Solution: 100 % Renewable Energy Based on Energy End Use Efficiency

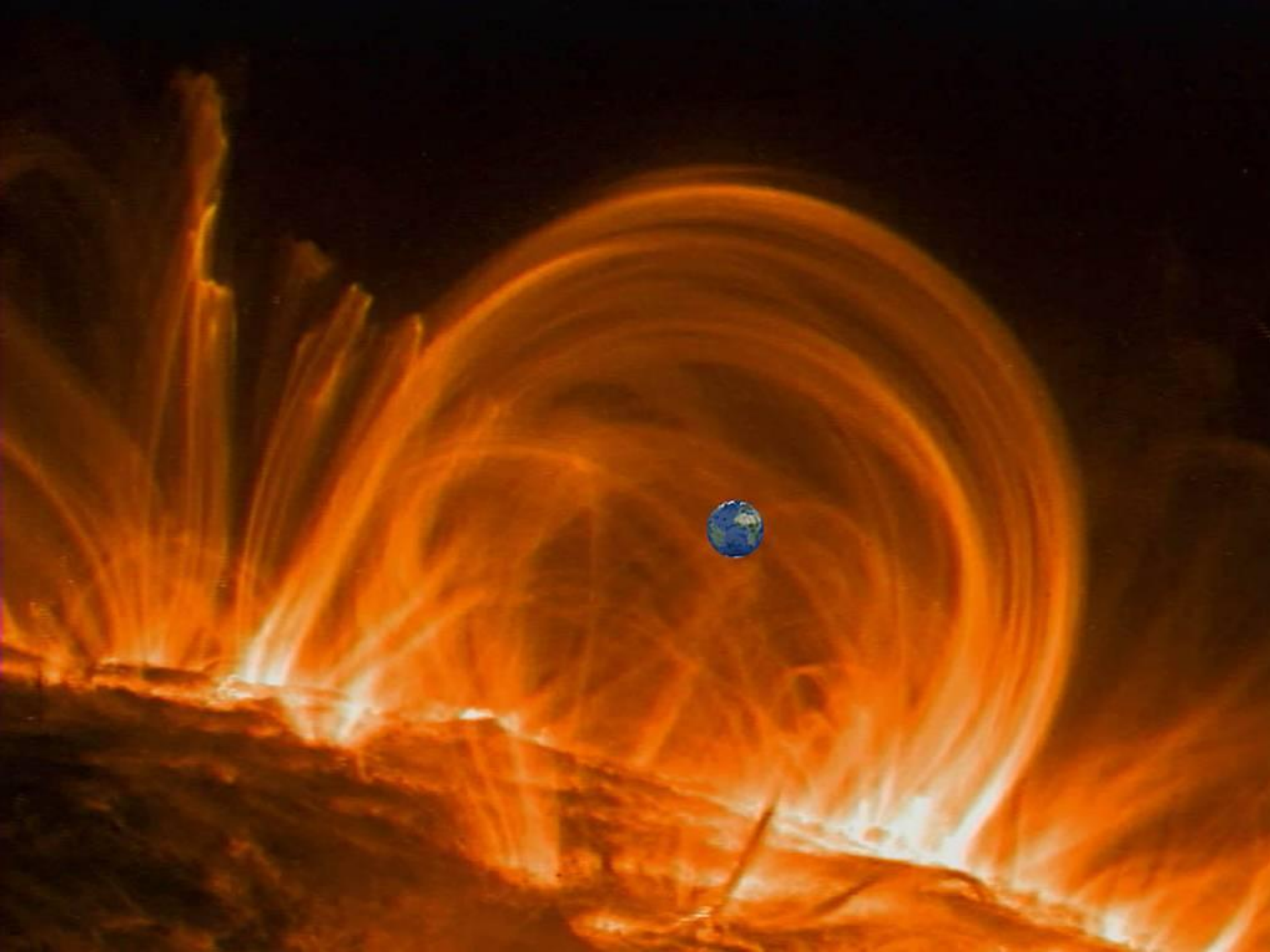
Prof. Dr. Tanay Sıdkı Uyar
President, EUROSOLAR Turkey
Director, New Technologies Research and Application Center Marmara University
Vice President, EUROSOLAR European Association for Renewable Energy
Vice President, WWEA World Wind Energy Association

Rhodes Island Greece, 30 April 2011

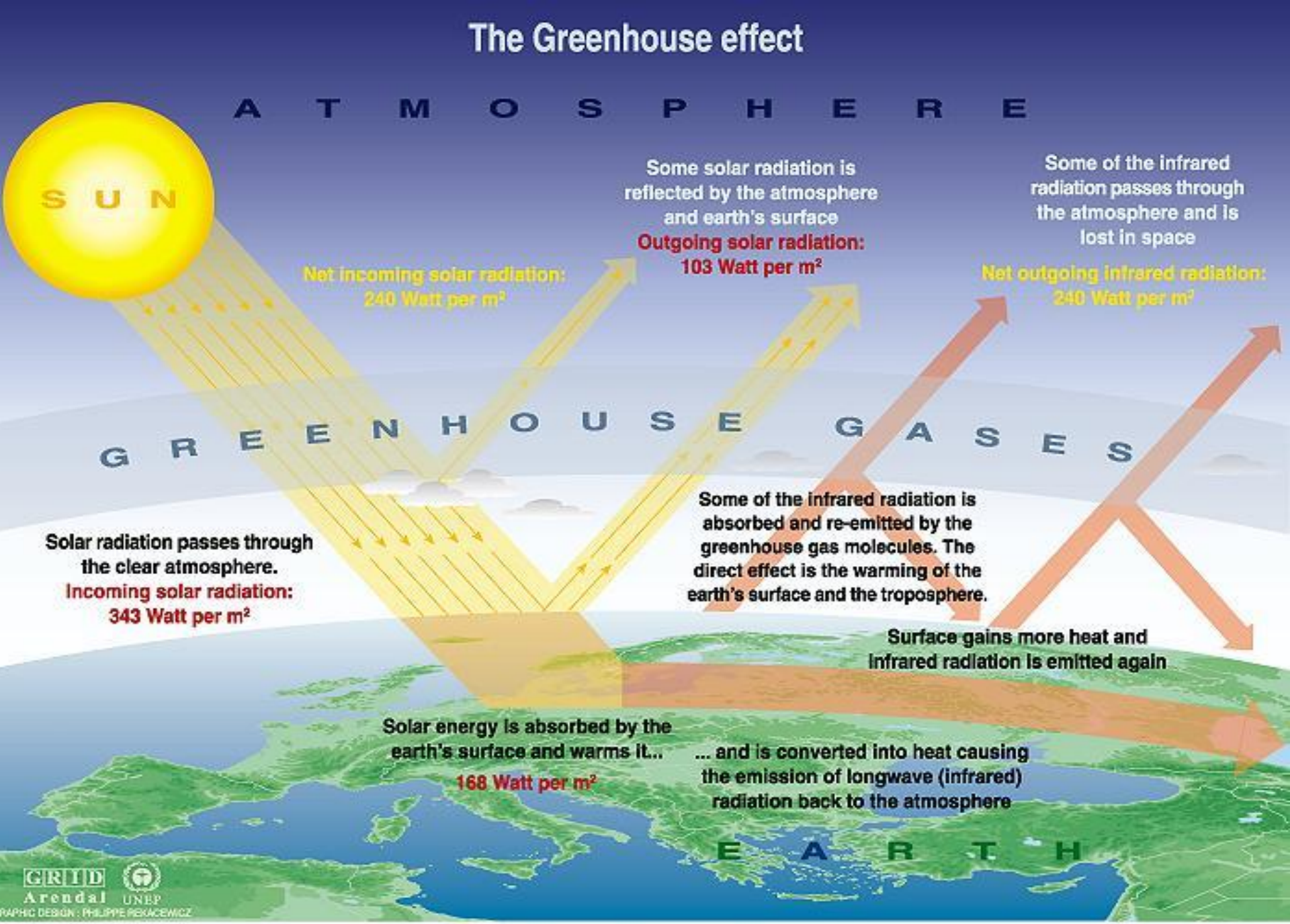
Thought leader, motivator, reformer, revolutionary

Berlin/Bonn, 19 October 2010

EUROSOLAR mourns the loss of Hermann Scheer, founder of the European Association for Renewable Energy and the World Council for Renewable Energy (WCRE). He was an intellectually brilliant, warm-hearted man and untiring politician. EUROSOLAR and the Hermann Scheer Foundation will carry on with his life's work.



The Greenhouse effect

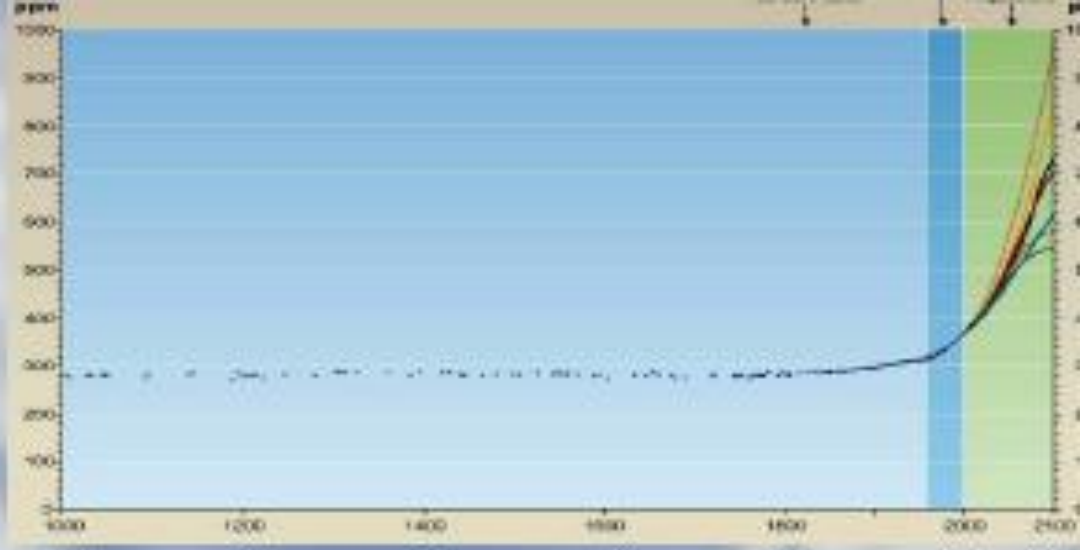


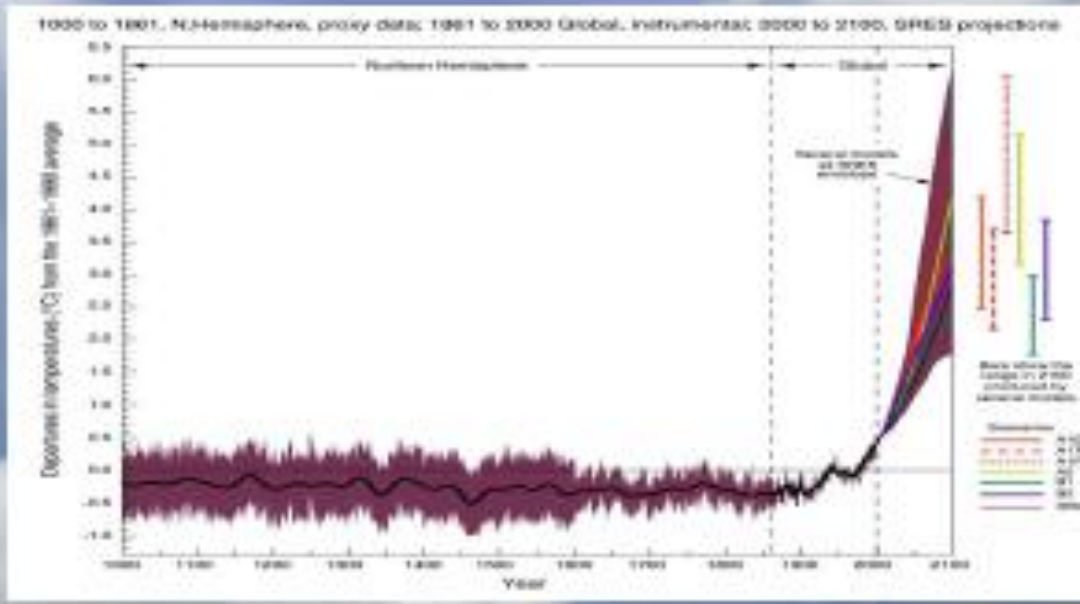
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

CO2 Accumulation in the Atmosphere

and

Global Temperature Changes





MARMARA UNIVERSITY
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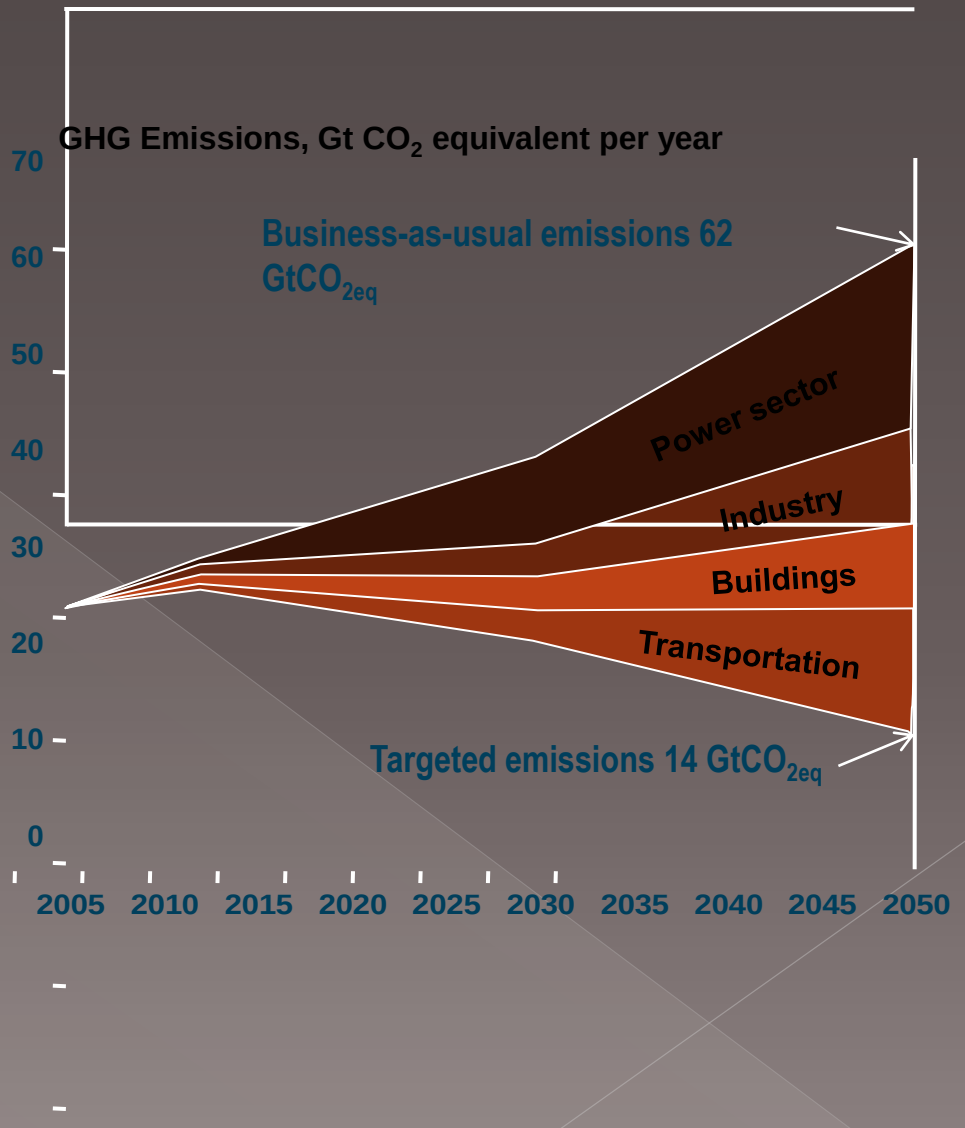
Climate Change Issues/Opportunities

- To avoid dangerous climate change ($\Delta T > 2^{o}C$), global GHG emissions by 2050 must be:
  - ½ current emissions level, or
  - Less than ¼ of projected 2050 "business-as-usual" emissions.
- IEA projects GHG emissions price in 2030 in OECD:
  - $90/t for 550 ppmv stabilization
  - $180/t for 450 ppmv stabilization
- Biomass will become much more valuable (including possibility for *negative* GHG emissions when biomass is used with CO_2 capture and storage (CCS).



