

Marginaalista keskiöön

– ratkaisevatko uudet energiateknologiat energia- ja ilmastokysymykset?

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Ammatilliset opettajapäivät 2013

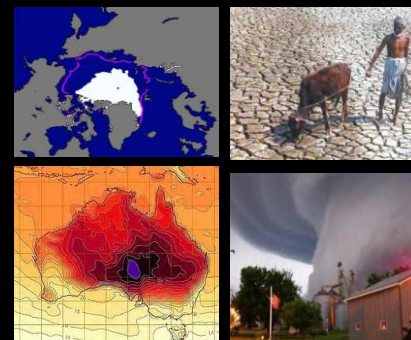
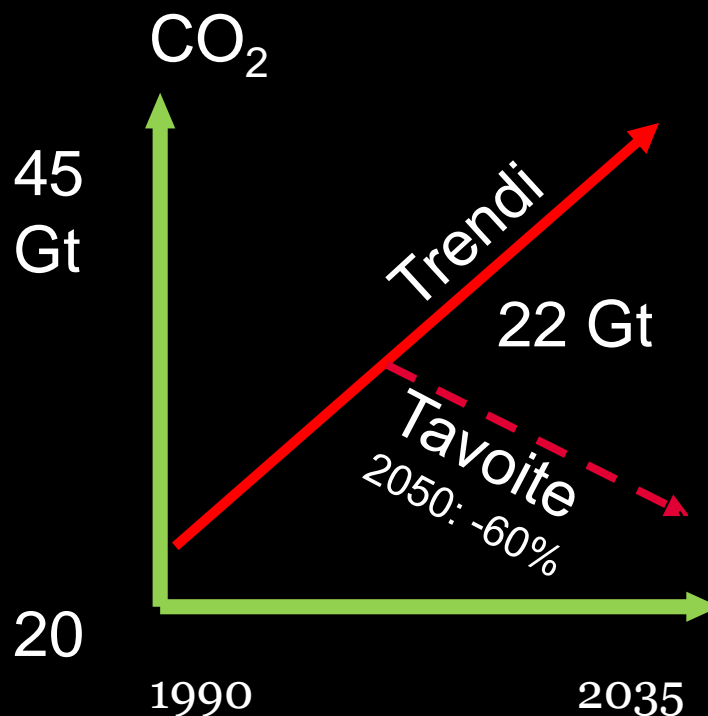
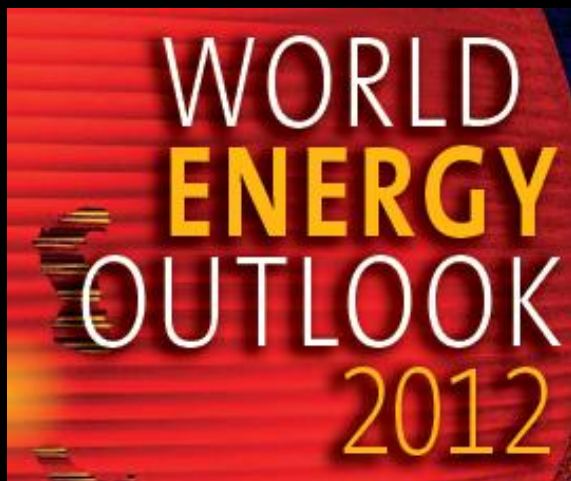
Kestävä kehitys ja sen eri ulottuvuudet

Naantali 20.9.2013

Ongelma=Ratkaisu

Trendi: Hiilipäästöt kasvavat edelleen (2012)

- 20% väestöstä käyttää 80% [energia] resursseista
- Puolet väestöstä tienaa alle 2\$ päivässä



Energia- ja ilmasto kytkeytyvät talouteen – myös ratkaisumallit



Ref: Linda Gratton, London Business School, 2010

- (Ympäristö)ongelmat syntyvät taloudesta
- Ratkaisumallit kytkeyvät talouteen
- Nykyinen talous = Kestämätön, Epävaka, Huolestuttava, Epäoikeudenmukainen

Ref: Stewart Walsh, 2013; LBS

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Vihreä talouskasvu

Talous, työ, energia, ilmasto, innovaatiot ja osaaminen ovat yksi kokonaisuus



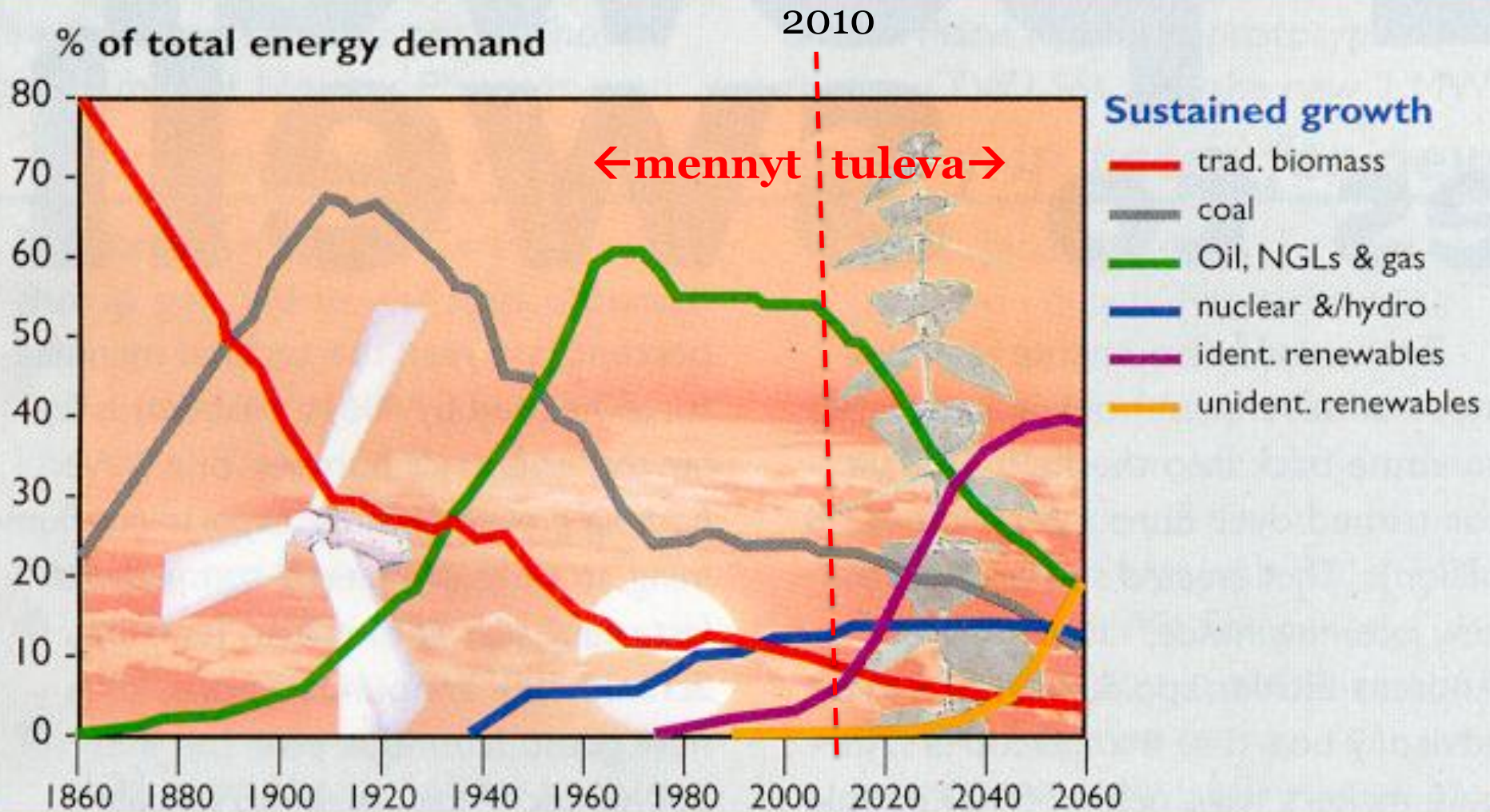
“ Shifting to a greener economy could generate up to 60 million additional jobs over the next two decades and lift millions of people out of poverty, UN agencies and trade unions said recently, urging governments to use the Rio+20 summit to turn this potential into reality.” [UNEP]

