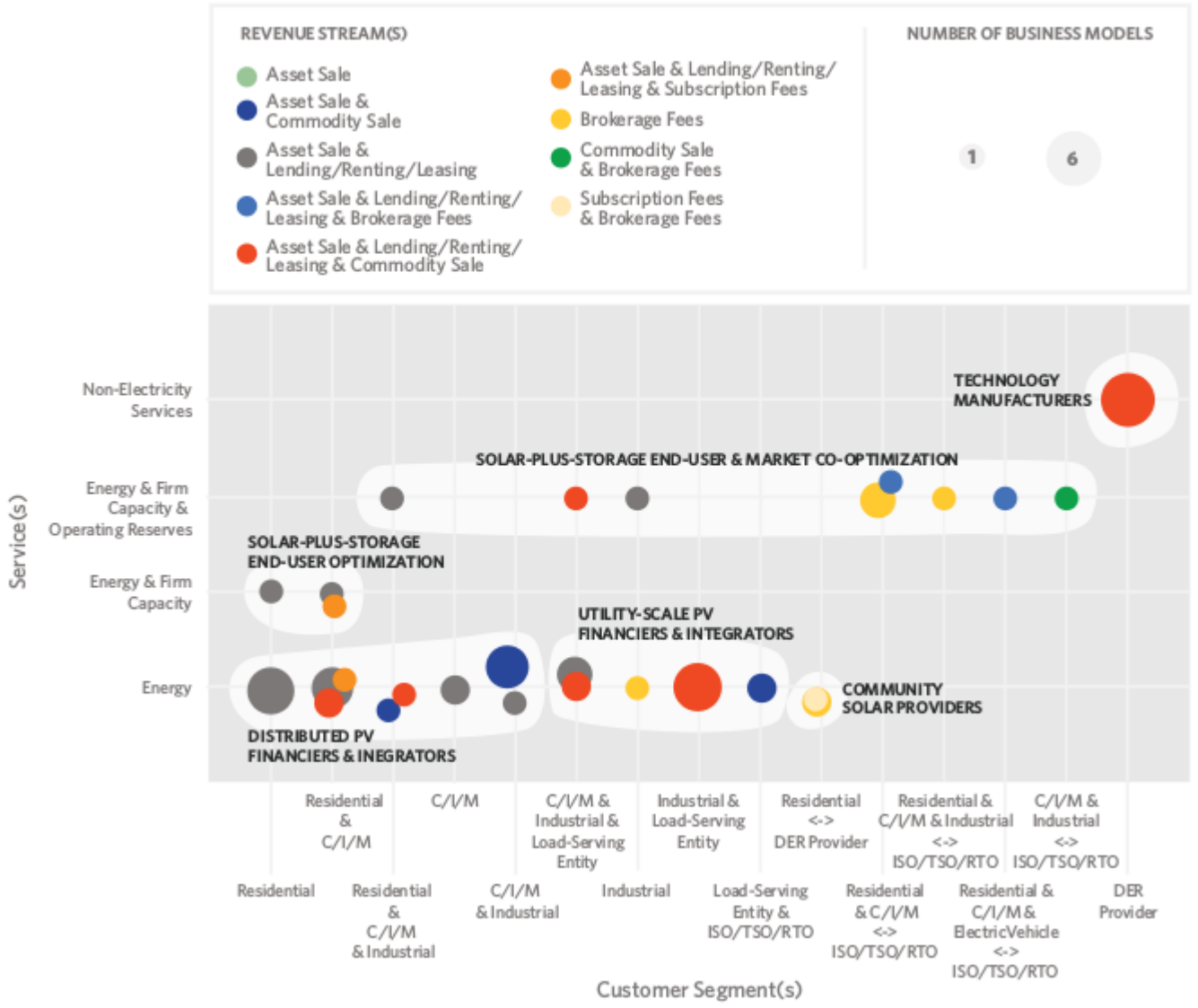
Elektrik sudan daha mı önemli

Figure 6.8: Taxonomy of Demand Response and Energy Management System Business Models