EE: Chronological overview

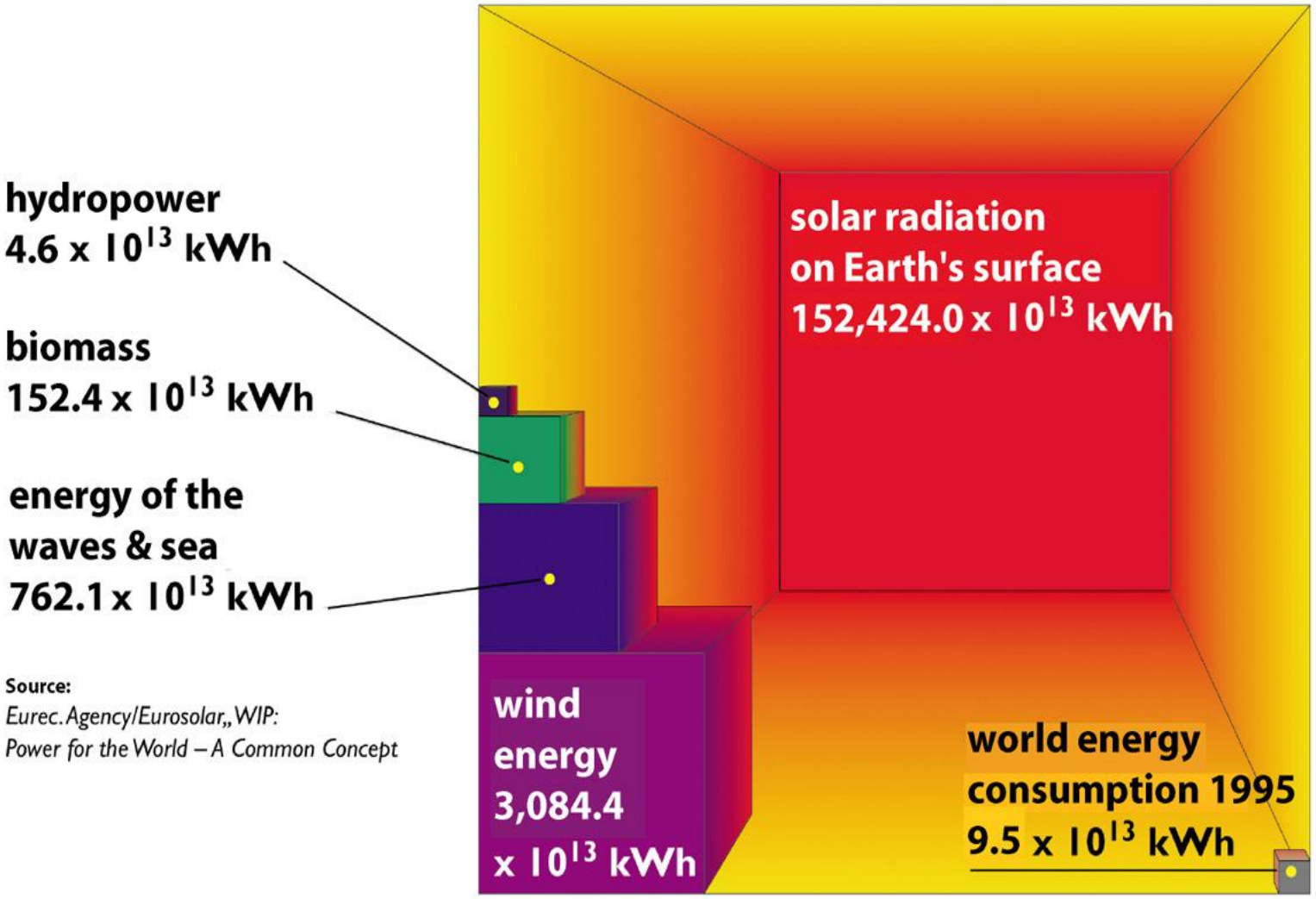
- 2005: Green Paper on EE
  - 20% savings target in a cost-effective manner
- 2006: EE Action Plan
- 2008: Climate and Energy Package
  - 20% EE target as a pillar for –20% GHG
- 2010 (June): 20% target adopted by the European Council
- Not explicit in any legally binding EU decision

Renewable Energy Directive (2009/28/EC)

- 20% target for the EU-27 (final consumption)
  - Individual national targets
- Obligation to submit a national RES action plans
- 10% target for transport (same for all MS)


MARMARA ÜNİVERSİTESİ
1982

The Potential of Renewable Energies Worldwide



Source:
Eurec. Agency/Eurosolar, „WIP: Power for the World – A Common Concept

Benefits

Renewable energies are inexhaustible.

Renewable energies are available almost everywhere.

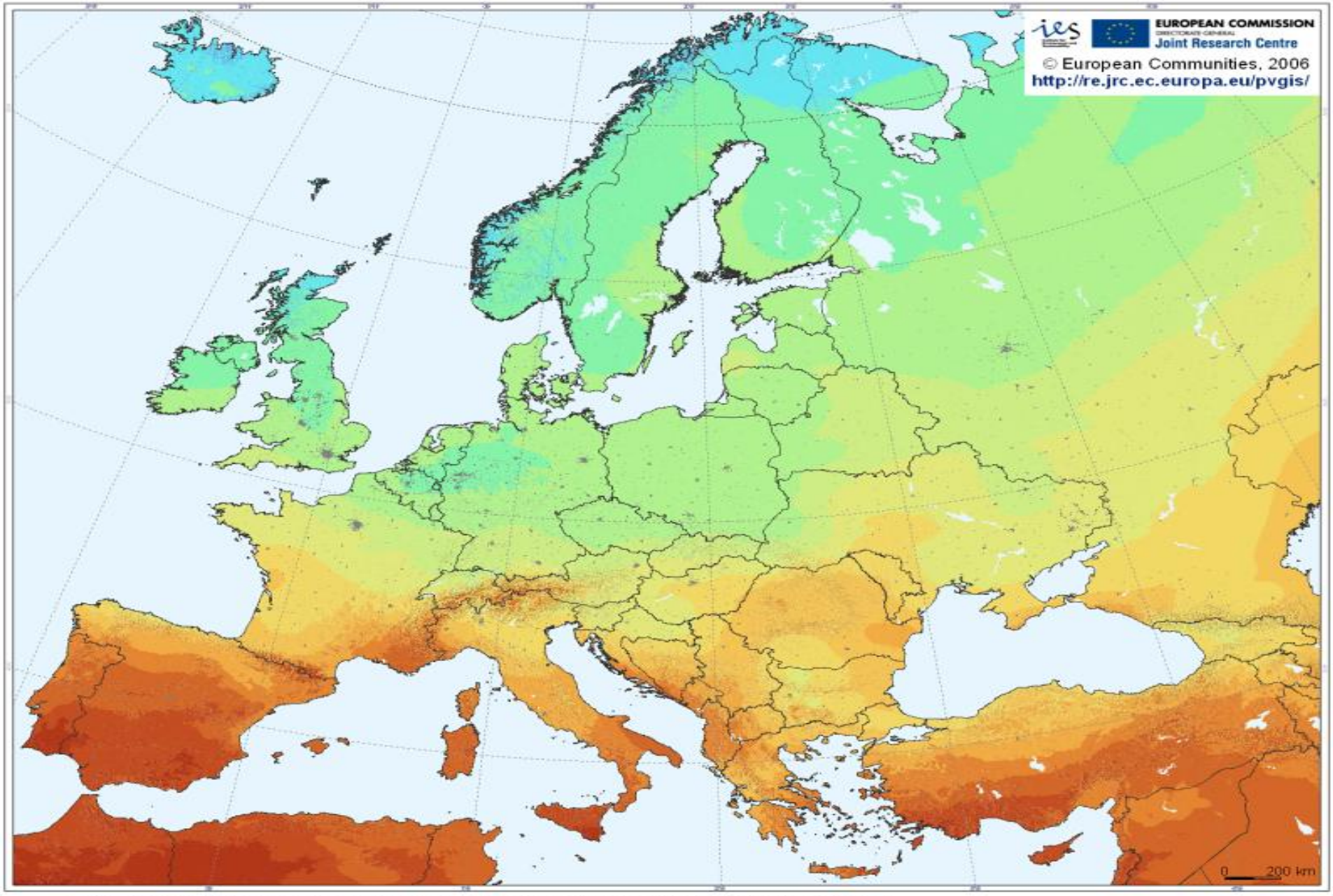
Renewable energies represent multiple win-win options.

They reduce dependence on oil.

They help save foreign currency.

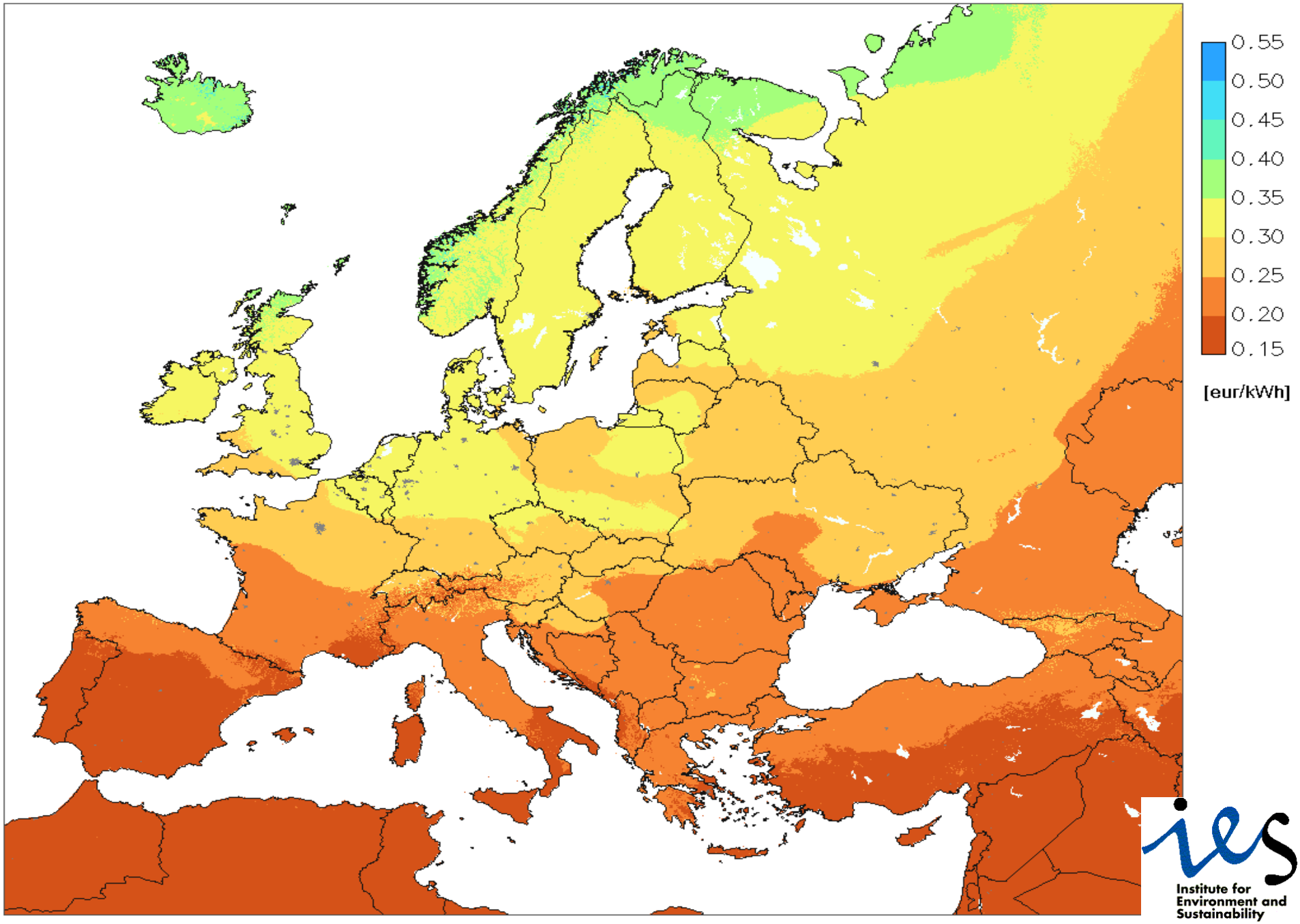
They create jobs

Photovoltaic Solar Electricity Potential in European Countries



Electricity generation costs of large PV power station (5 MWp)

(system price 4 eur/Wp, interest rate 3%, inflation 2%, maintenance 1%, optimum angle mounting, capital payback time 20 years)



Institute for Environment and Sustainability

Context for European Interest in Renewable Energy

- Meltdown at Chernobyl nuclear plant, 1986
- Awareness of “social costs” of energy production
  - Olav Hohmeyer (Germany, 1990’s) initiated the discussion
- Climate change/ attempt to meet Kyoto protocol requirements
- Relatively limited conventional fuels in Europe
- Renewable energy products/economic growth

J. F. Manwell, Professor and Director, Renewable Energy Research Laboratory Department of Mechanical and Industrial Engineering University of Massachusetts

GIVING THE RIGHT PRICE TO ENERGY PRODUCTION

External costs

Internal or private costs

Focus on EU 25, Bulgaria, Turkey, China, Brazil, India

NEEDS-IP and CASES-CA

ExternE

External costs (I)

Update impacts of:

- **Acidification**
  - on freshwater fish
- **Acidifying compounds**
  - (SO_2, NO_x and NH_3) on terrestrial ecosystems, including agriculture
- **Eutrophication**
  - on drinking water, boating, swimming, recreational fishing
- **Visual intrusion**
  - landscape aesthetics of renewable energy (wind and hydro) and eutrophication.