Historia

Energian evoluutio

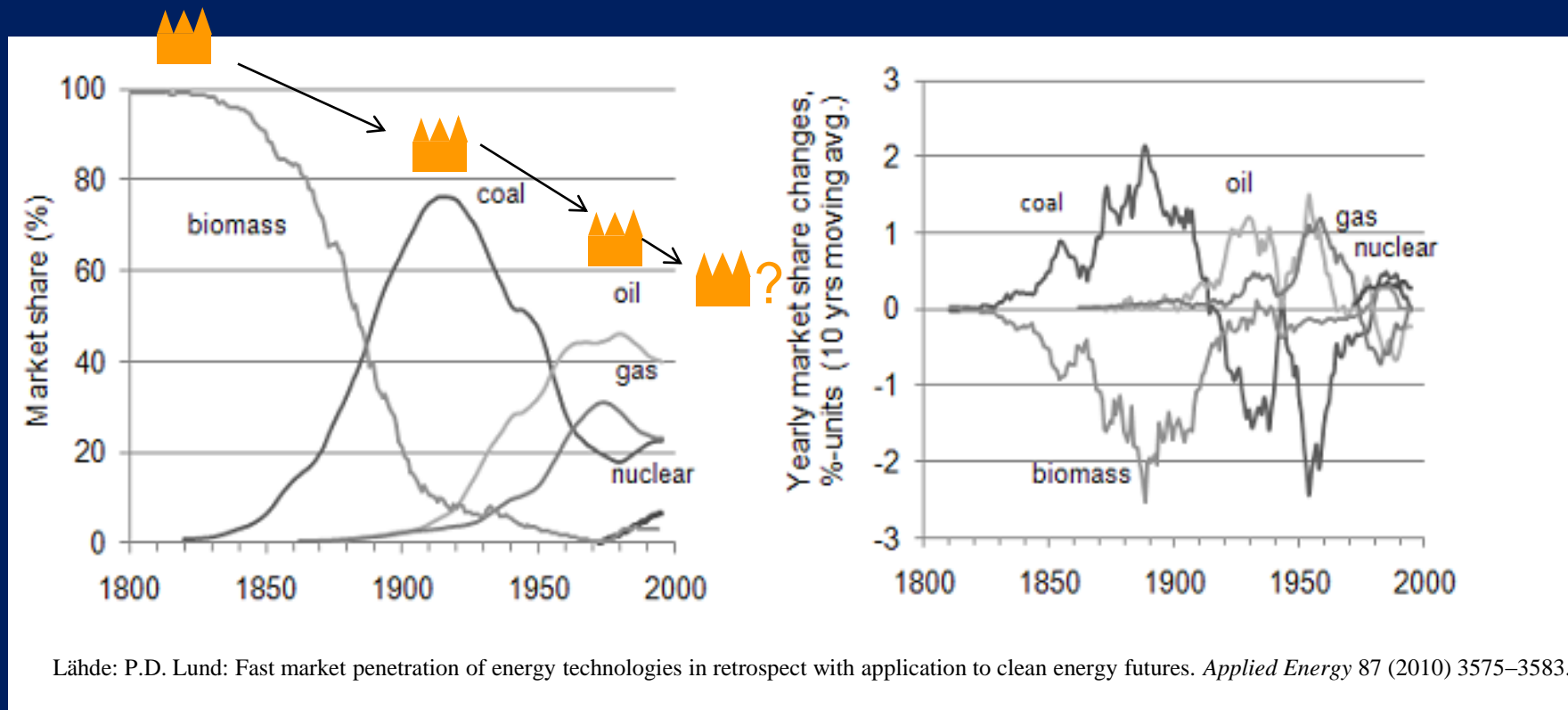
1860-2060 (Shell skenaariot 200x)

Shell scenario: Energy market 1860 - 2060



Energia-evoluutio – kohti puhtaampia polttoaineita?

Energialähteiden osuudet ja muutokset USA:ssa 1800-2000



Lähde: P.D. Lund: Fast market penetration of energy technologies in retrospect with application to clean energy futures. *Applied Energy* 87 (2010) 3575–3583.

Tulevaisuus?

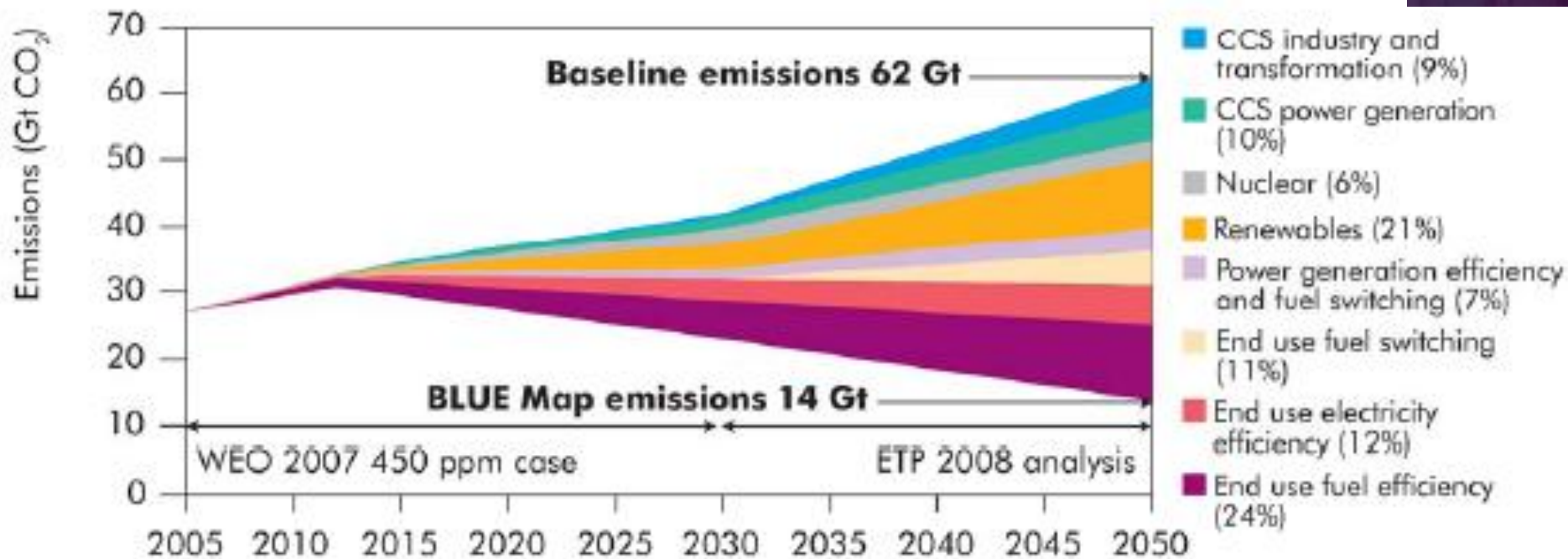
Energia-ilmasto luvut

- I. Fossiiliset polttoaineet >80% energiasta, öljy >98% liikenteestä
- II. Hiili (sähkö) ja öljy (liikenne) 80% CO₂:sta
- III. Tavoite: CO₂ alas 60% 2050, >80% teollisuusmaissa
- IV. 65% energiasta käytetään kaupungeissa (80% 2040)
- V. Energian painopiste siirtyy itään ja kehittyviin talouksiin