İş modelleri

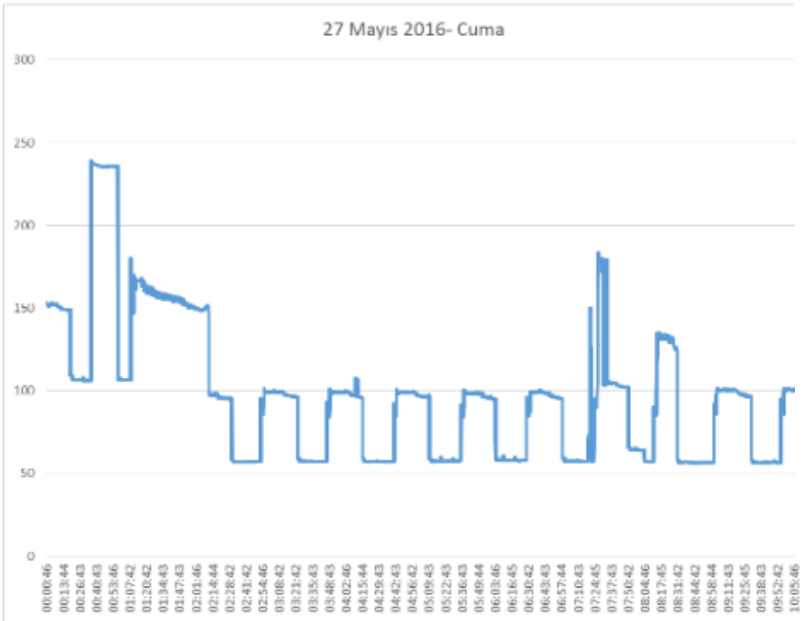
Figure 6.9: Taxonomy of Solar PV and Solar-plus-Storage Business Models



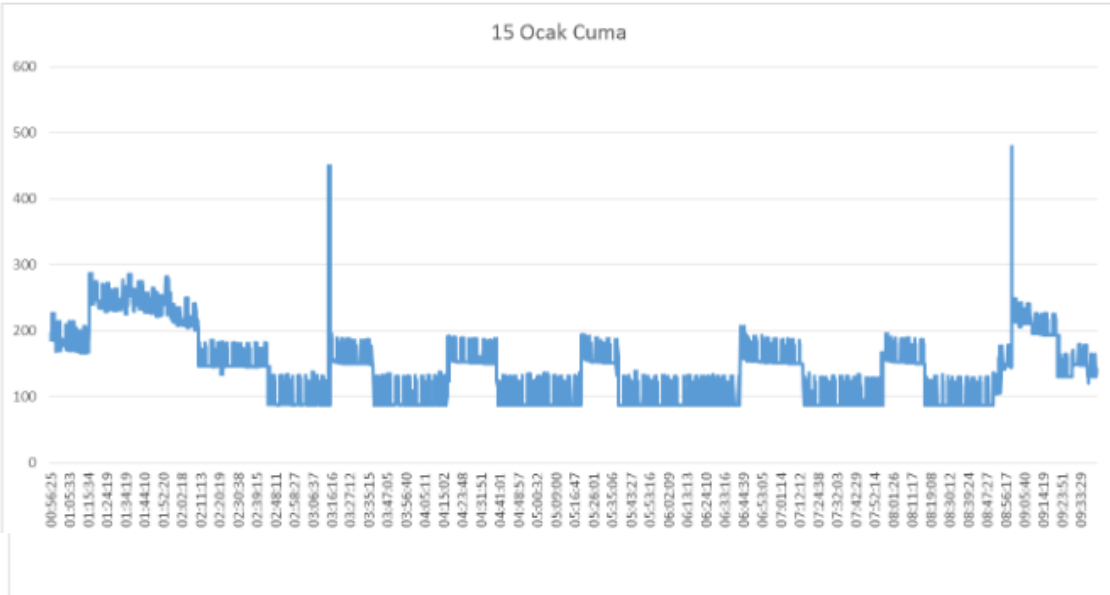
Daha çok veri?

- Kışın elektrik faturaları neden yüksek gelir?