External costs (II)

- **Energy security**

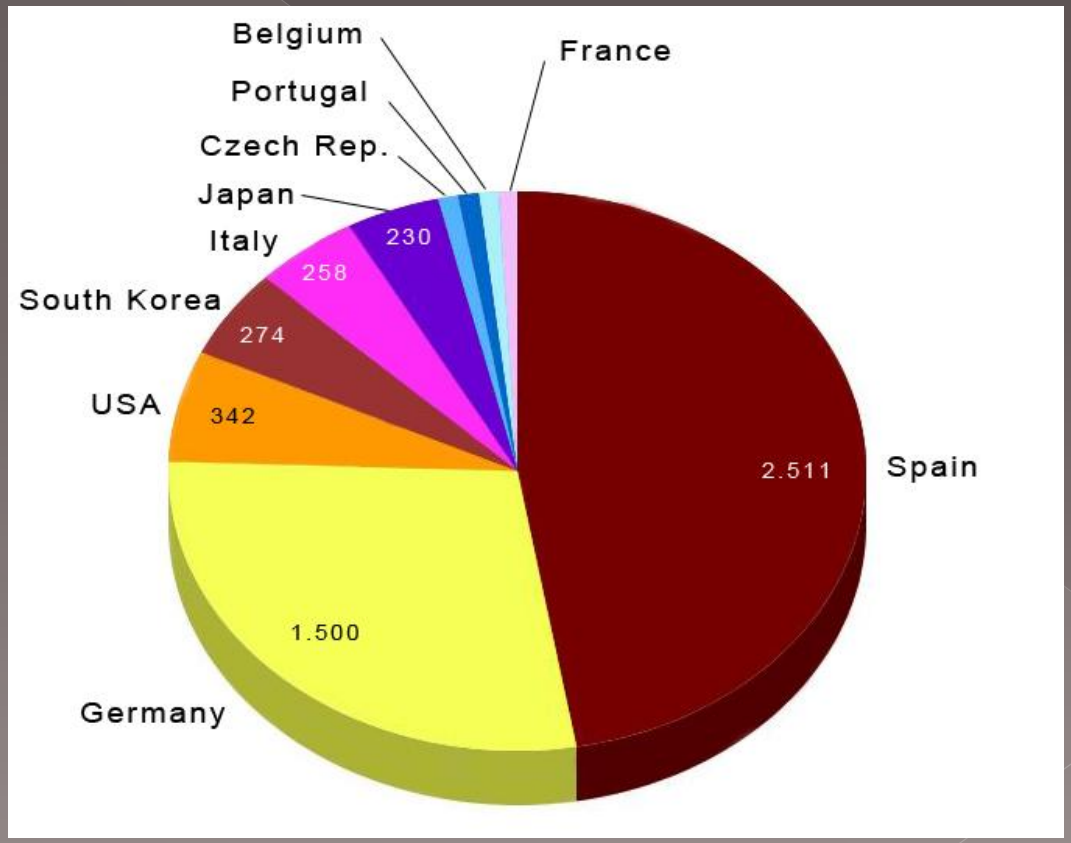
  assessment of policy options to reduce - and insure against - the costs of energy insecurity
- **Damocles risk**

  risk where the possible damage can be very high, but the probability that it occurs is very low
  - mega-dams or nuclear power plants.
- **Risk aversion**

pvs in bloom

Intelligent Energy Europe

PV installations in 2008



Renewable Energy Vision in Europe

- A very high rate of deployment of renewable energy projects is needed
- Some form of financial support is required
  - Cannot rely on market alone
- Regulatory encouragement

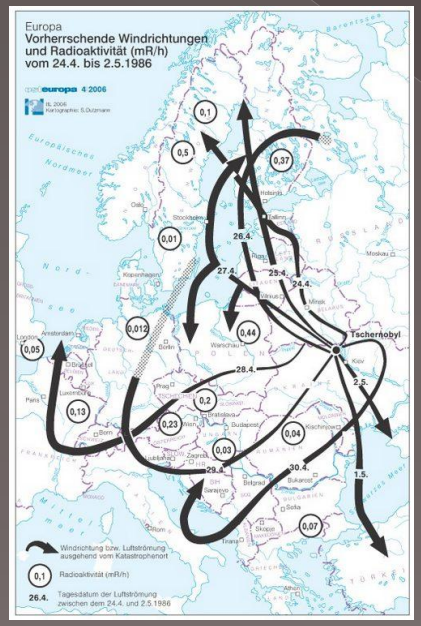
  e.g. building codes
- Support of research and development

  Comprehensive approach
- Support for education at all levels

  e.g. European Masters in Renewable Energy

J. F. Manwell, Professor and Director, Renewable Energy Research Laboratory Department of Mechanical and Industrial Engineering University of Massachusetts

Germany employs renewable energies to reduce dependency on nuclear power and fossil fuels.



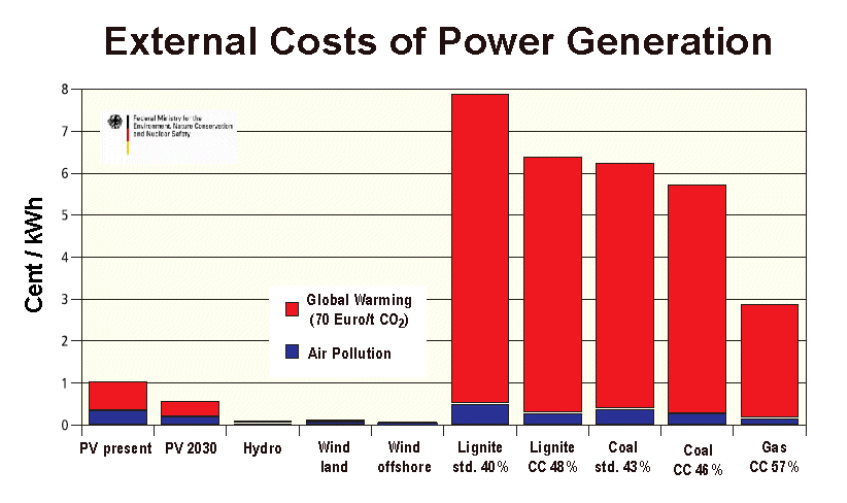
Phase-out by 2021 of all nuclear power plants (30% of current generation) has been legislated to avoid “another Chernobyl”.

75% of Germany’s energy supplies are imported.

Jeffrey H. Michel, MSc. Ing.-Büro Michel
Community of Heuersdorf 04565 Regis-Breitingen
Germany jeffrey.michel@gmx.net

Landscape devastation equivalent to excavation of Suez Canal every 25 days results from mining 180 million tons of lignite per year for generation of one quarter of Germany’s electricity (150 TWh/a).

Renewable feed-in payments enable higher costs to be avoided.



The emissions of fossil fuel power plants impose a three to eightfold greater environmental burden than renewable energy generation.

Jeffrey H. Michel, MSc. Ing.-Büro Michel Community of Heuersdorf 04565 Regis-Breitingen Germany jeffrey.michel@gmx.net

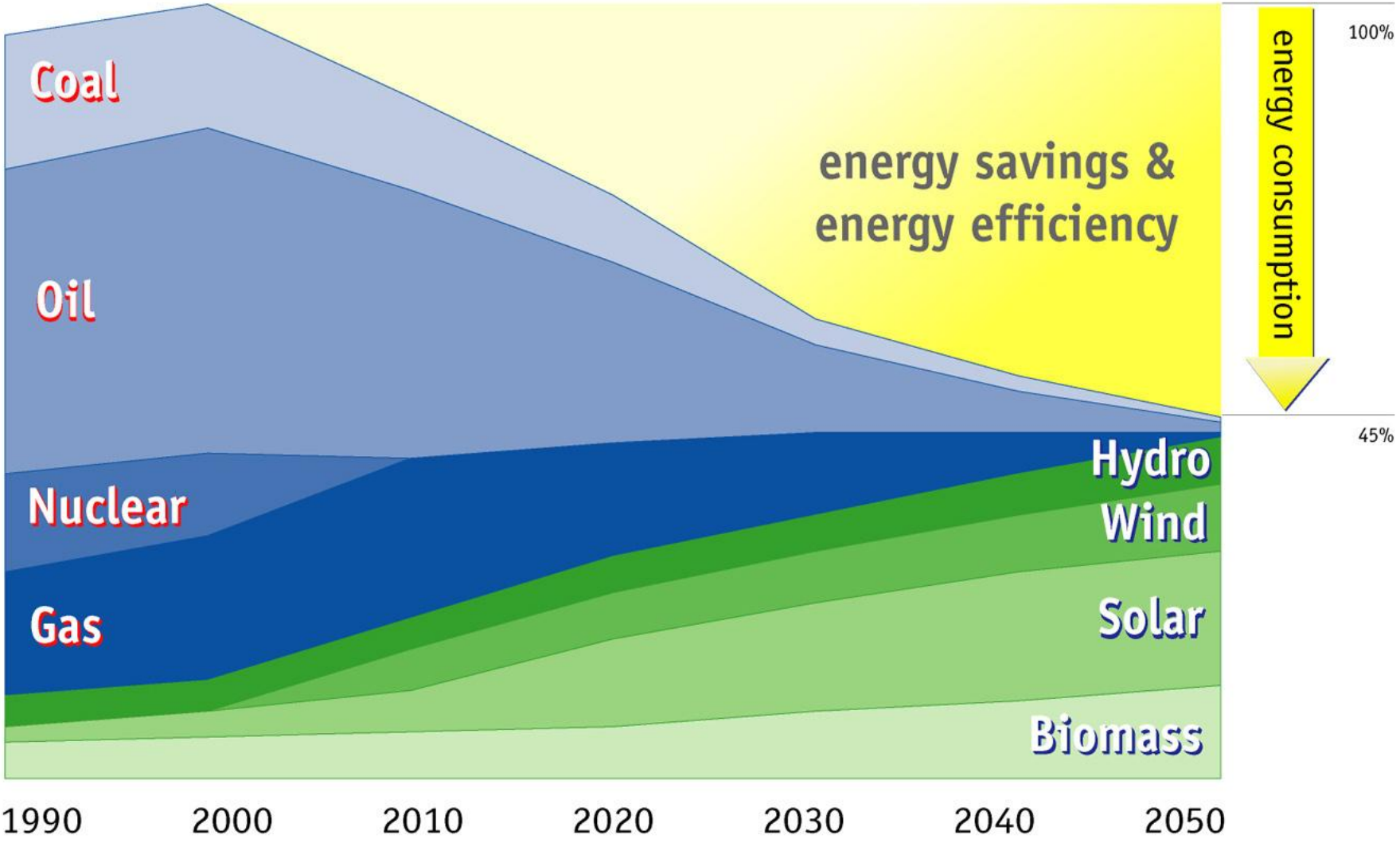
Incurred and Avoided Costs of the German Renewable Energy Sources Act (EEG) in 2006

Incurred Costs		Avoided Costs	
Feed-in payments	3.2 billion euro	Power purchases	5 billion euro
Reserve generating capacities	0.1 billion euro	Fuel imports	0.9 billion euro
		Climate, air pollution	3.4 billion euro

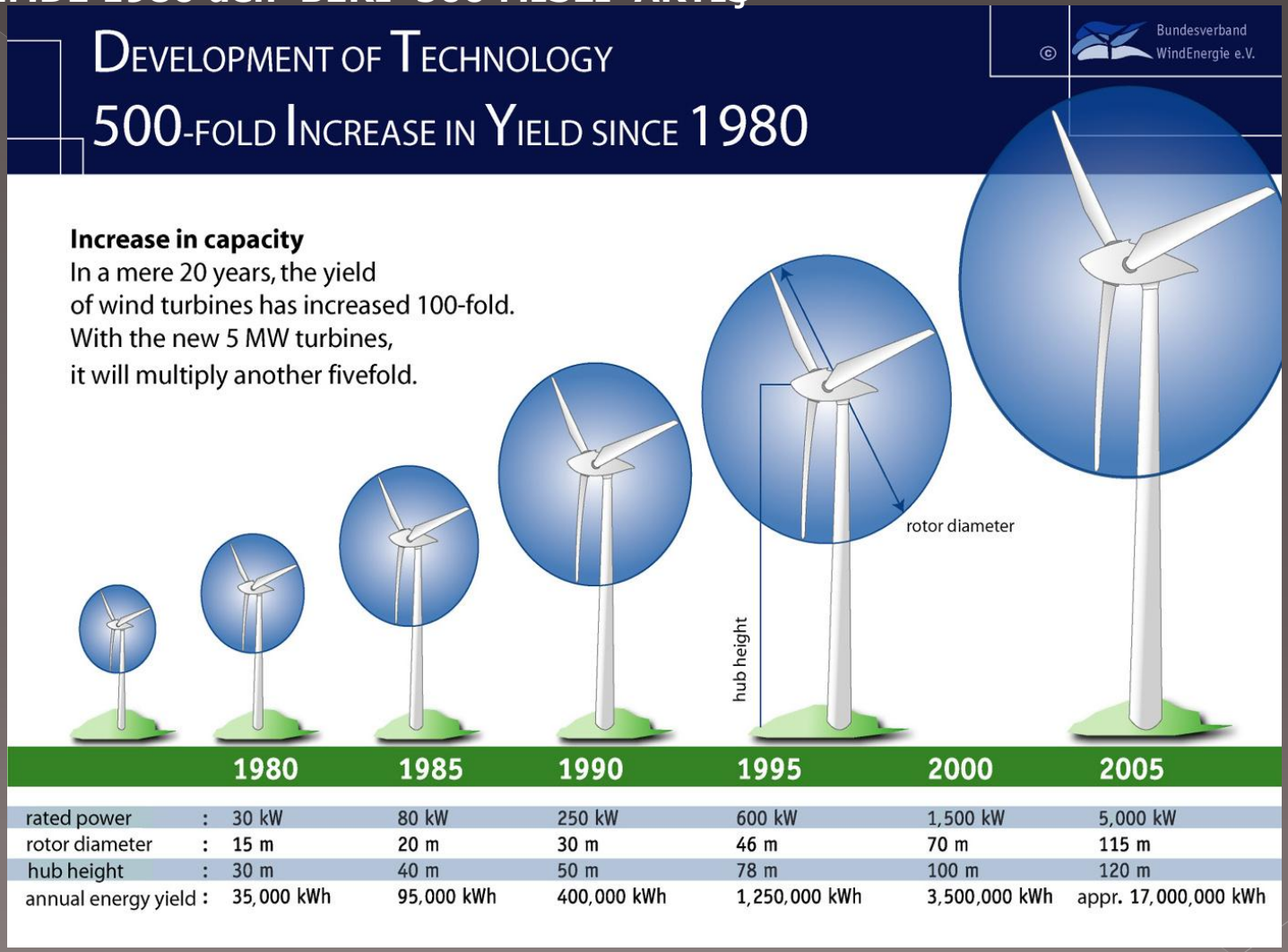
Source: *Erfahrungsbericht 2007 zum Erneuerbaren-Energien-Gesetz (EEG) gemäß § 20 EEG. BMU-Entwurf. Zusammenfassung* (Berlin: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, July 5, 2007), p. 5