Energiateknologia-vaihtoehdot v:een 2050 (IEA 2008)

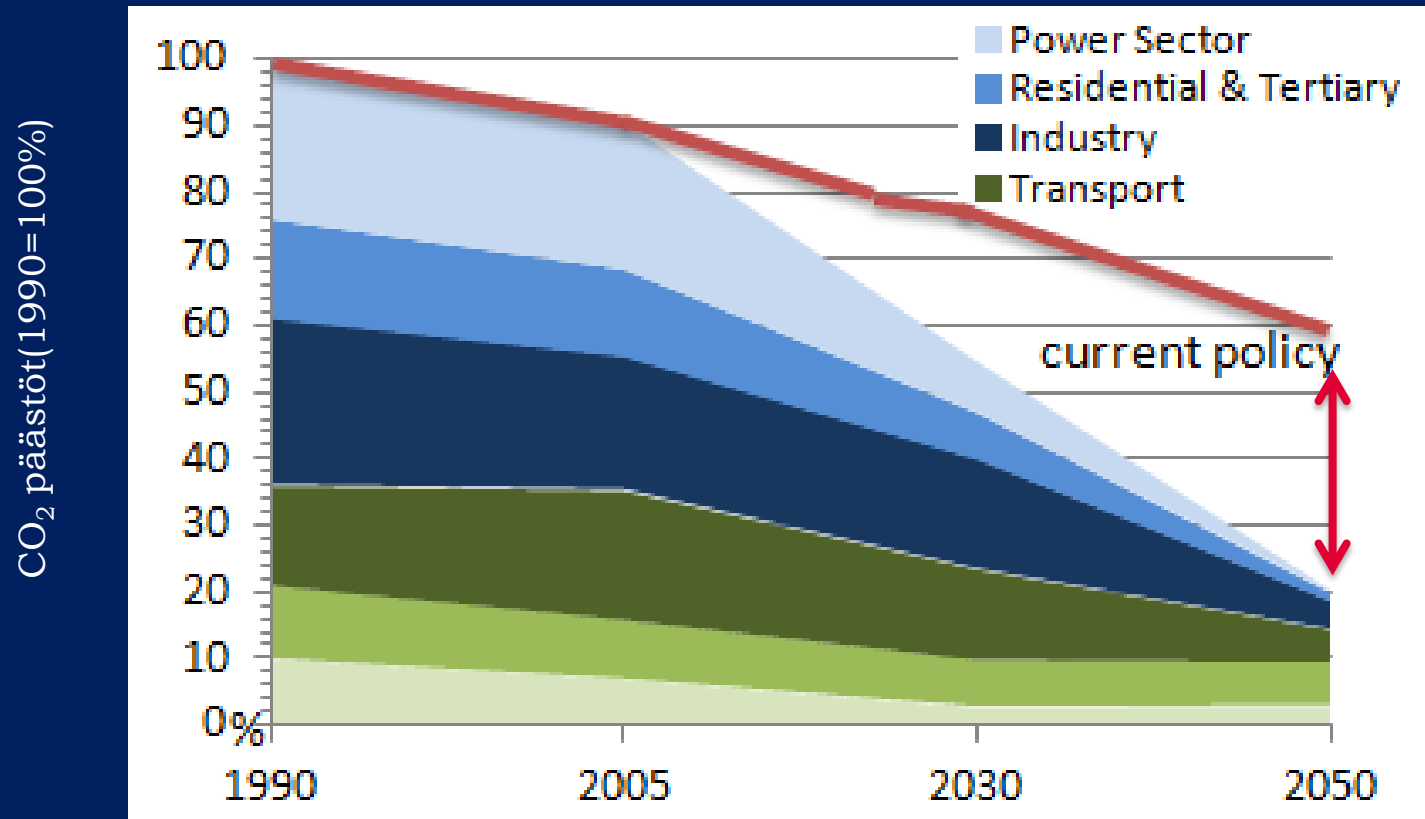
Contribution of emission reduction options,
2005-2050

ENERGY
TECHNOLOGY
PERSPECTIVES
2008



© OECD/IEA, 2008

Euroopan energia- ja ilmastohaasteet 2050



Lähde: Euroopan
Komissio, 2011

Energian käytön tehostaminen >40%

Uusiutuvien osuus energiasta 55%

Uusiutuvien osuus sähköstä 64-97%

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Ratkaisut

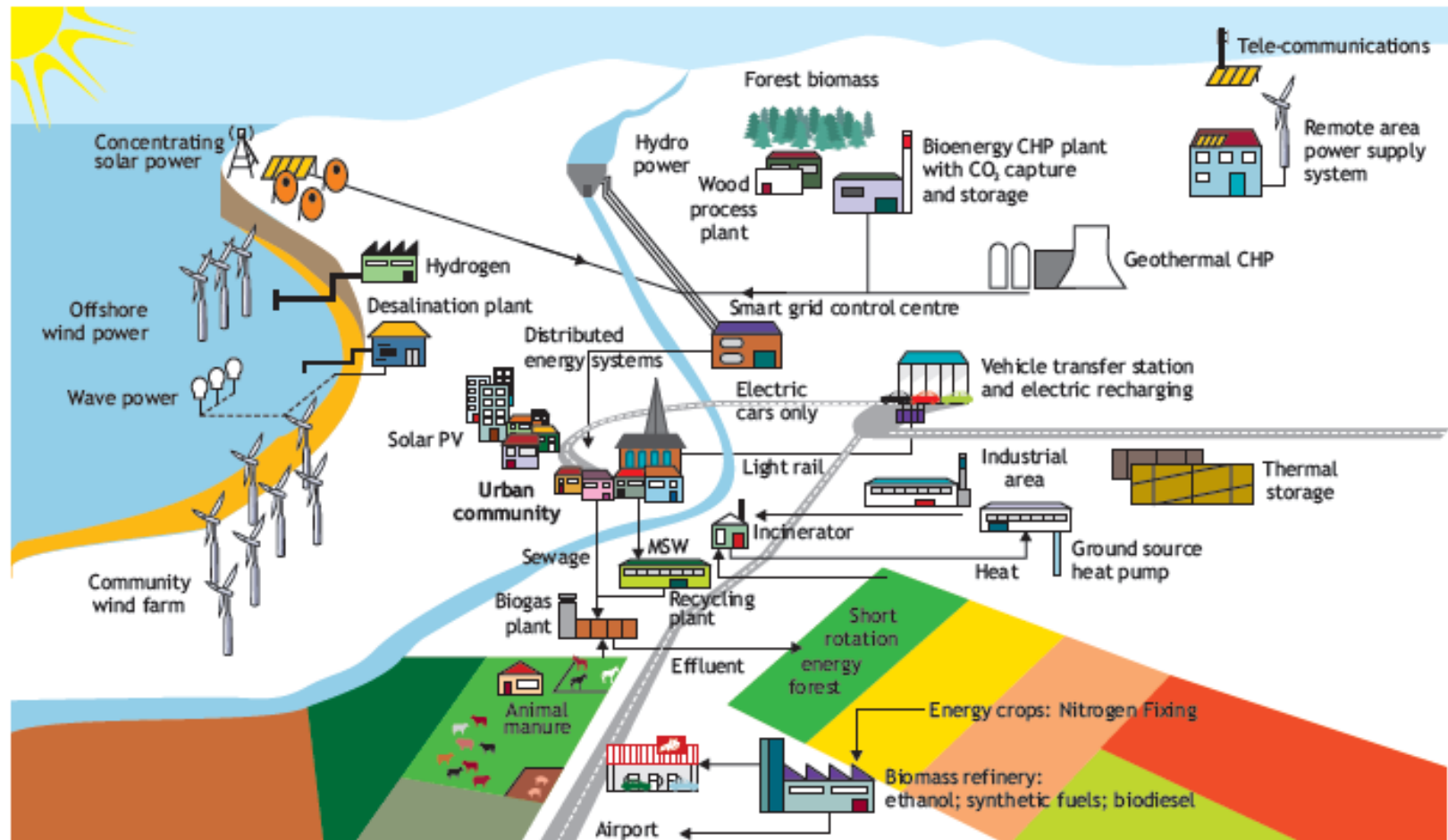
Miten rakennan voimallaitoksen ”1 minuutissa” ?