27 Mayıs Cuma



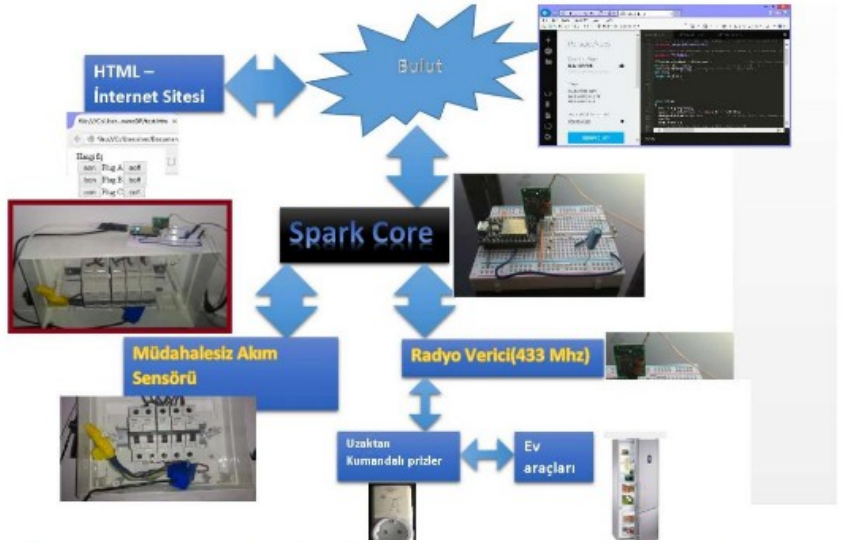
15 Ocak Cuma

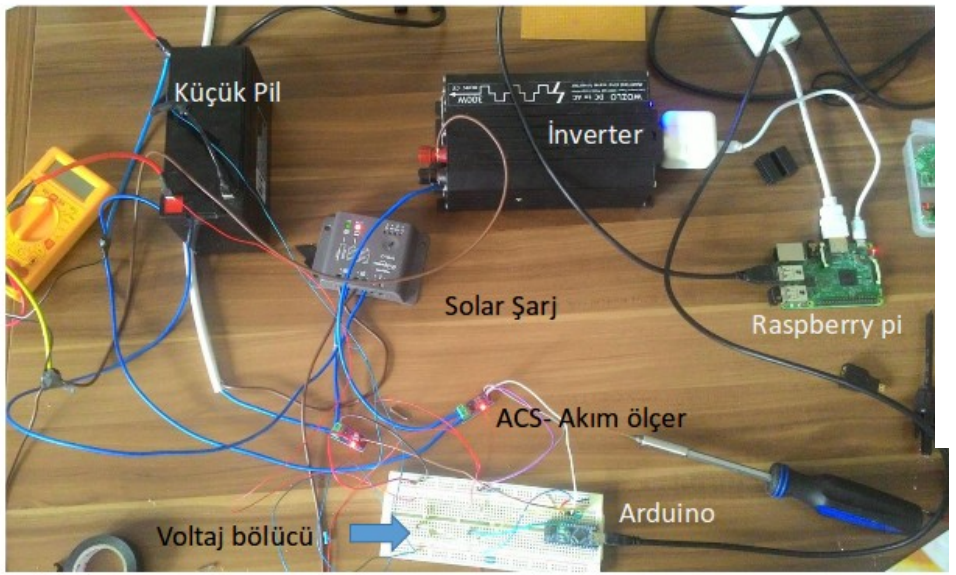


http://www.barissanli.com/calismalar/2017/20170216-bsanli-iot.pdf

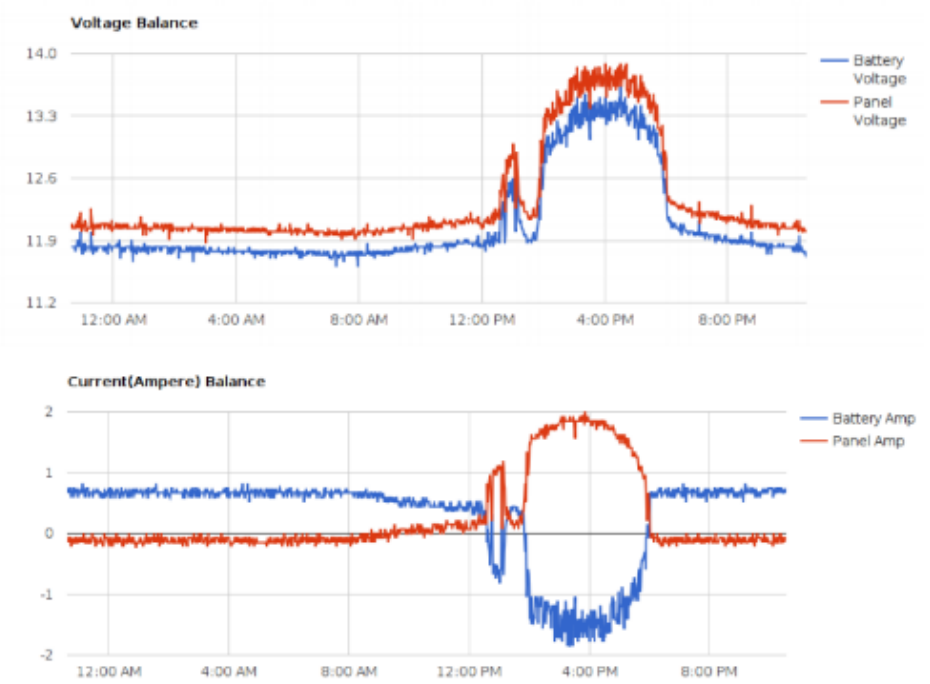
Garaj yok ama ...