Energy Scenario 2050
Primary Energy Consumption Covered

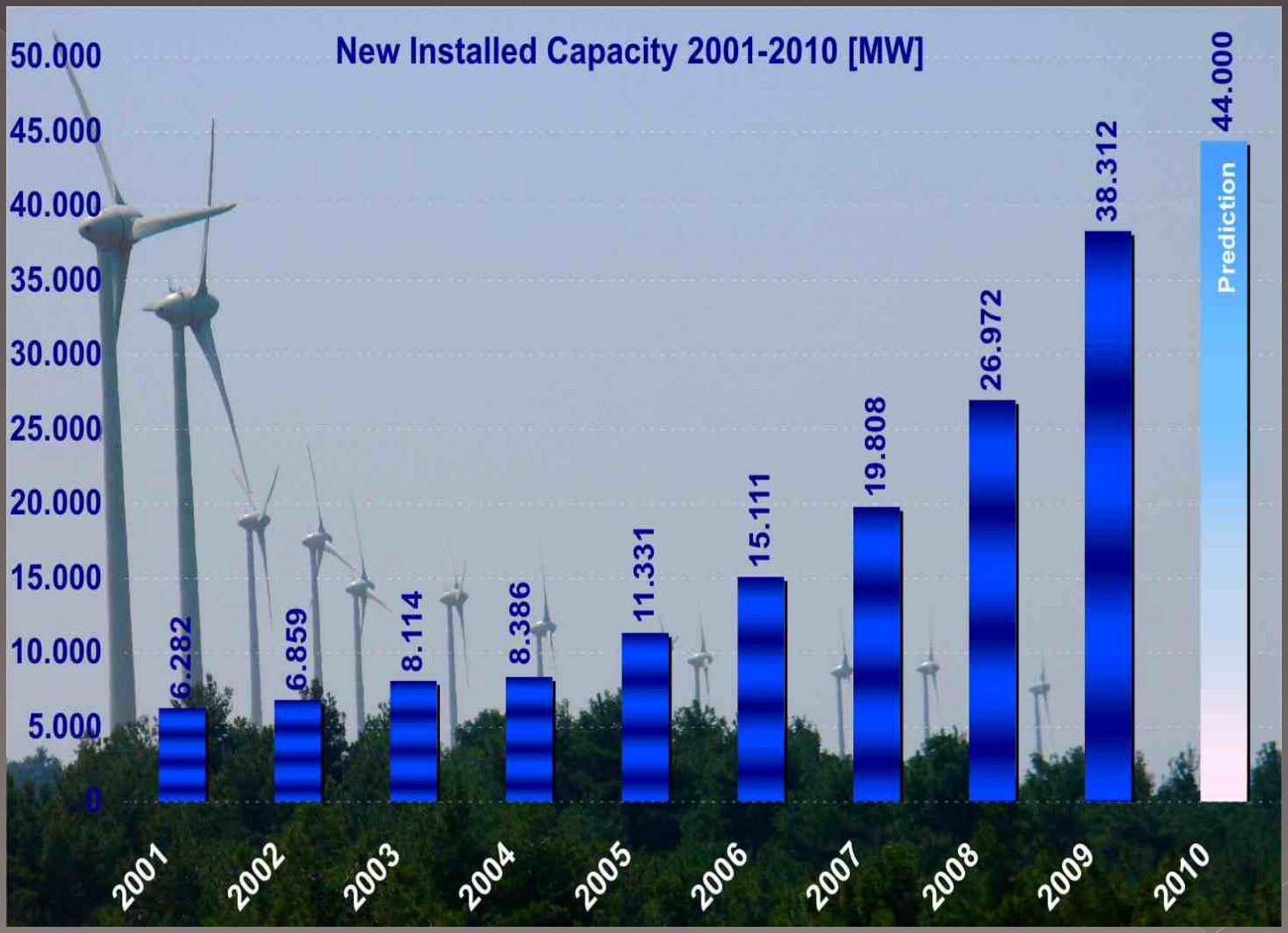
Source:
H. Lehmann, Wuppertal Institute for climate, environment and energy



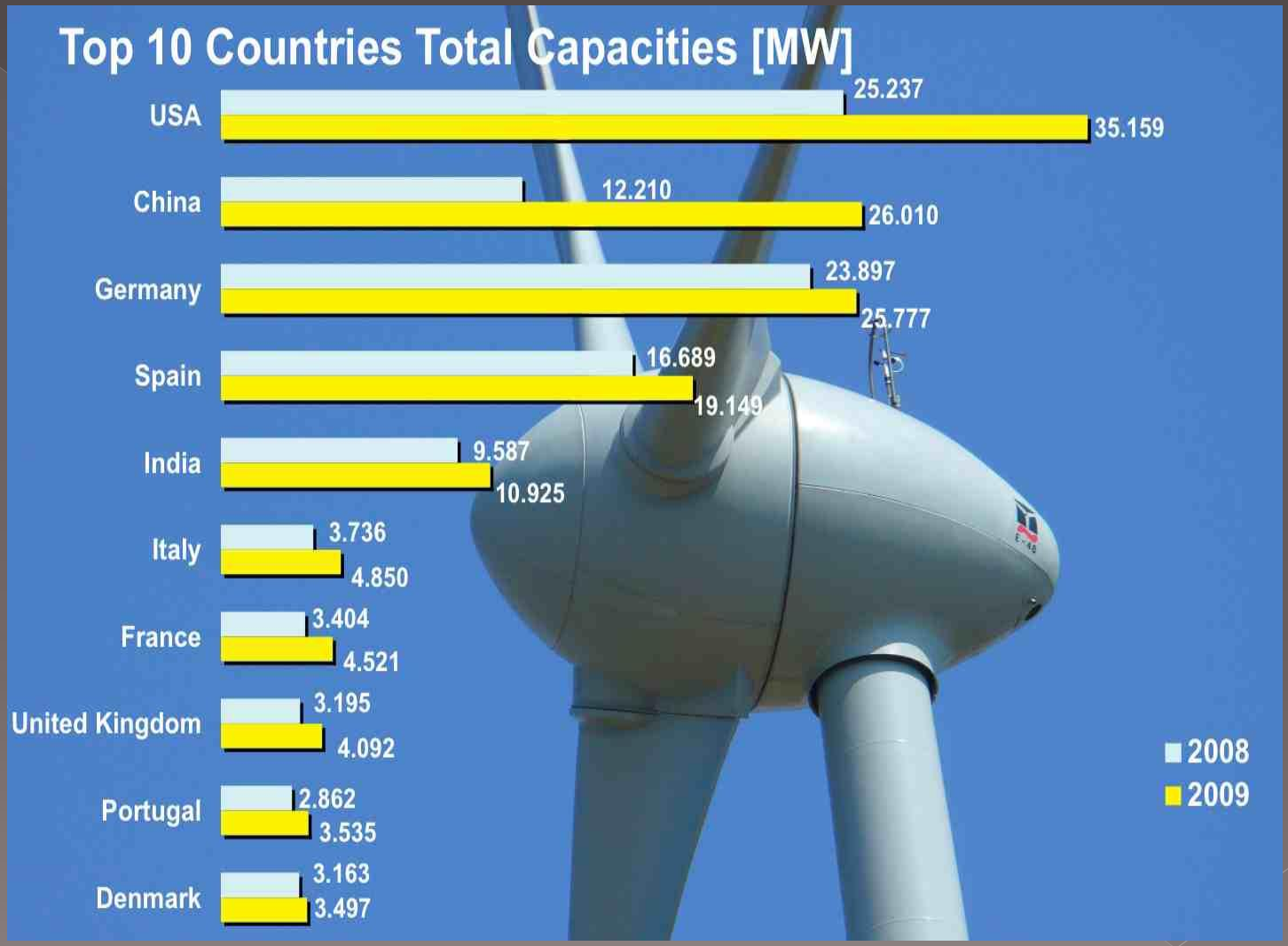
TEKNOLOJİ GELİŞİMİ:
VERİMDE 1980'den BERİ 500 MİSLİ ARTIŞ



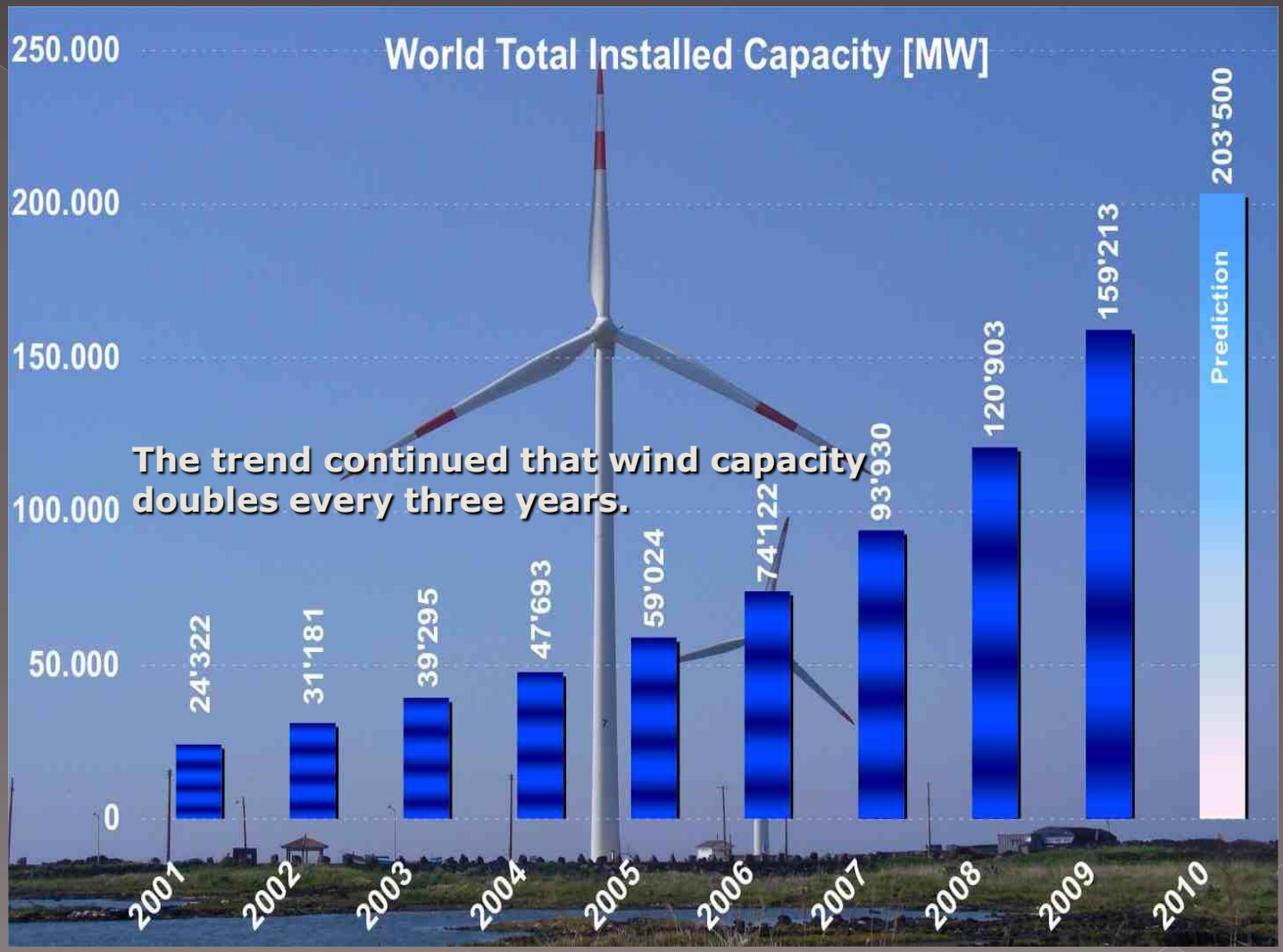
2001-2010 YILLARI ARASINDA HER YIL KURULAN KAPASİTE (MW)



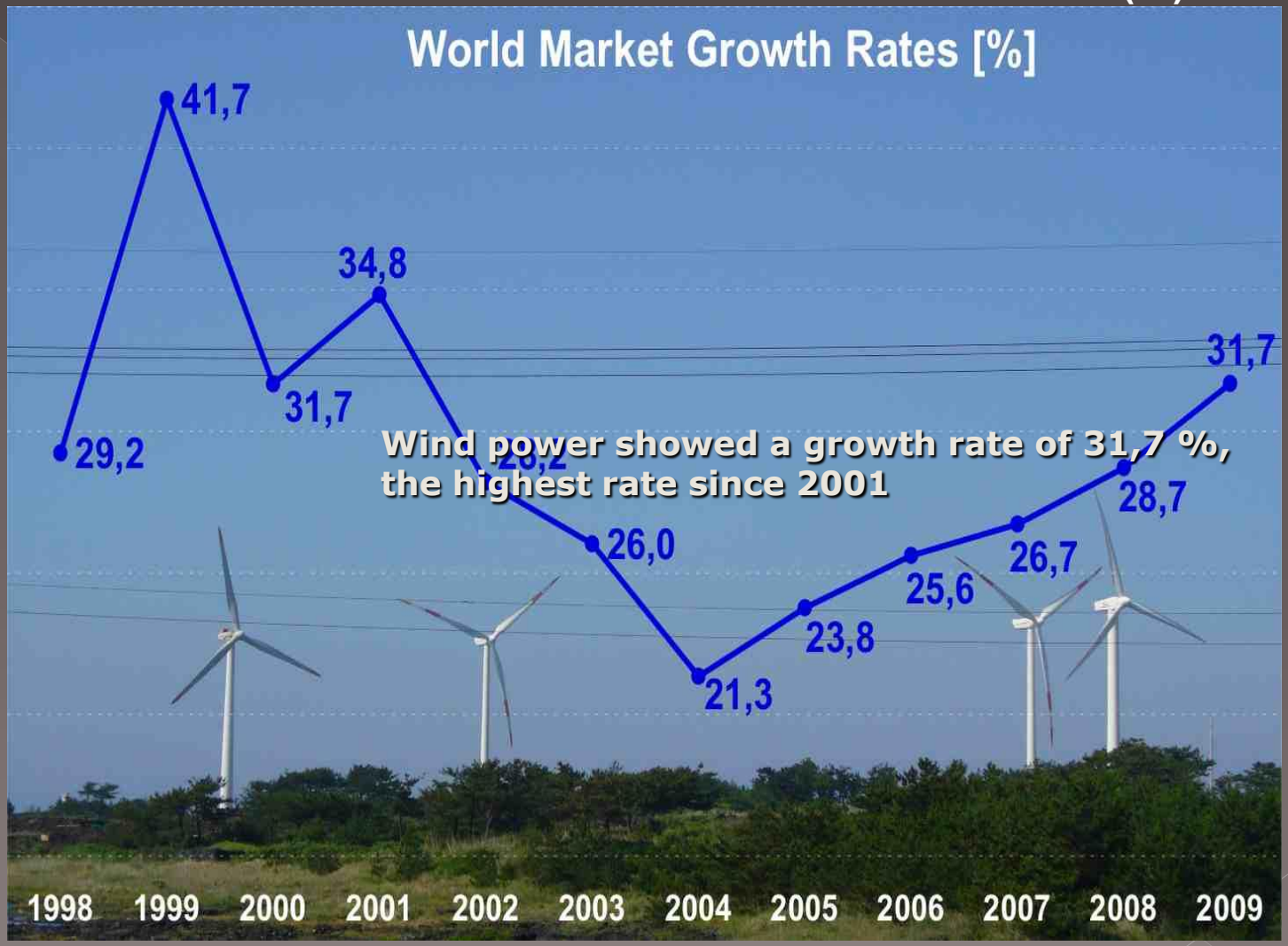
İLK 10 ÜLKENİN TOPLAM KAPASİTELERİ (MW)