<http://vimeo.com/66544428>

Hajautettu energia – paljon valinnanvaraa kuluttajille

Figure 3 • Producing significant shares of heat, power and biofuels from locally available resources including solar, wind, ocean, geothermal, energy crops and biomass from wastes, could be a future option for a municipality



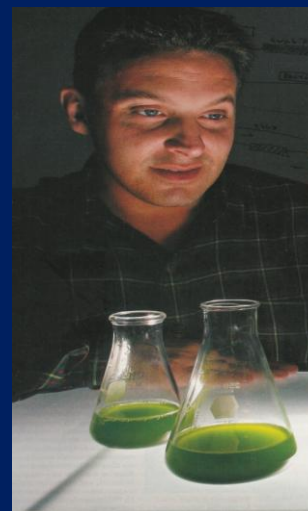
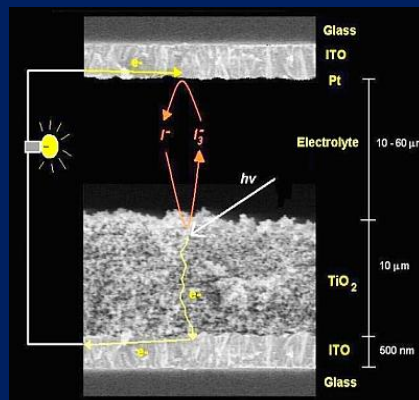
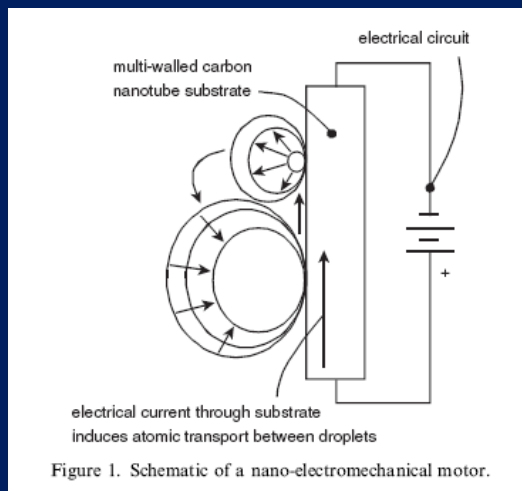
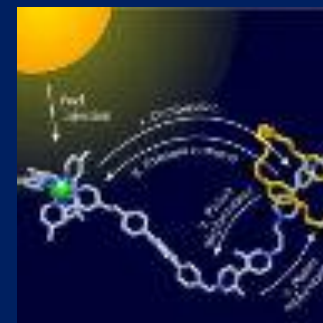
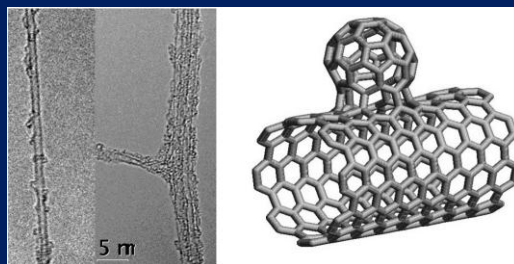
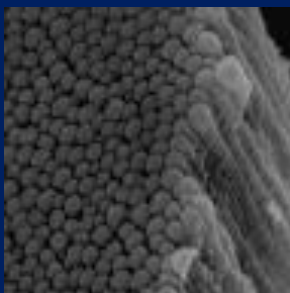


Scientific American, 2010

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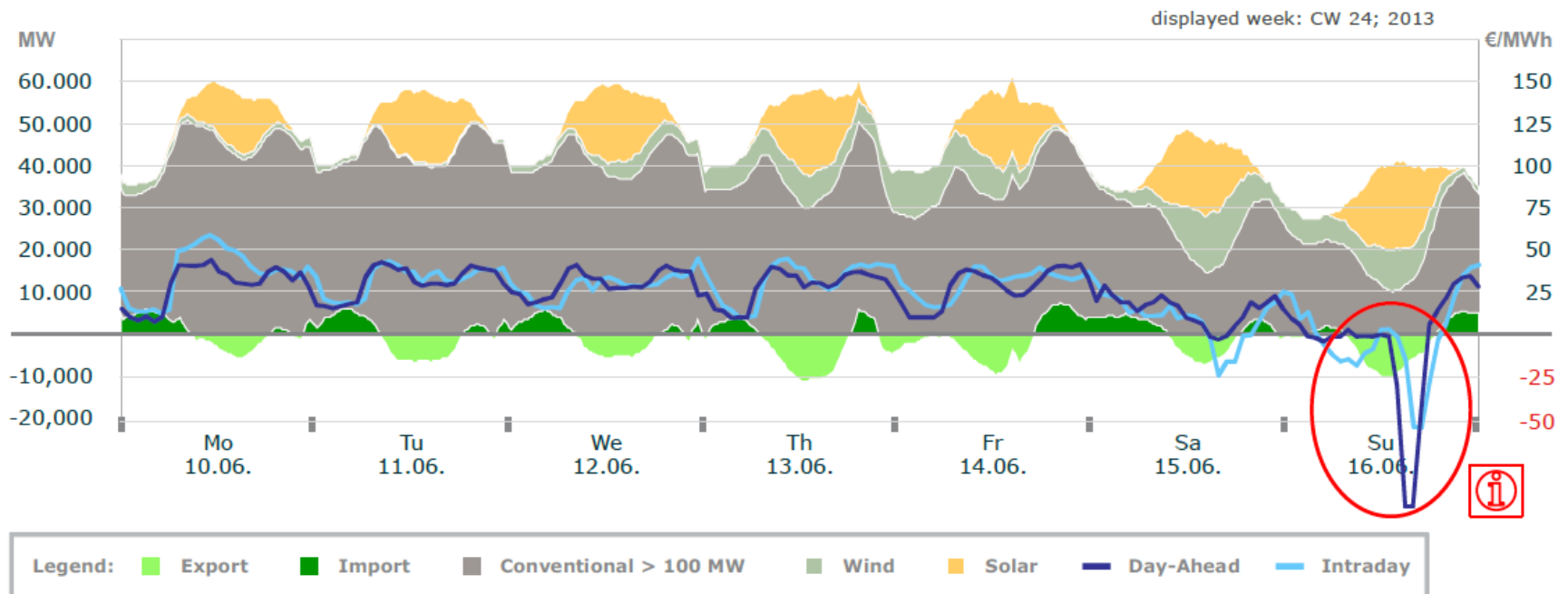
Radikaaleja energiaratkaisuja – tiede tunkeutuu energiaan