Proje sistemi





Akım - Voltaj



http://www.barissanli.com/calismalar/2017/20170216-bsanli-iot.pdf

Kayıtzinciri

```python
import hashlib


deneme="barissanli.com"
say=0

while(say<1000000000000):

 ozut=hashlib.sha256(deneme+" "+str(say)).hexdigest()

 if(ozut[60:64]=="0000"):
                print (deneme+" "+str(say)+" --> "+str(ozut)+ " "+str(say))
 say=say+1
```

```
barissanli.com 1155507 --> fc401e93ea824a4c2e237aee61d2bc78475b94f48b9ee202e14ec0380760000 1155507
barissanli.com 2865544 --> bb5fa89a05c4215a9ea5bb37f4f040603dc4a3e5cef65cd2347f14edb5c00000 2865544
```

```
barissanli.com 59844 --> 194ef3c8da31d2b2dfea4adaa9e70d8f24f3dab4ff6b052c821cbf502c3b0000 59844
barissanli.com 249752 --> e3dbb244044a001b2543c5c04e4936606f9ed44271fc66aa5338l4e8a3c60000 249752
barissanli.com 315422 --> 4d1e01dcce1a2a2ff5c8885fa139f83a65d57a82980e2bbbd41e67a2c61e0000 315422
barissanli.com 341983 --> 68ab32d601a86940e600402c2b5c50f21033fffdf93b3480758a54e29bf10000 341983
```

Kayıtzinciri – barisCoin:)

```
def kayit_islem_blogu(kim, kime , nekadar):
        mesaj=kim+","+kime+","+str(nekadar)
        return mesaj

def bitmis_kayit(sira,onceki_ozet,islem_blogu, zorlugu_saglayan_rakam):
        mesaj="----Sira no:"+str(sira)+"----------------------------------------\n"
        mesaj=mesaj+"| Onceki ozet:"+onceki_ozet+" |\n"
        mesaj=mesaj+"| Zaman damgasi:"+'{:%Y-%m-%d %H:%M:%S}'.format(datetime.datetime.now())+"\n"
        mesaj=mesaj+ "| Zorlugu Saglayan Rakam:"+str(zorlugu_saglayan_rakam)+"                          \n"
        mesaj=mesaj+ "|-------------------------------------------------------|\n"
        mesaj=mesaj+ "| "+islem_blogu+"                                         \n"
        mesaj=mesaj+ "---------------------------------------------------------\n"
        return mesaj
```