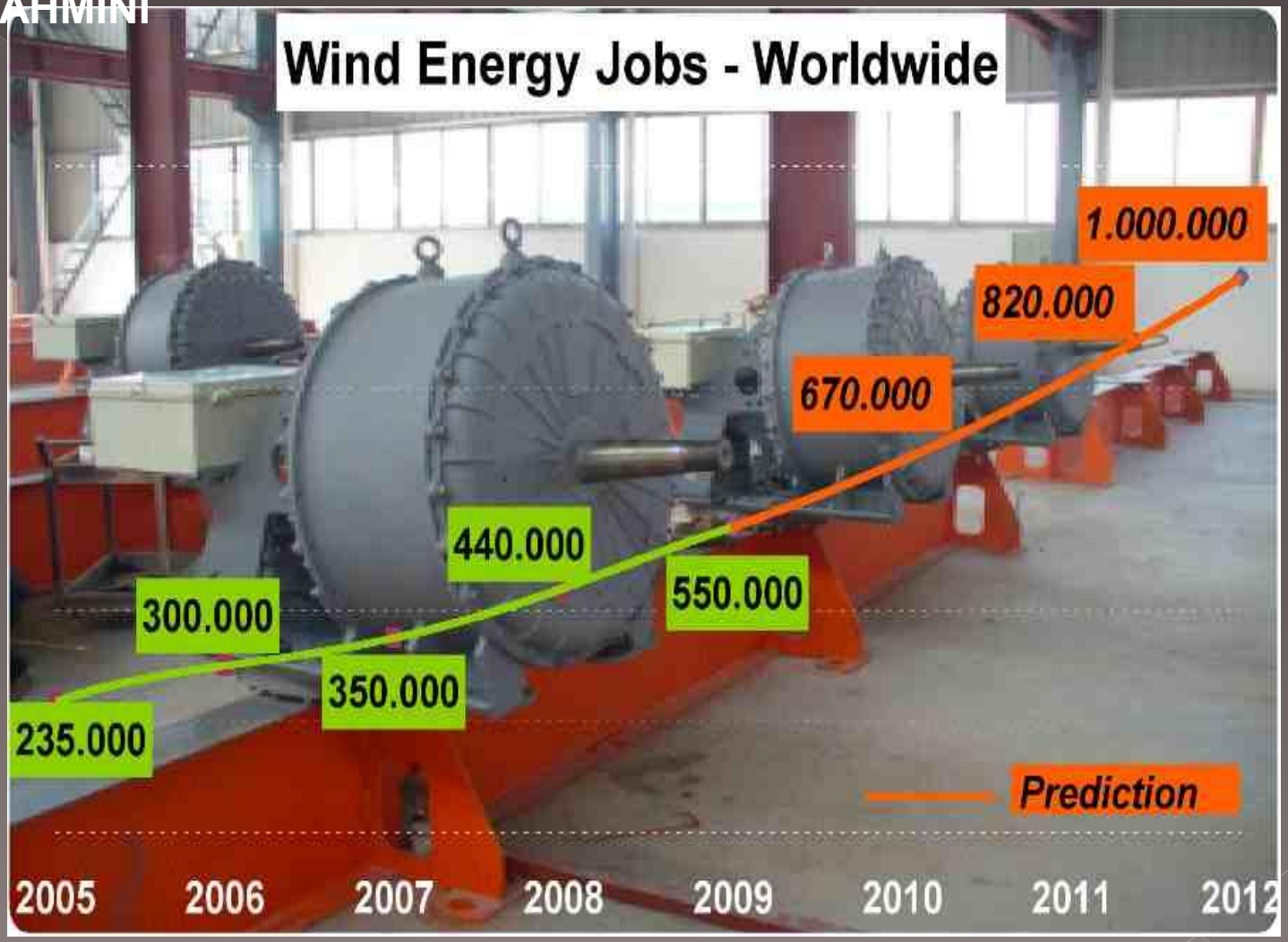
DÜNYADA KURULU TOPLAM RÜZGAR GÜÇ KAPASİTESİ (MW)



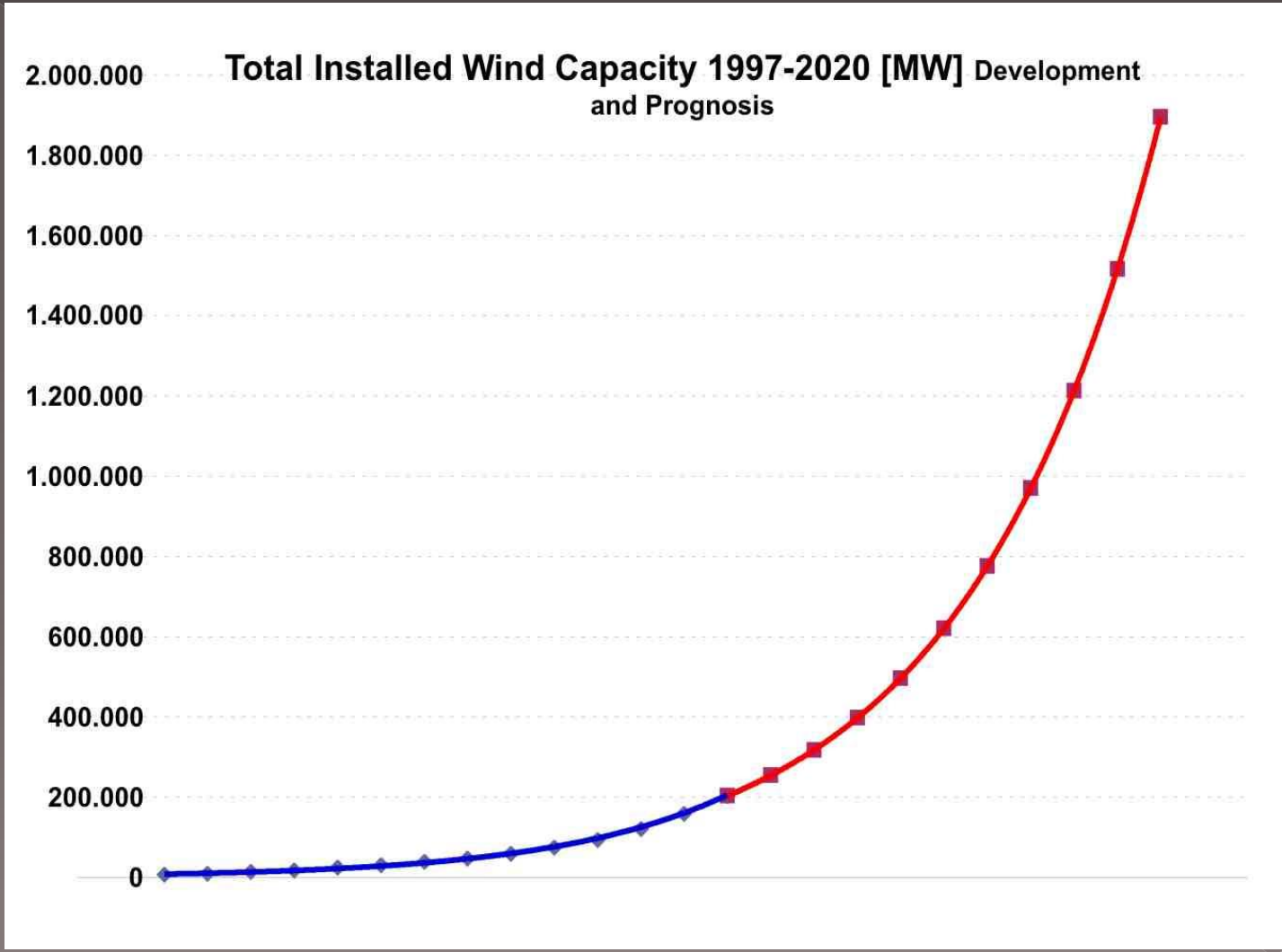
DÜNYA RÜZGAR ENERJİSİ PAZARI BÜYÜME ORANLARI (%)



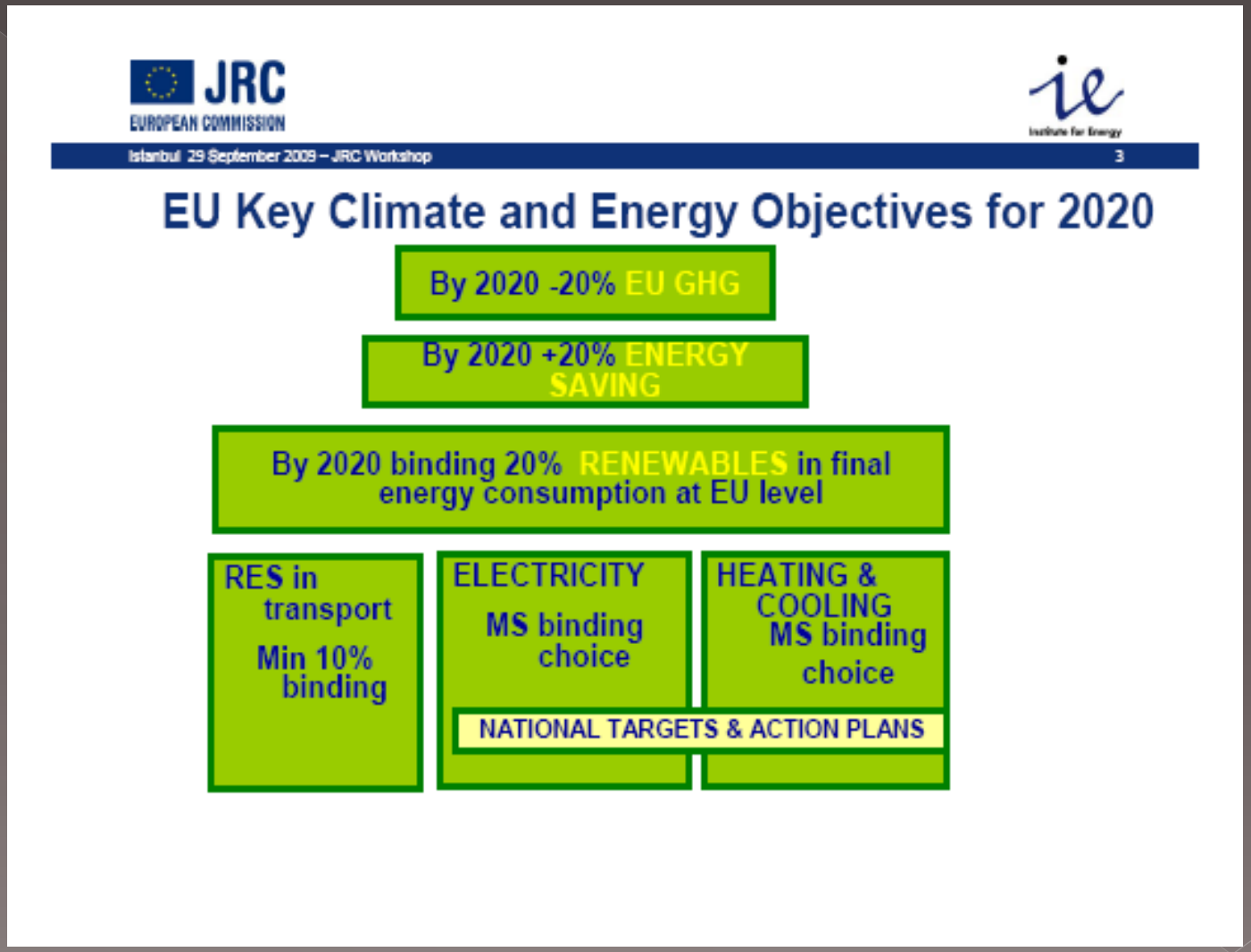
RÜZGAR ENERJİSİ İSTİHDAM DEĞERLERİ VE TAHMİNİ

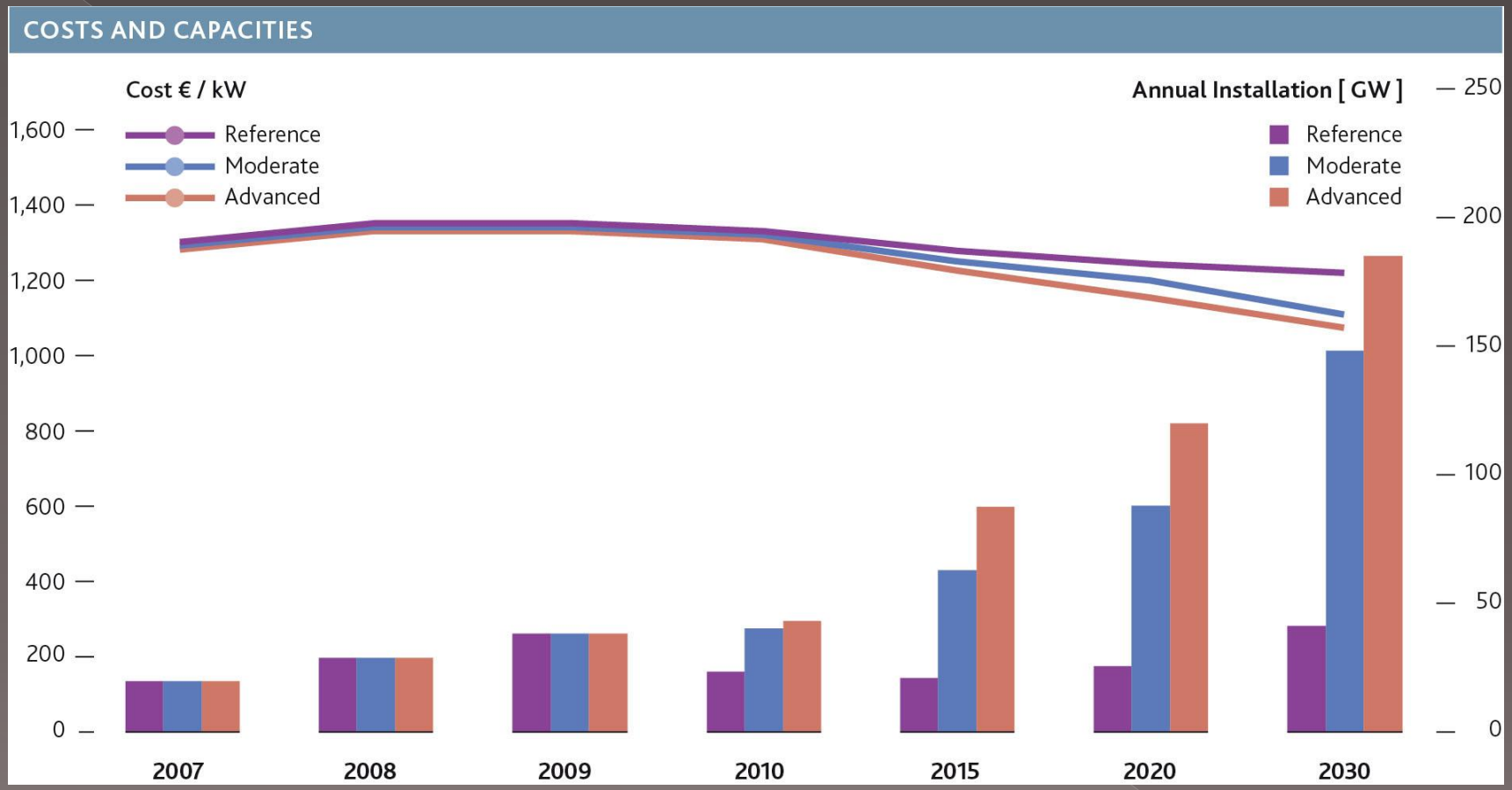


DÜNYA TOPLAM RÜZGAR KURULU GÜÇ GELİŞİM VE ÖNGÖRÜMÜ 1997-2020 (MW)