Nano, informaatio, bio, materiaalit, tekoäly



Sähkön hintavaihtelut Saksassa

Electricity Production and Spot-Prices: CW 24 2013



€/ MWh	Period Mean	Period Min	Period Max	Std Deviation
Day-Ahead	23.28	- 100.00	45.00	19.72
Intraday	26.95	- 53.50	59.50	18.99

Energiamuutos vanhasta uuteen edellyttää **systemisiä innovaatioita**

Vanha 100%



Uusi 0%

Uusi100%



Vanha 0% Peter Lind 2013

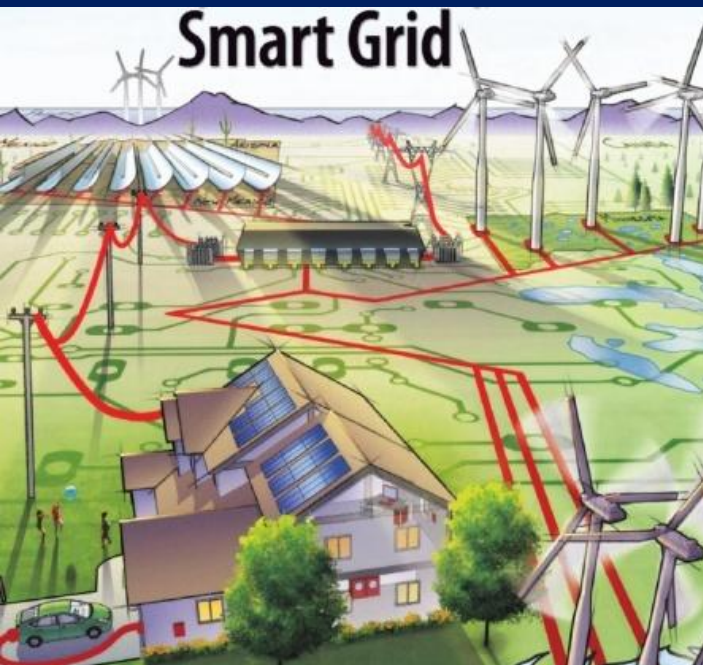
- Monienergiaverkot
- Joustava kulutus
- Sähköautot, ICT

Miten energijärjestelmä toimii, jos paljon uusiutuvaa energiaa?

- Varastointi
- E2T, V2G, E2Gas, E2H₂



”Älyverkot”



The Smart House

Xcel Energy's Smart Grid Consortium is imagining a future that would allow you to communicate your energy choices to the power grid and automatically receive electricity based on your personal needs.

The potential benefits:

- Lower cost of power
- Cleaner power
- A more efficient and resilient grid
- Improved system reliability
- Increased conservation and energy efficiency

Plug-in Hybrid Electric Car

Xcel Energy is studying how plug-in electric vehicles can store energy, act as backup generators for homes and supplement the grid during peak hours.

Smart Meter

Real-time pricing signals create increased options for consumers.

Smart Appliances

Smart appliances contain on-board intelligence that "talks" to the grid, senses grid conditions and automatically turns devices on and off as needed.



High-Speed Connections

Advanced sensors distributed throughout the grid and a high-speed communications network tie the entire system together.

Customer Choice

Customers may be offered an opportunity to choose the type and amount of energy they'd like to receive with just the click of a mouse on their computer: 100 percent green power? A mix of sources? The cheapest priced source? In Smart Grid City, it could be up to you.

Smart Thermostat

Customers can opt to use a smart thermostat, which can communicate with the grid and adjust device settings to help optimize load management. Other "smart devices" could control your air conditioner or pool pump.

Energiajärjestelmän

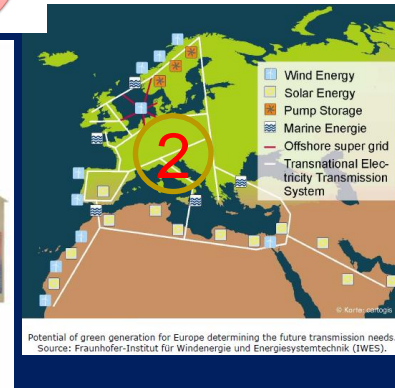
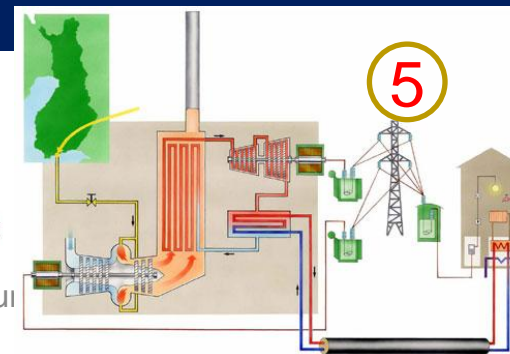
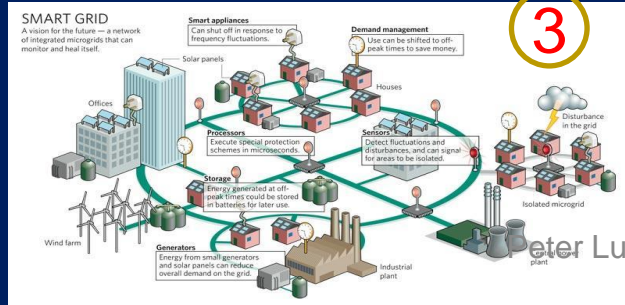
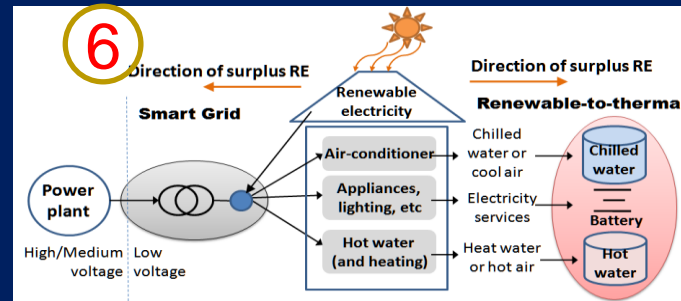
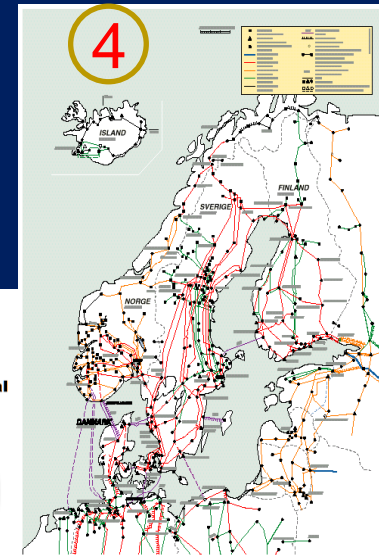
joustavuuden parantaminen