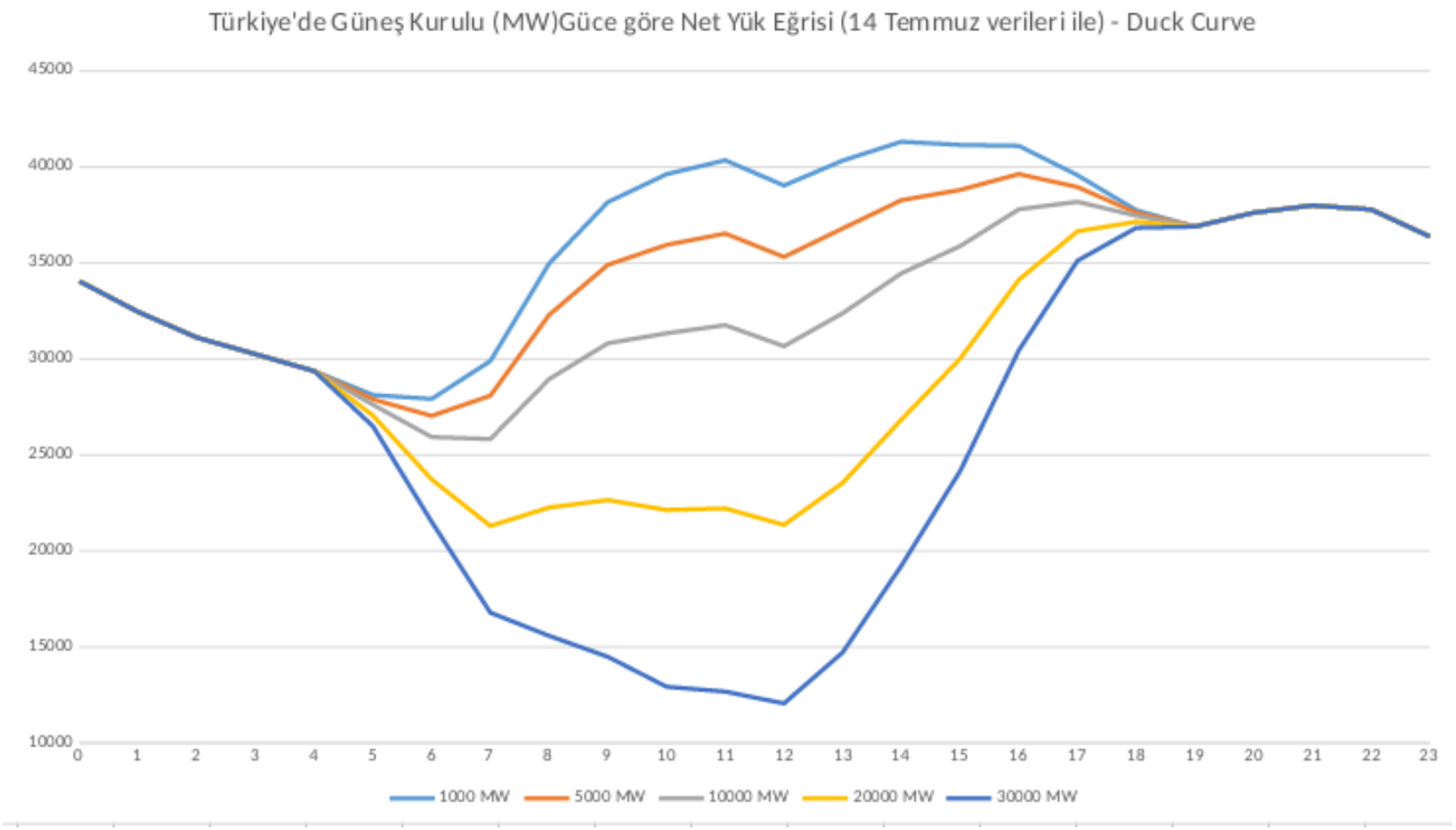
```
zorluk=4
for i in range(0,7):
        kisiler=["baris","ali","ayse", "mehmet","elif"]
        gonderen=random.choice(kisiler)
        kisiler.remove(gonderen)
        alan=random.choice(kisiler)
        gonderilecek_miktar=random.randrange(1,25)
        onceki_ozet=ozet.hexdigest()    # bir onceki islemin ozeti
        kayit=kayit_islemi(sira,onceki_ozet,zorluk,gonderen, alan, gonderilecek_miktar)
        print kayit
        ozet=SHA.new()
        ozet.update(kayit)
        print ("Ozet Kontrol:"+ozet.hexdigest()+"\n")
        sira=sira+1
```

```
----Sira no:0----------------------------------------
| Onceki ozet:7de49d89557ae108bbc6b502e5fc8c6da5991562 |
| Zaman damgasi:2017-12-20 04:47:07
| Zorlugu Saglayan Rakam:71628
|-------------------------------------------------------|
| ayse,baris,11
---------------------------------------------------------

Ozet Kontrol:000017c21c28d6c67a9eee9804bcd2bdf9a8021e

----Sira no:1----------------------------------------
| Onceki ozet:000017c21c28d6c67a9eee9804bcd2bdf9a8021e |
| Zaman damgasi:2017-12-20 04:47:11
| Zorlugu Saglayan Rakam:49172
|-------------------------------------------------------|
| ayse,ali,23
---------------------------------------------------------

Ozet Kontrol:000008d5db34c2b2125bcd2d5bbf82efd8c69f76
```

Kayıtzinciri – ne eksik?

- Vurucu bir uygulama yok
- Neler olabilir?
  - Tüketici hem elektrik üretecek, hem depolayacak, hem arabasını şarj edecek
  - Çoklu işlem
  - Herkese fatura mı kesecek
  - Veya altyapı/araba paylaşımı
    - Pil, araba, veri

Türkiye Güneş Gelişimi – Ördek Eğrisi



2050 Elektrik şebekesi

- Ne kadar dağıtım olacak
- Üretim planlaması mı – üretim+stok
- Kaset -> mp3 -> Spotify
- Sabit telefon hattı-> cep -> whatsapp
- Dağıtım şirketi -> üretüketici -> kop kop
- Herkes kendi elektriğini üretmek kendi hizmetini sağlamak istermi? (hobi bahçesi?)

Atölye Çalışmaları

Petrol fiyatları nasıl oluşuyor

- Herkesin bir üretim miktarı bir de maliyeti var
- 1 Alıcı – 1 Satıcı (Fiyatı kim belirledi)
- 3 Alıcı - 3 Satıcı (Fiyat nasıl oluştu)
- Fiyat hangisi?

Teşekkürler

www.barissanli.com