AB NİN 2020 YILI İÇİN
TEMEL İKLİM VE ENERJİ HEDEFLERİ



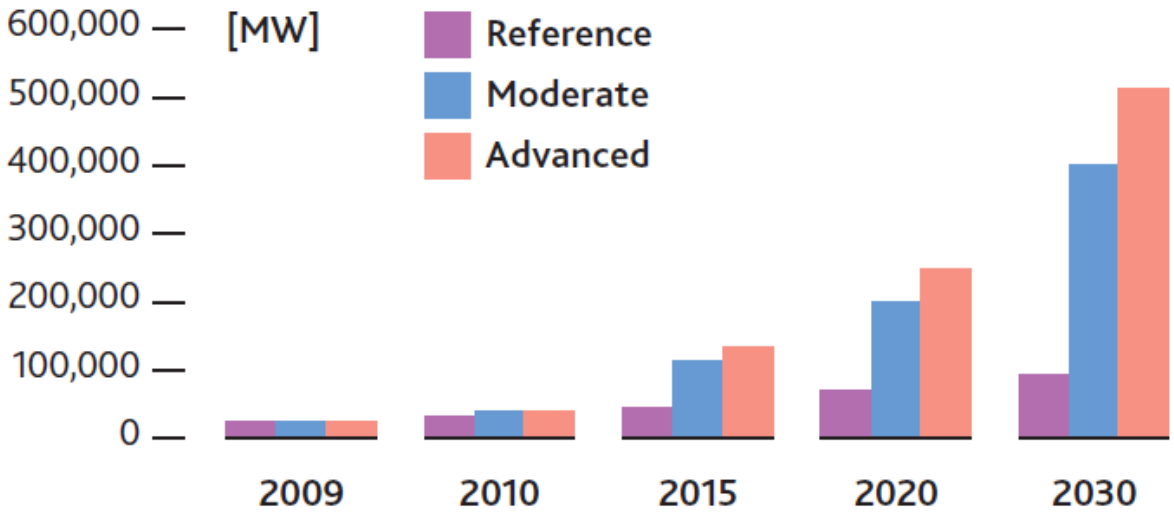


Maliyet ve Kapasiteler

Kaynak: GWEC

Çin Halk Cumhuriyeti

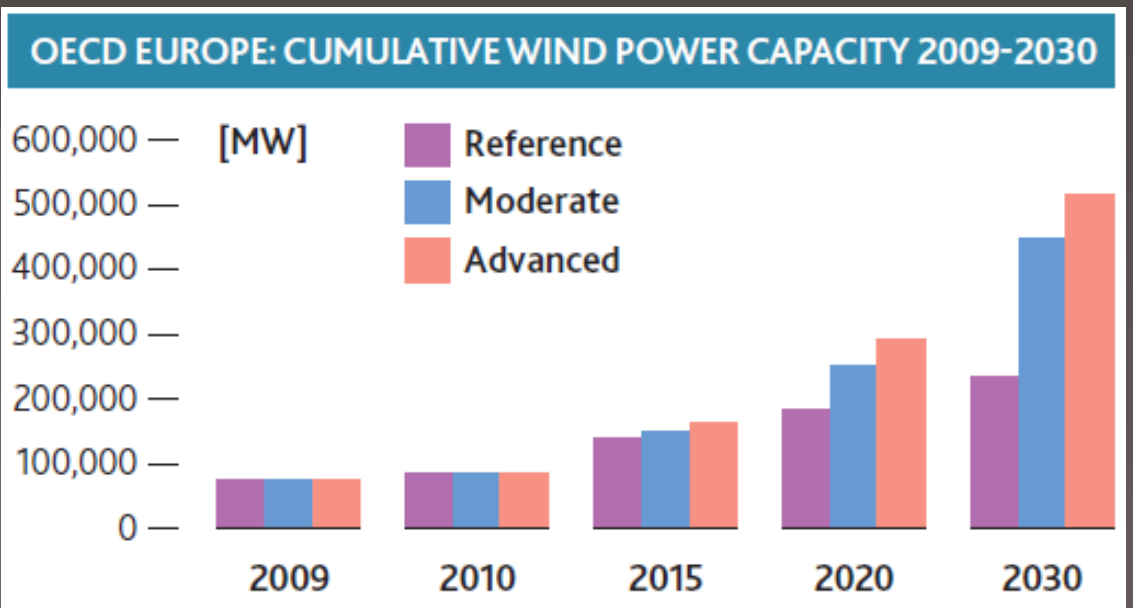
CHINA: CUMULATIVE WIND POWER CAPACITY 2009-2030



Year	Reference	Moderate	Advanced
2009	25,805	25,805	25,805
2010	32,805	39,608	41,030
2015	45,305	115,088	134,712
2020	70,305	200,026	250,397
2030	95,305	403,741	513,246

Kaynak: GWEC

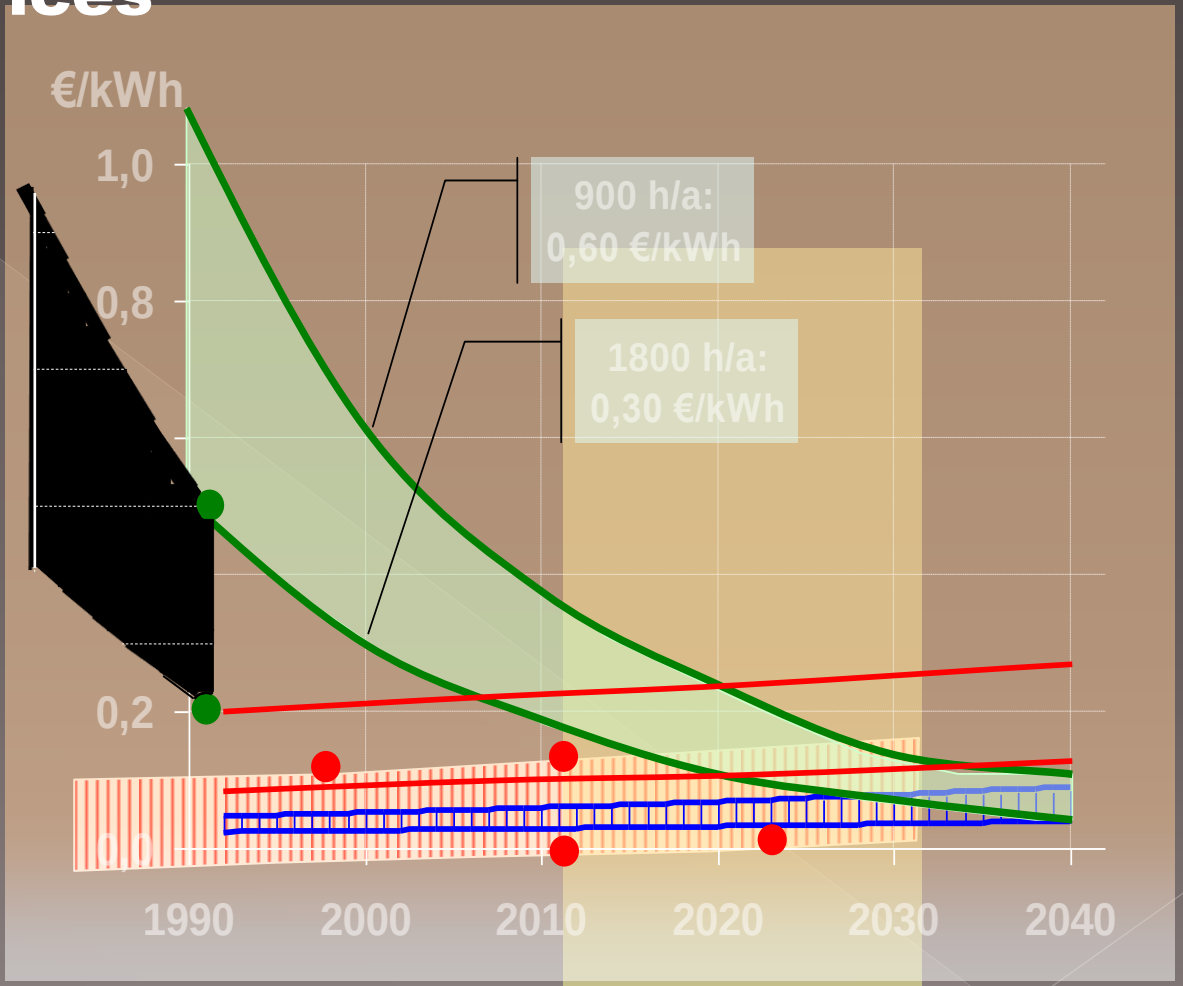
OECD Üyesi Avrupa Ülkeleri



Year	Reference	Moderate	Advanced
2009	75,565	75,565	75,565
2010	85,696	86,175	87,140
2015	138,596	150,049	163,109
2020	183,996	250,824	293,963
2030	233,796	447,432	514,806