Q1: sähkön kysynnän ja (RE) tuotannon yhteensovittaminen

Q2: (RE) tuotannon integrointi energiajärjestelmään

Examples of solutions:

1. RE in urban context
2. Grid infrastructures
3. Smart Grids
4. Electricity markets
5. Co-generation (CHP)
6. RE coupled with end-use
7. Electricity-to-Gas
8. RE+Gas integration
9. Demand flexibility
10. Storage



2013

Mitä maailmalla tapahtuu uudessa energiassa?

- **2050 vuoden tavoite: Tanska 100% uusiutuvaa energiaa, Saksa 80% uusiutuvaa sähköä**
- **2025 vuoden tavoite: Ruotsi luopuu öljystä liikenteessä, Kööpenhamina hiilitön**
- **2013: Aurinkosähkön hinta Saksassa alempi kuin kuluttajasähkön hinta, tuet poistuvat**
- **2013: Aurinkosähkömodulin hinta min. \$0.7/W_p; business >\$100 miljardia**
- **2012: Aurinkosähköä rakennettu 100.000 MW, Saksassa 30.000 MW**
- **2012: Tuulivoima ja aurinkosähkö 60% EU:n uudesta sähkötuotantokapasiteetista**

Uusi energiategnologia siirtymässä suureen mittakaavaan

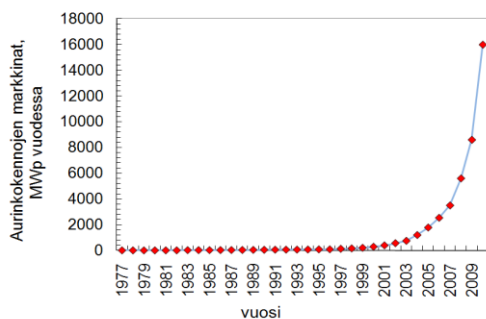
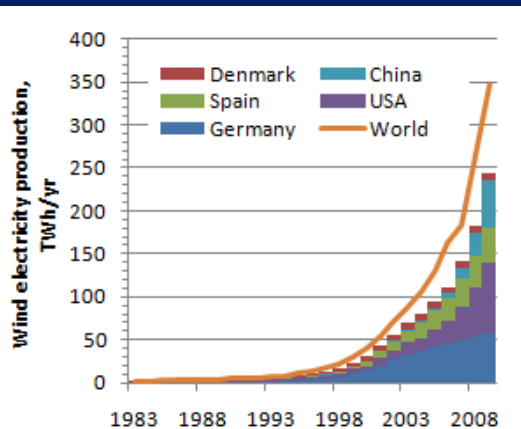
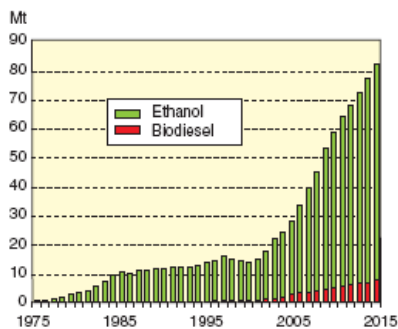


Fig. 1 Trend in world biofuel production



Source: F.O. Licht, Christoph Berg, presentation made at World Biofuels 2006, Seville, May 2006

- Tuulivoima: 3 % maailman sähköstä, 25% 2050 ; Tuulivoiman pohjahinta n 1/2 nykytasosta



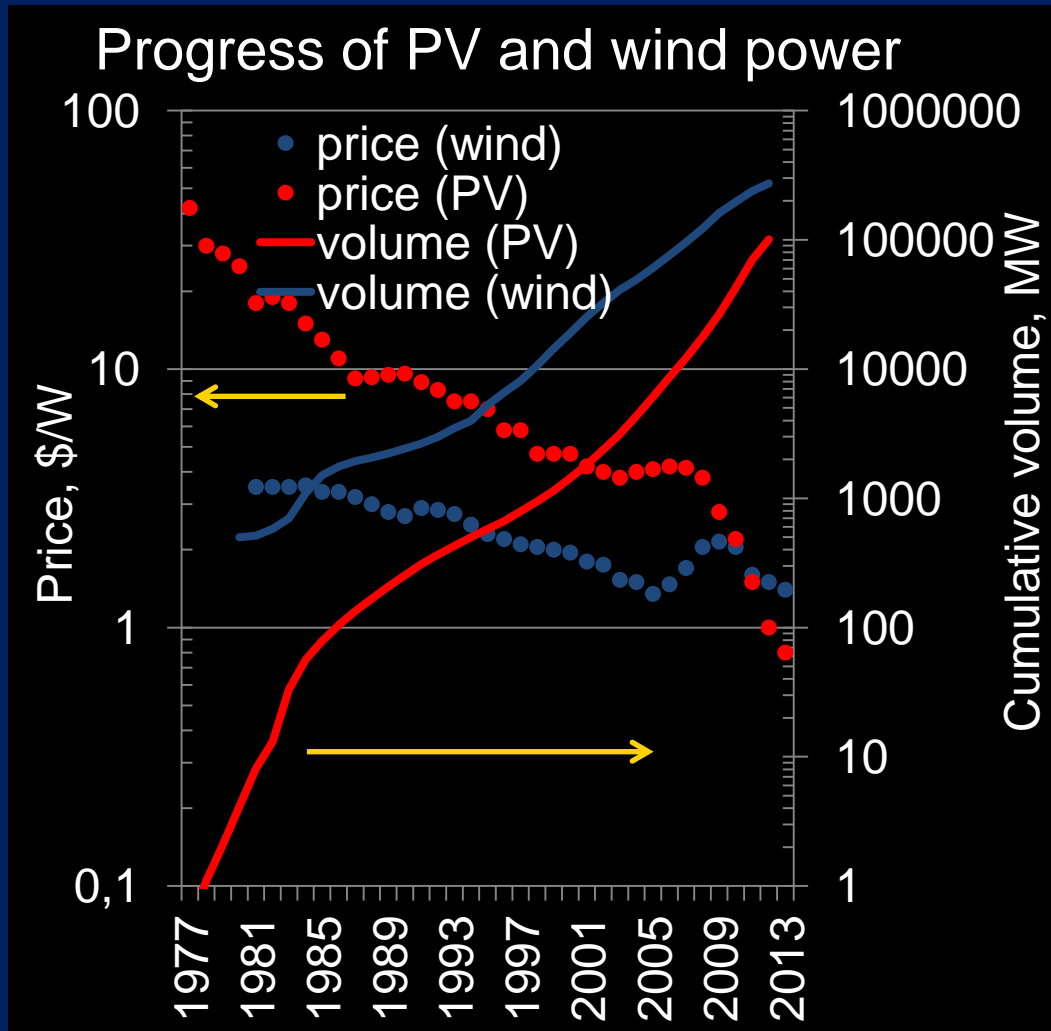
- Aurinkosähkö (PV) : 1/2% maailman sähköstä (\$100 mrd business), 5-25% 2050; Hinta alle \$1/Wp, massatuote?



- Bioenergia: 4% EU:n energiasta, potentiaali 15%; Energia asettaa hinnan, ympäristö ja ruoka ylärajan käytölle; Suuri kehityspotentiaali (2&3&4 sukupolven biopolttoaineet)

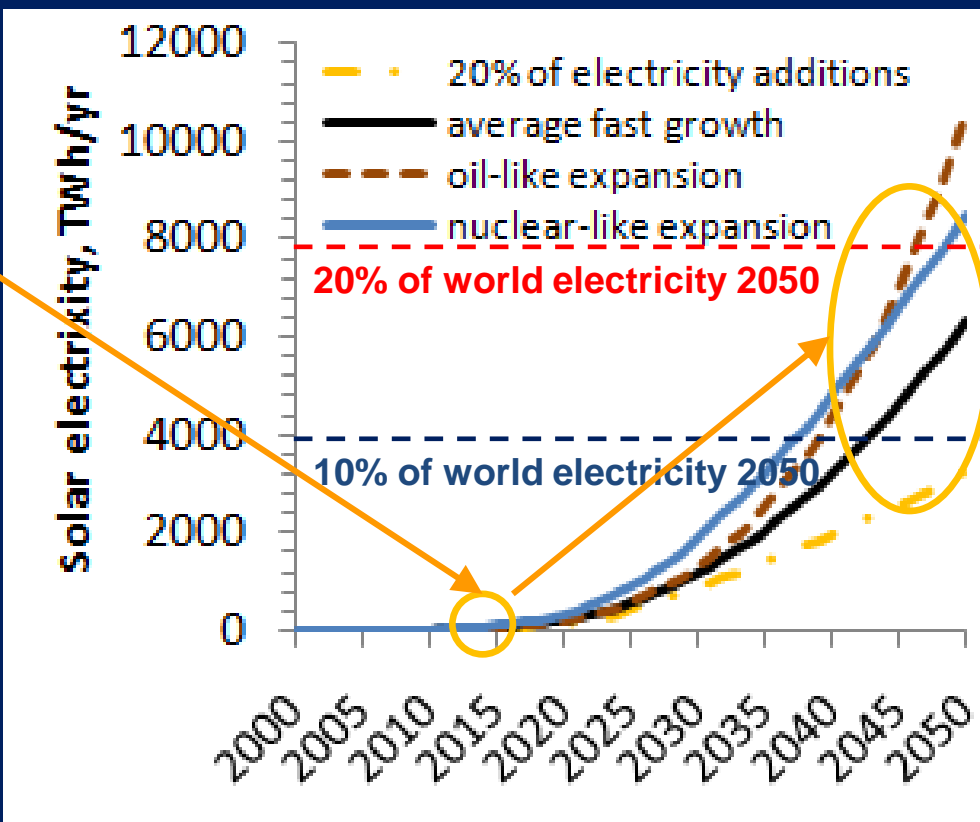
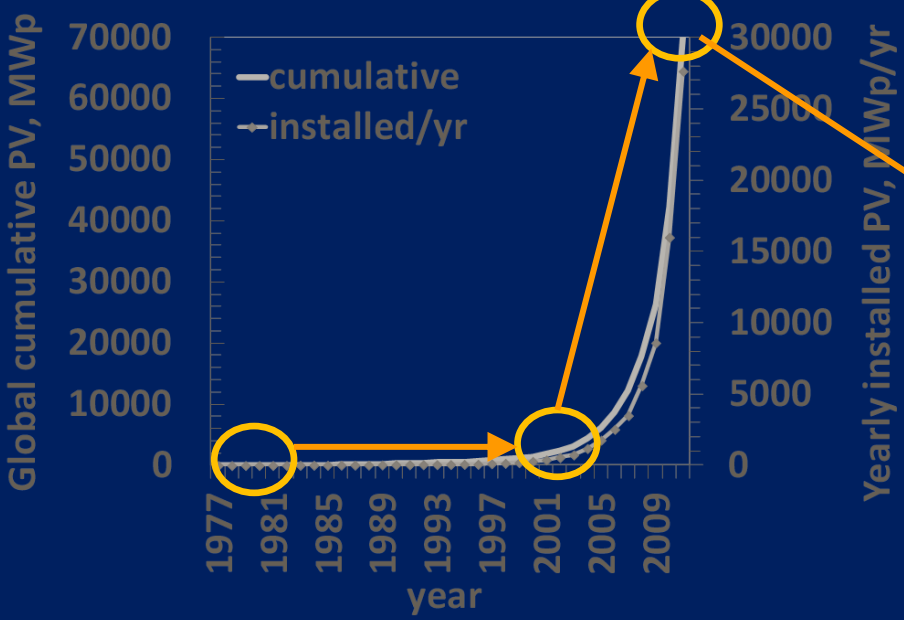


Uuden energian markkinat kasvavat ja hinnat laskevat



Aurinkosähkön penetraatio

- Aurinkosähkön (\$100mrd) markkinaosuus 2013 < 1%; 2050: 5% (hidastuva)... 25% (nopeutuva kehitys)