Kaynak: GWEC

Electricity Generating Cost for PV and utility prices



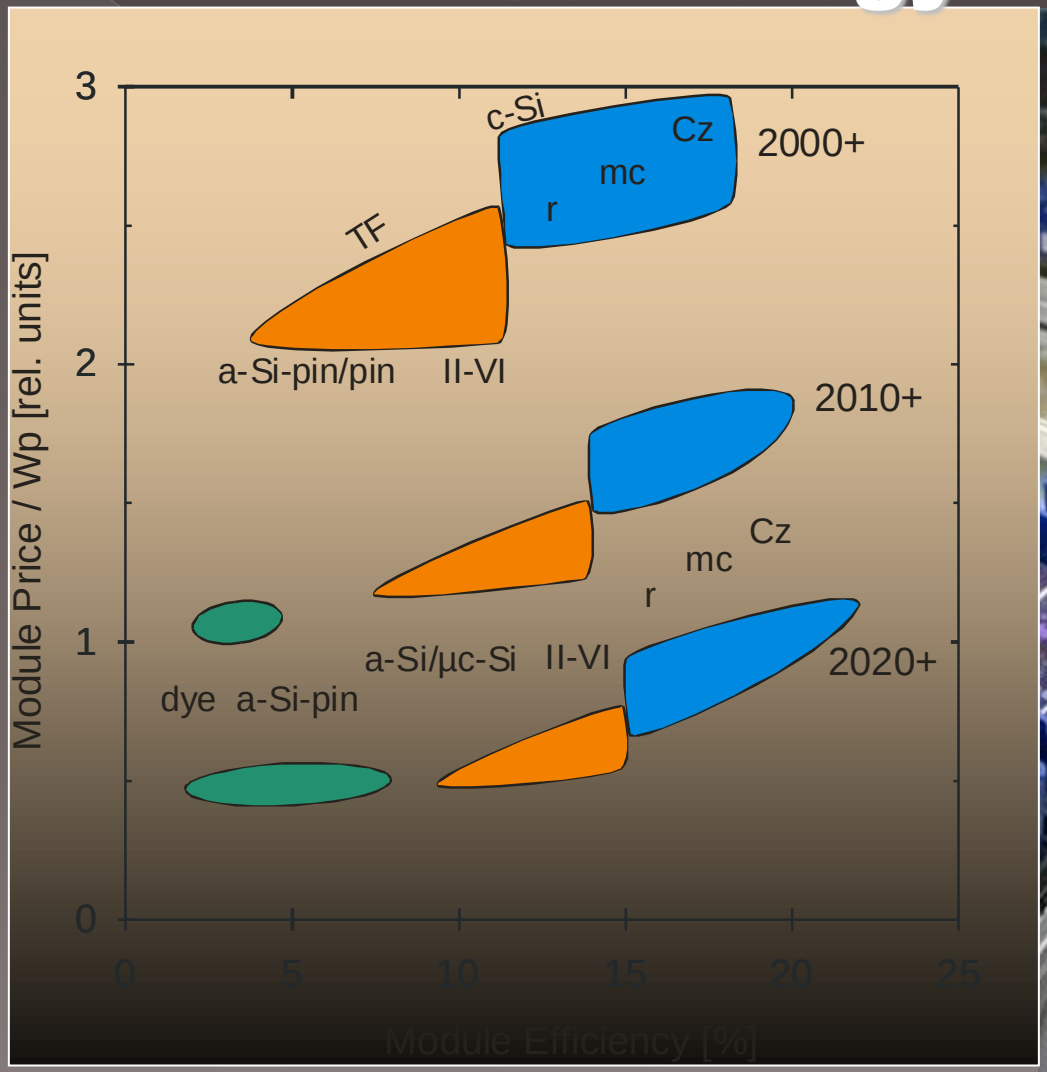
Photovoltaics

Utility peak power

Bulk power

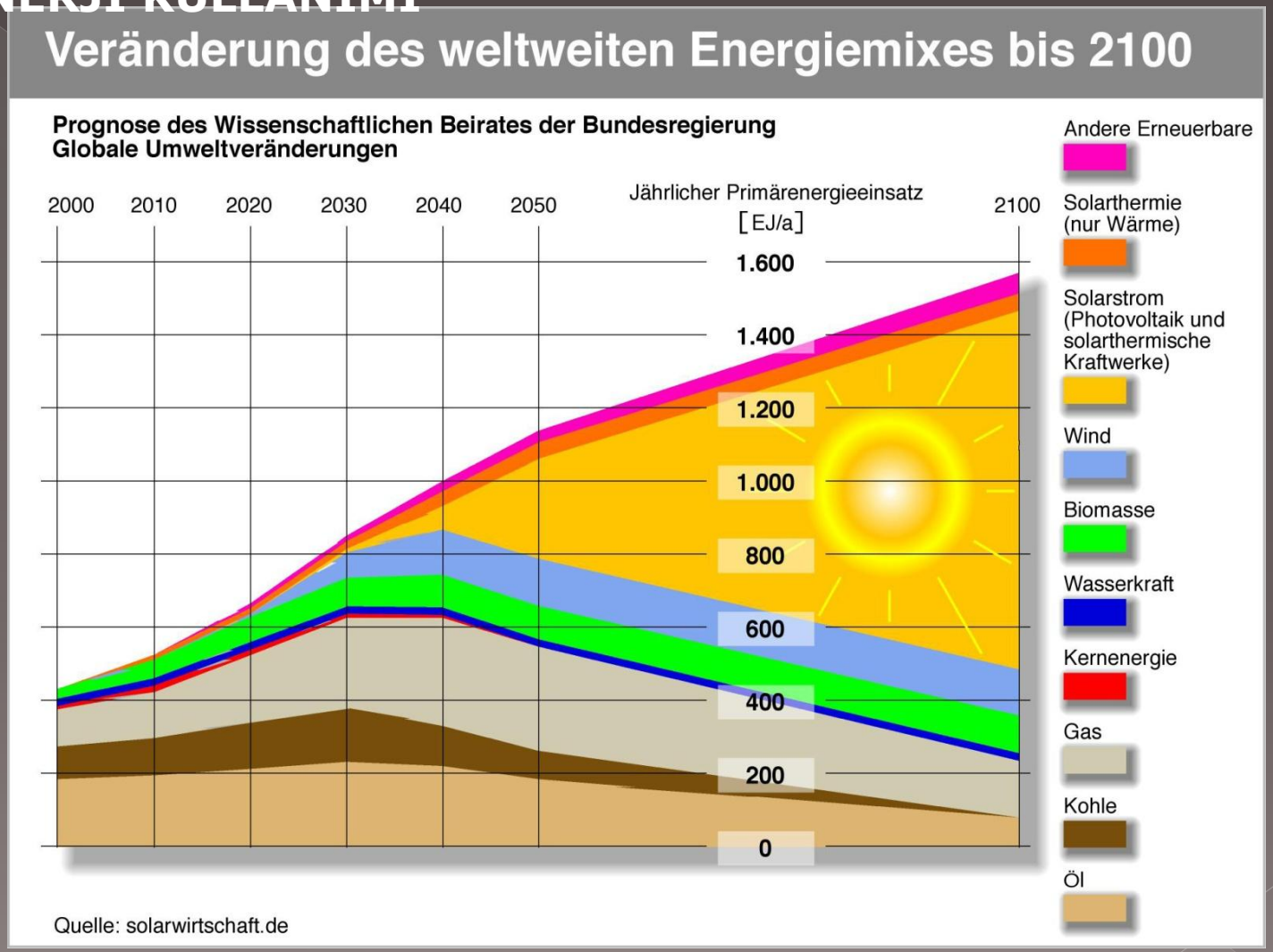
Source: RWE Energie AG and RSS GmbH

Technology evolution



Source: @ RWE SCHOTT Solar GmbH

2100 YILINA KADAR ÖNGÖRÜLEN BİRİNCİL ENERJİ KULLANIMI

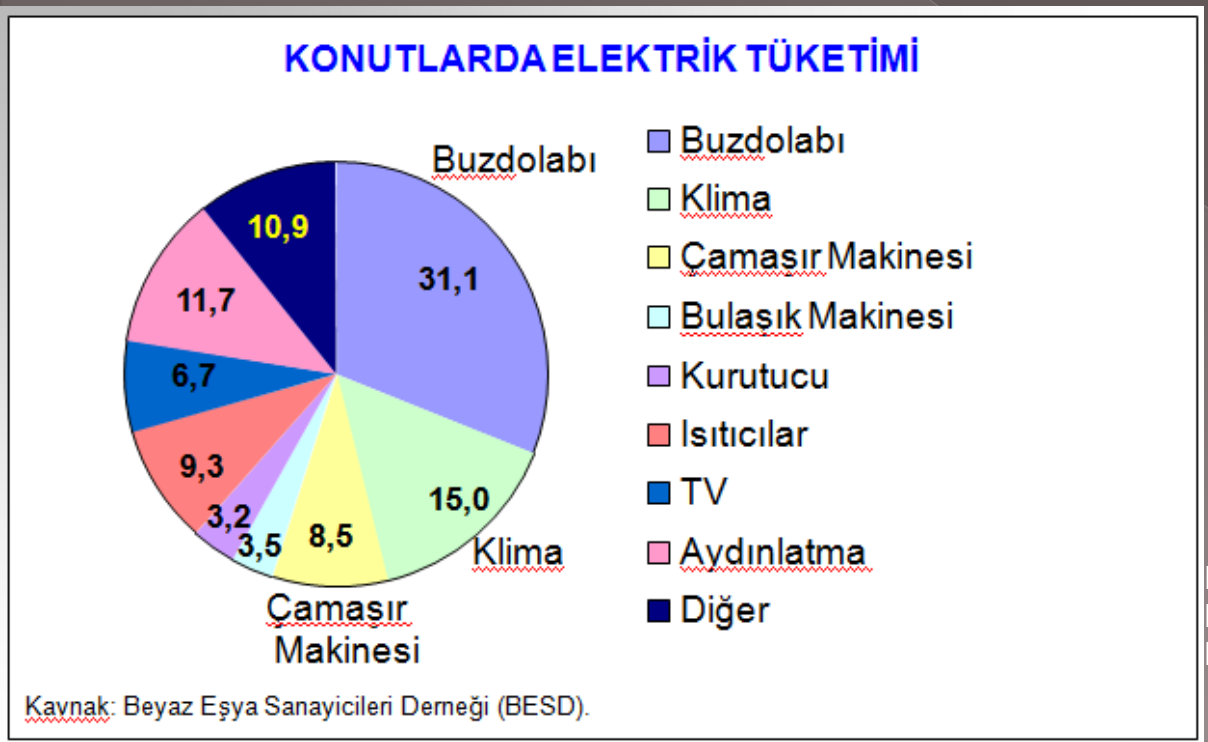


Konutlarda Enerji Tüketimi (2007)

Türkiye'nin brüt elektrik üretimi (2007): 191.6 milyar kWh
Türkiye'nin net elektrik tüketimi (2007): 155.1 milyar kWh

Konutlarda toplam elektrik tüketimi: 36.5 milyar kWh (Net tüketimin %23.5'i)
[Abone sayısı: 24.7 milyon]

Buzdolaplarının elektrik tüketim oranı (2007): %23.5 x %31.1 = **%7.3**



Türkiye net elektrik tüketiminin % 7.3'ü

Kaynak: TEİAŞ ve TEDAŞ
http://www.teias.gov.tr/ist2007/index.htm
http://www.tedas.gov.tr/29,Istatistiki_Bilgiler.html.

Değişik verimlilik sınıflarındaki buzdolaplarının A+ sınıfına kıyasla verimlilik ve ekonomiklikleri

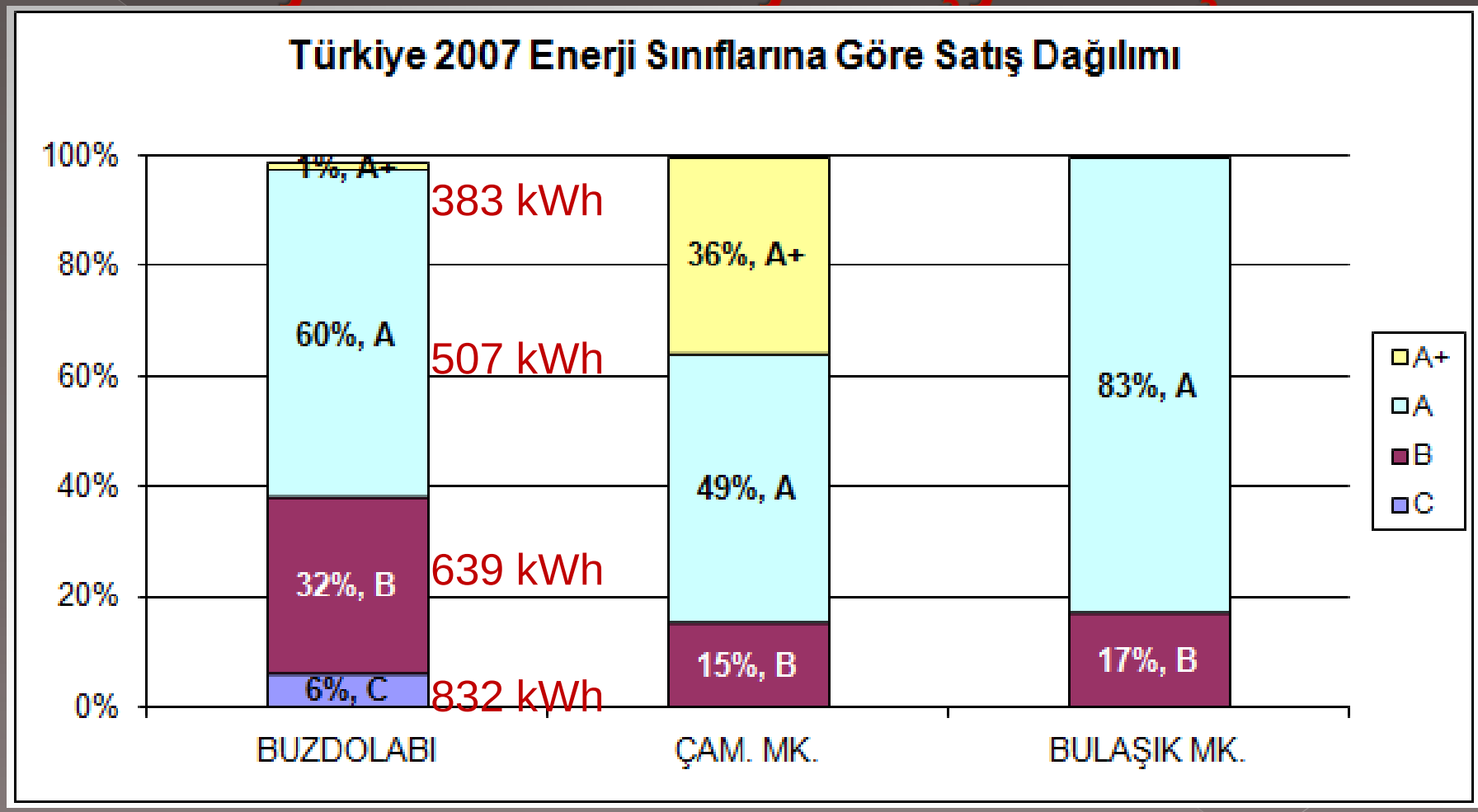
Verimlilik Sınıfı	Yıllık Enerji tüketimi, kWh/yıl	A+'dan fazla enerji tüketimi, kWh/yıl		A+'dan fazla enerji maliyeti, TL/yıl	A+'dan fiat farkı, TL*	A+'la fiat farkını geri ödeme süresi, yıl
A++	274	(-109)	(-28%)	(- 20)	-	-
A+	383	-	-	-	-	-
A	507	124	%32	42	350	8.3
B	639	256	%67	66	700	10.6
C	832	449	%117	100		
D	916	533	%139	116		
E	1149	766	%200	138		

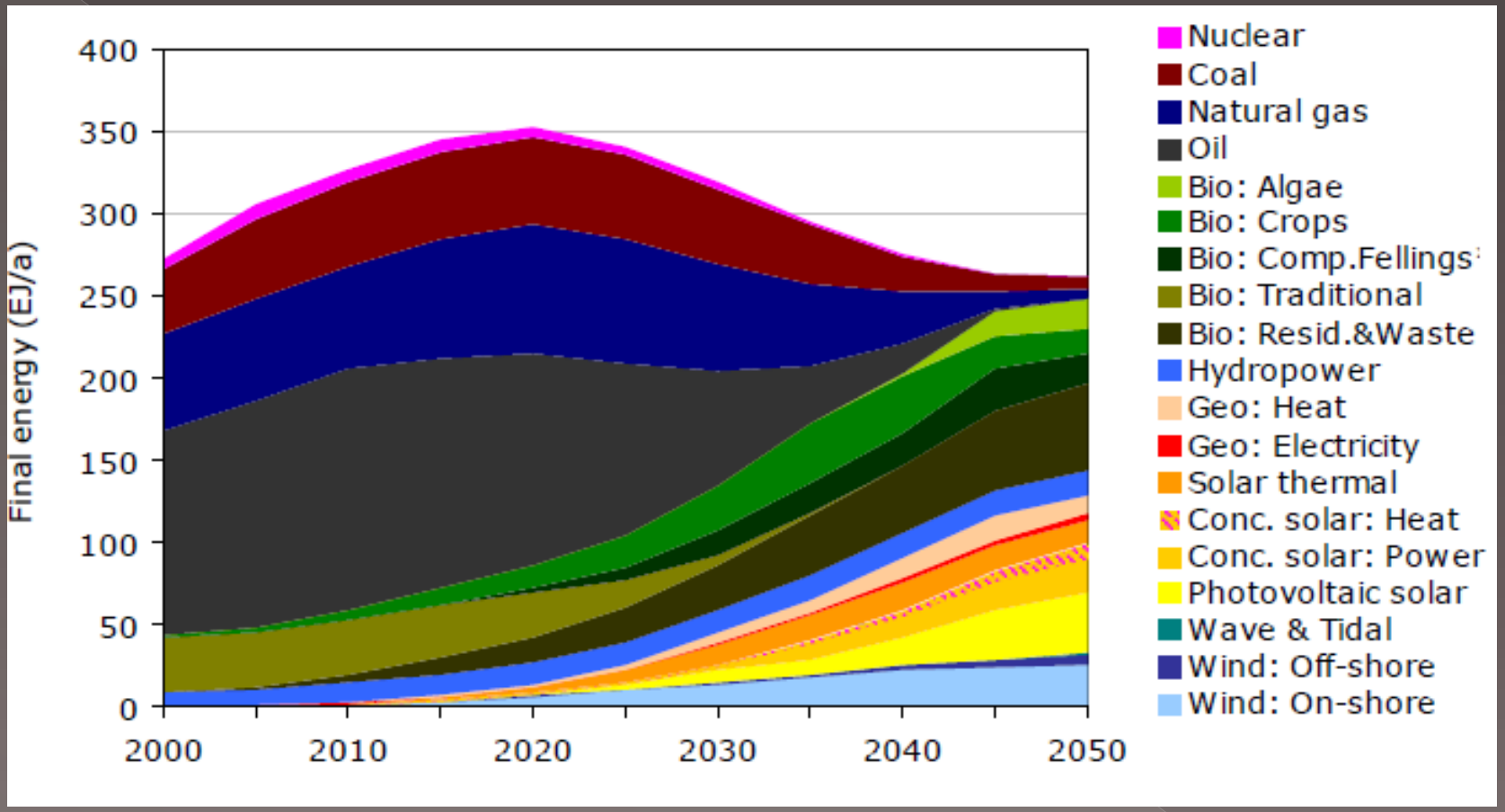
*A+ buzdolabının fiatı 1750 TL alınmıştır.

Kaynak: Beyaz Eşya Sanayicileri Derneği, BESD.

- C sınıfı bir buzdolabı, A++'nın 3 katı enerji kullanmaktadır.
- B sınıfı bir buzdolabı, A+'a göre %67 daha fazla enerji kullanmaktadır. Ancak 66 TL'lik yıllık tasarruf, 700 TL'lik fiat farkını 11 yılda geri öder.

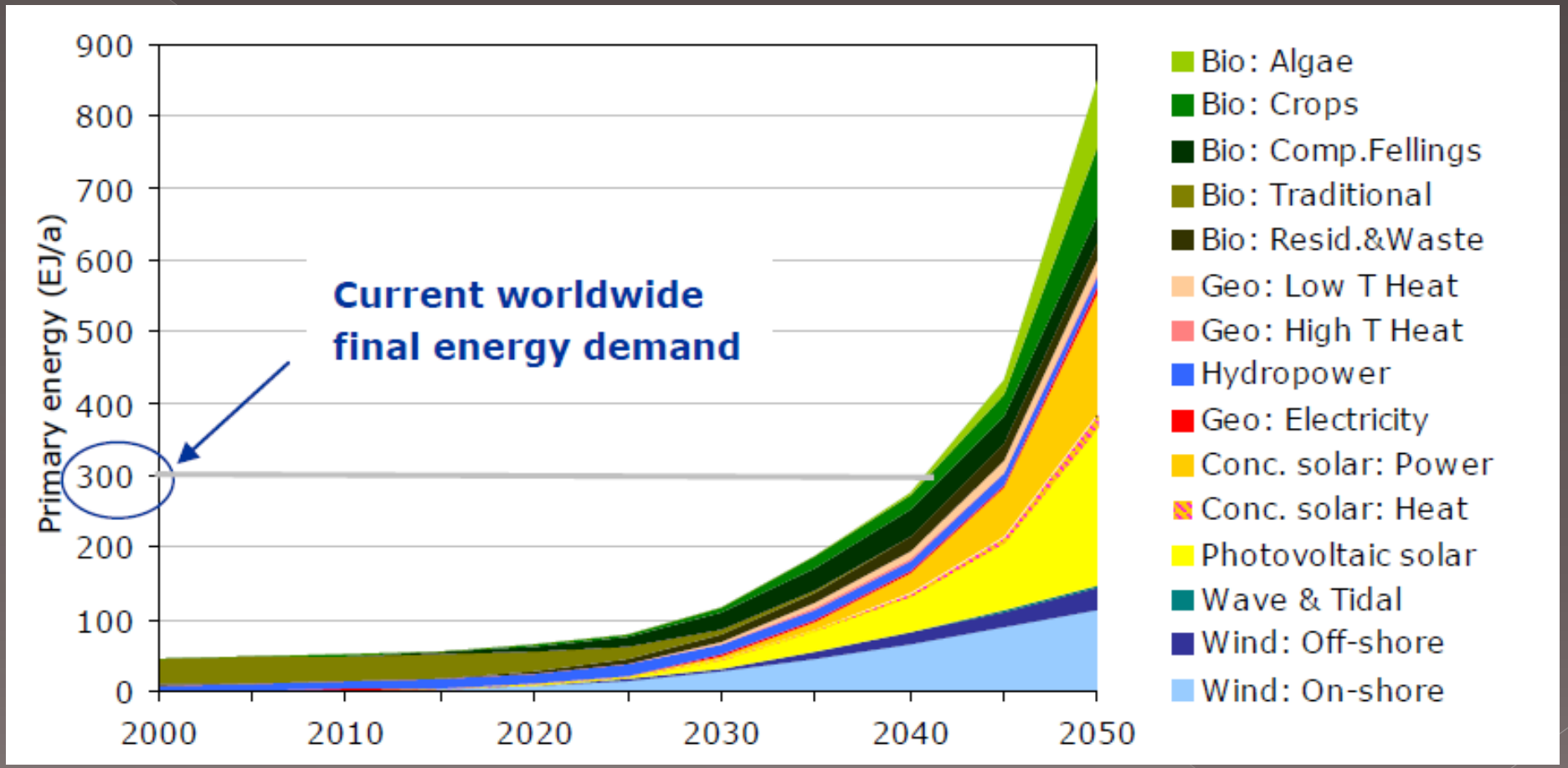
Enerji verimliliği sınıflarına göre Türkiye'nin 2007 beyaz eşya satışları





Küresel Enerji Arzı Senaryosu

Kaynak: GWEC



Çeşitli yenilenebilir enerji kaynaklarının küresel arz potansiyeli.

Kaynak: GWEC

YENİLENEBİLİR KAYNAKLARA DAYALI LİSANS İŞLEMLERİ

	Başvuru		İnceleme & Değerlendirme		Uygun Bulma		Lisans Verilen		İptal Edilen Lisanslar		Sonlandırılan Lisanslar	
	Adet	MW	Adet	MW	Adet	MW	Adet	MW	Adet	MW	Adet	MW
Rüzgar	3	39,60	619	28.530,42	46	1.654,50	101	3.910,20	13	537,81	9	378,90
Jeotermal			3	69,90			12	281,70			1	15,00
Biyogaz							18	103,33	1	15,00		
Biyokütle							2	17,12	1	10,00		
TOPLAM	3	39,60	622	28.600,32	46	1.654,50	133	4.312,35	15	562,81	10	393,90

Kaynak: EPDK

İŞLETMEDEKİ RÜZGAR SANTRALLARI

Doğal A.Ş.
Çanakkale-Gelibolu / 14,9 MW

Anemon A.Ş.
Çanakkale-İntepe / 30,4 MW

Yapısan A.Ş.
Balıkesir-Bandırma / 30 MW

Baki A.Ş.
Balıkesir–Şamlı /90 MW

Asmakinsan A.Ş.
Balıkesir-Bandırma / 24 MW

Akenerji A.Ş.
Balıkesir-Bandırma / 15 MW

Alize A.Ş.
Çanakkale-Ezine / 20,8 MW

Bores A.Ş.
Çanakkale-Bozcaada / 10,2 MW

Garet A.Ş.
Çanakkale-Ezine / 15 MW

Borasco A.Ş.
Balıkesir-Bandırma / 57 MW

Alize A.Ş.
Balıkesir-Susurluk / 20,7 MW

Boreas A.Ş.
Edirne–Enez / 15 MW

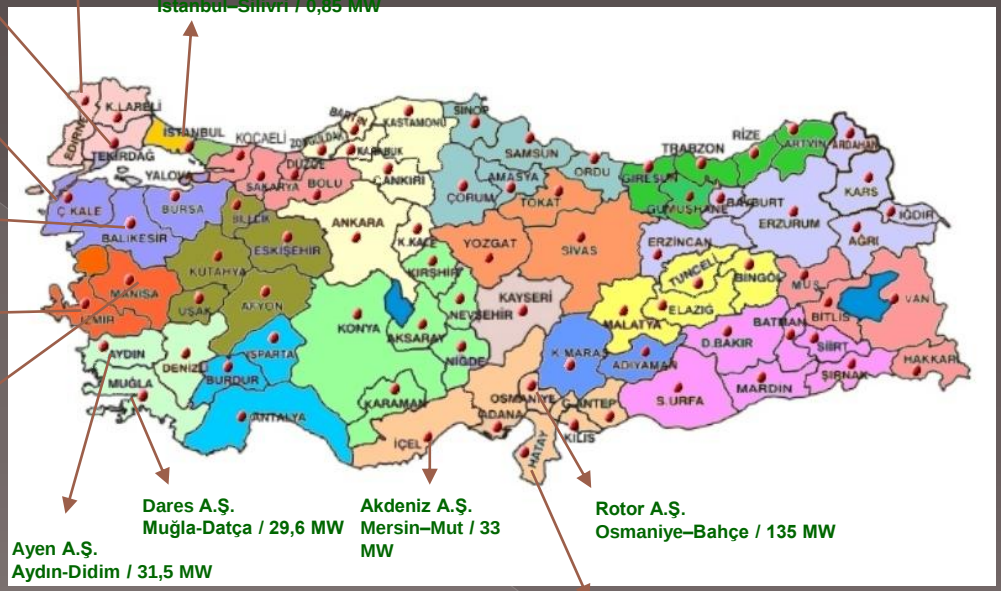
Alize A.Ş.
Tekirdağ-Şarköy / 28,8 MW

Sunjüt A.Ş.
İstanbul-Hadımköy / 1,2 MW

Lodos A.Ş.
İstanbul-G.O.P. / 24 MW

Ertürk A.Ş.
İstanbul–Çatalca / 60 MW

Teperes A.Ş.
İstanbul–Silivri / 0,85 MW



Kores A.Ş.
İzmir-Urla / 15 MW

Alize A.Ş.
İzmir-Çeşme / 1,5 MW

Ares A.Ş.
İzmir-Çeşme / 7,2 MW

İnnores A.Ş.
İzmir-Aliağa / 42,5 MW

Ütopya A.Ş.
İzmir-Bergama / 30 MW

Mare A.Ş.
İzmir-Çeşme / 39,2 MW

Mazı 3 A.Ş.
İzmir-Çeşme / 30 MW

Bergama RES A.Ş.
İzmir-Aliağa / 90 MW

Soma Enerji A.Ş.
Manisa- Soma / 88,2 MW

Bilgin A.Ş.
Manisa- Soma / 90 MW

Doğal A.Ş.
Manisa-Sayalar / 34,2 MW

Deniz A.Ş.
Manisa-Akhisar / 10,8 MW

Alize A.Ş.
Manisa-Kırkağaç / 25,6 MW

Ayen A.Ş.
Aydın-Didim / 31,5 MW

Sabaş A.Ş.
Aydın-Çine / 22 MW

Dares A.Ş.
Muğla-Datça / 29,6 MW

Akdeniz A.Ş.
Mersin–Mut / 33 MW

Rotor A.Ş.
Osmaniye–Bahçe / 135 MW

Bakras A.Ş.
Hatay–Belen / 15 MW

Belen A.Ş.
Hatay–Belen / 36 MW

Deniz A.Ş.
Hatay–Samandağ / 30 MW

Ziyaret RES A.Ş.
Hatay–Samandağ / 35 MW

Tamamlanan tesisler
Kısmi işletmedeki tesisler
Yap İşlet Devret modelindeki tesisler

Kaynak: EPDK

6094 sayılı Kanuna göre

I Sayılı Cetvel	
Yenilenebilir Enerji Kaynağına Dayalı Üretim Tesis Tipi	Uygulanacak Fiyatlar (ABD Doları cent/kWh)
a. Hidroelektrik üretim tesisi	7,3
b. Rüzgar enerjisine dayalı üretim tesisi	7,3
c. Jeotermal enerjisine dayalı üretim tesisi	10,5
d. Biyokütleye dayalı üretim tesisi (çöp gazı dahil)	13,3
e. Güneş enerjisine dayalı üretim tesisi	13,3

Kaynak: TBMM

II Sayılı Cetvel		
Tesis Tipi	Yurt İçinde Gerçekleşen İmalat	Yerli Katkı İlavesi (ABD Doları cent/kWh)
A- Hidrolelektrik üretim tesisi	1- Türbin	1,3
	2- Jeneratör ve güç elektroniği	1,0
B- Rüzgar enerjisine dayalı üretim tesisi	1- Kanat	0,8
	2- Jeneratör ve güç elektroniği	1,0
	3- Türbin kulesi	0,6
	4- Rotor ve nasel gruplarındaki mekanik aksamın tamamı (Kanat grubu ile jeneratör ve güç elektroniği için yapılan ödemeler hariç.)	1,3
C- Fotovoltaik güneş enerjisine dayalı üretim tesisi	1- PV panel entegrasyonu ve güneş yapısal mekaniği imalatı	0,8
	2- PV modülleri	1,3
	3- PV modülünü oluşturan hücreler	3,5
	4- İnvertör	0,6
	5- PV modülü üzerine güneş ışınını odaklayan malzeme	0,5

Kaynak: TBMM

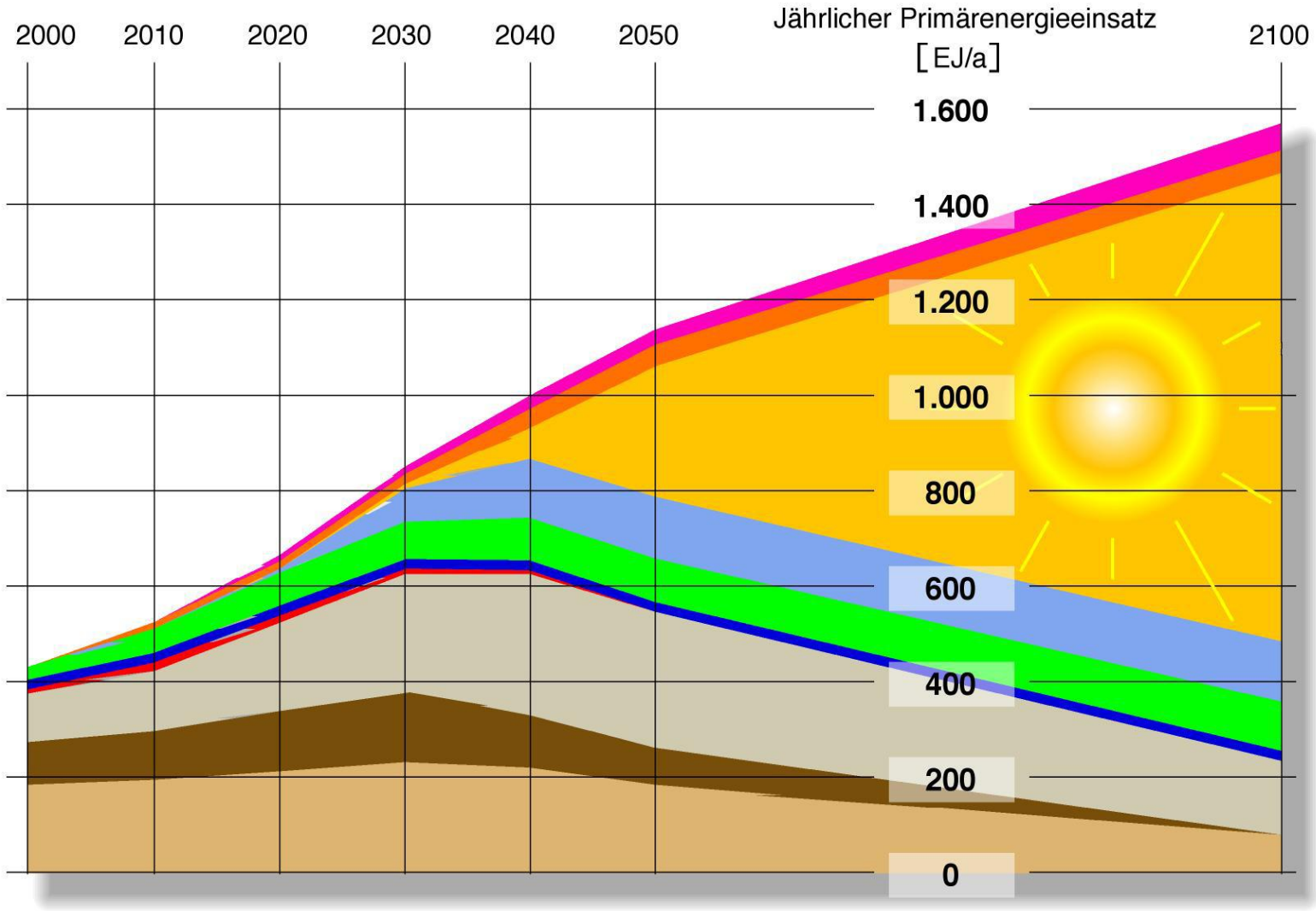
Global potential of concentrating solar power (CSP)

- Current parabolic trough technology with molten salt storage towers, steam cycle power block and dry cooling tower
- Global potential = 3million TWh/yr (current world electricity consumption = 18,000 TWh/yr)
- CSP plants mainly concentrated in desert regions with exports/imports by high voltage super-grid to many regions of the world
- Best options are Africa, Australia, Middle East, China central South America and developing Asia.
- High cost at present but can become a competitive option of electricity supply in the medium term (2020-2030) and later contribute significantly to stabilizing global elctricity costs

Trieb et al., Institute of Technical Thermodynamics, German Aerospace Center, 2009)

Veränderung des weltweiten Energiemixes bis 2100

Prognose des Wissenschaftlichen Beirates der Bundesregierung Globale Umweltveränderungen



Andere Erneuerbare

Solarthermie (nur Wärme)

Solarstrom (Photovoltaik und solarthermische Kraftwerke)

Wind

Biomasse

Wasserkraft

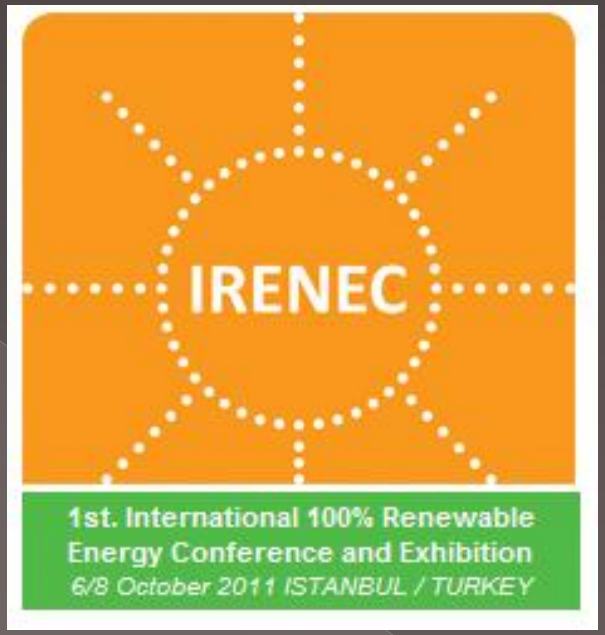
Kernenergie

Gas

Kohle

Öl

Quelle: solarwirtschaft.de



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