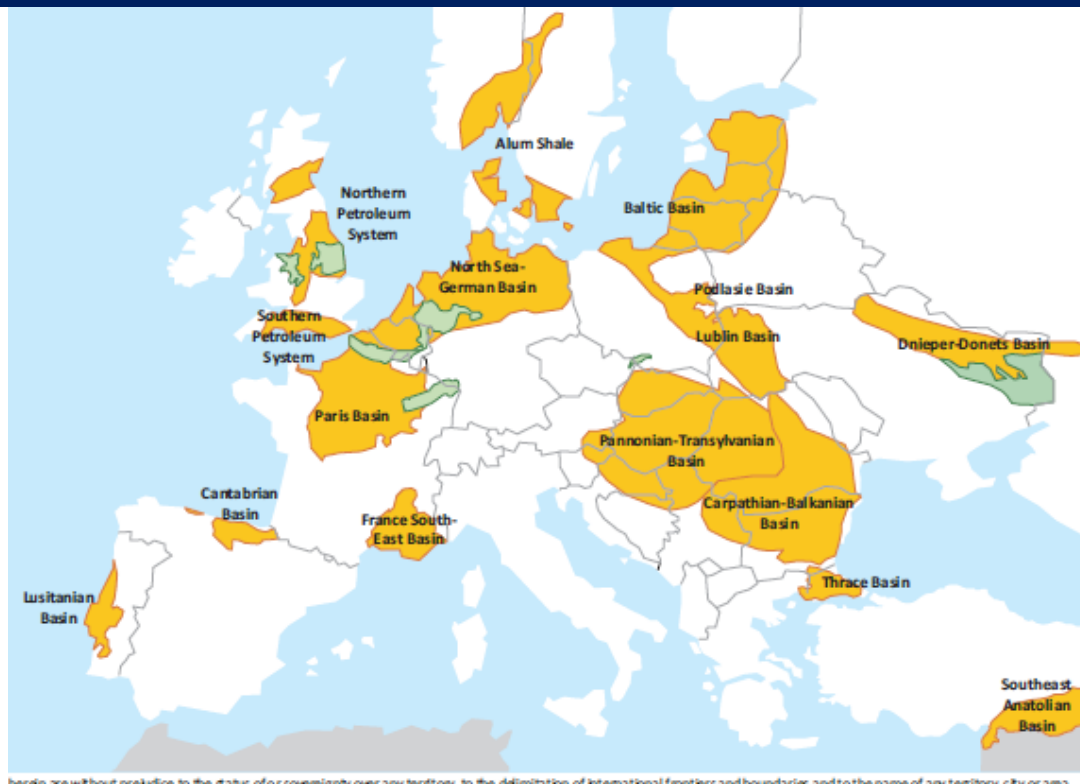
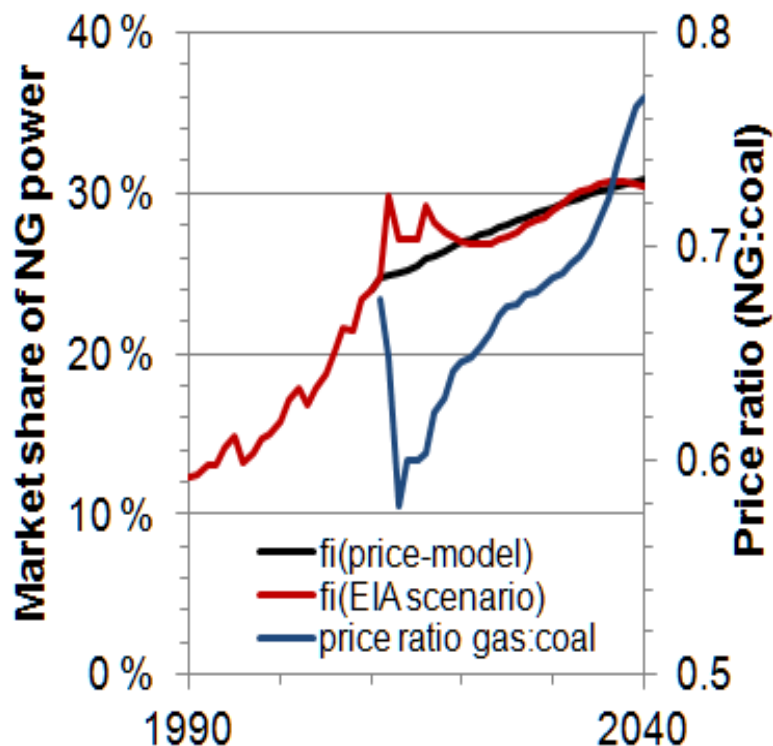


Ref Lund PD. Fast market penetration of energy technologies in retrospect with application to clean energy futures. Applied Energy (2010), doi:10.1016/j.apenergy.2010.05.024; P.D. Lund: Exploring past energy changes and their implications for the pace of penetration of new energy technologies. Energy 35 (2010) 647–656

Die **Energiewende**

Liuskekaasu

- Liusekaasuvarat 4-5 × maakaasuvarat
- Maantiede: Venäjä (480 PWh); Kiina (389 PWh), Australia (121 PWh), USA (740 PWh); Puola & Ranska

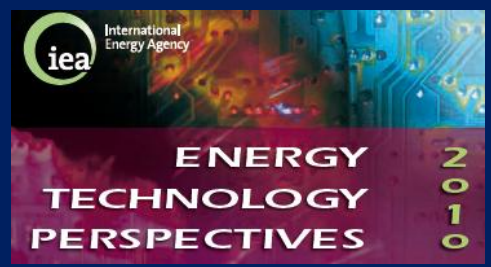
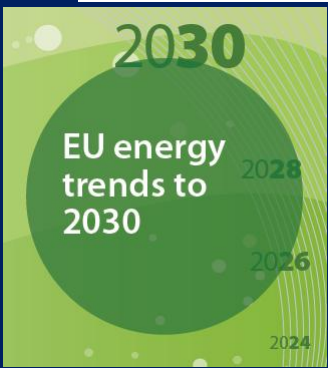
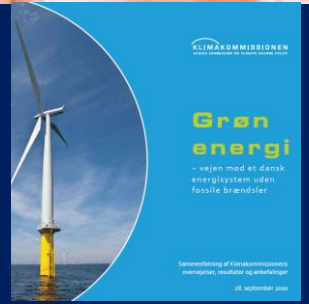
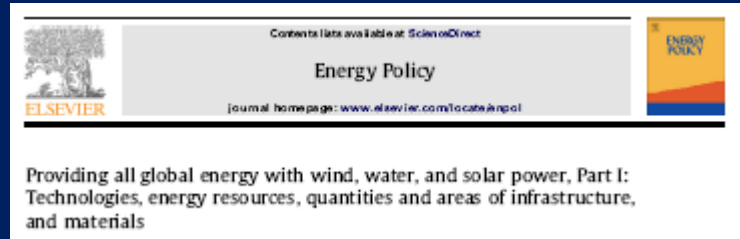
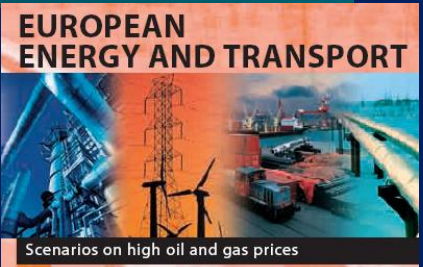
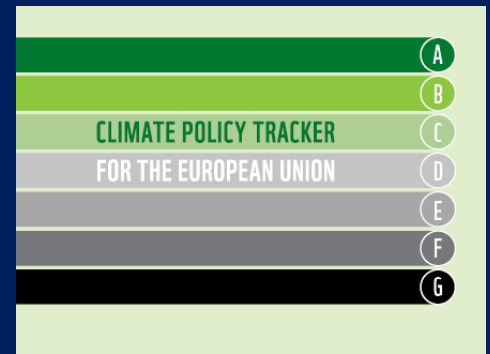
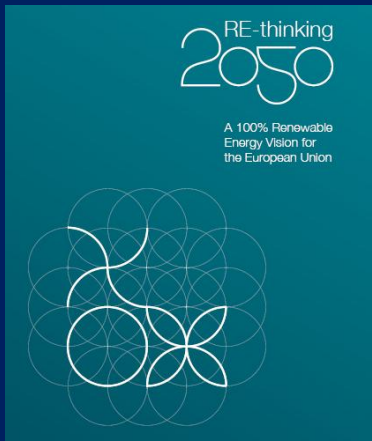


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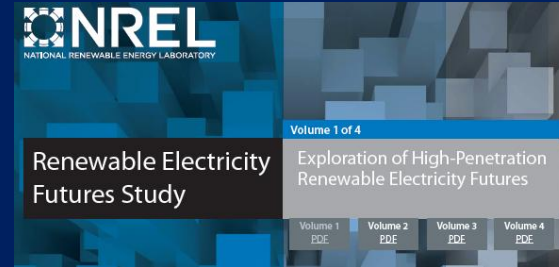
Left: U.S. market growth of natural gas power; Right: Shale gas regions in Europe

REF: EIA: World Shale Gas Resources :An Initial Assessment of 14 Regions Outside the United States, 2011; P.D. Lund, Energy policy planning near to grid-parity using a price-driven technology penetration model, Submitted, 2013.

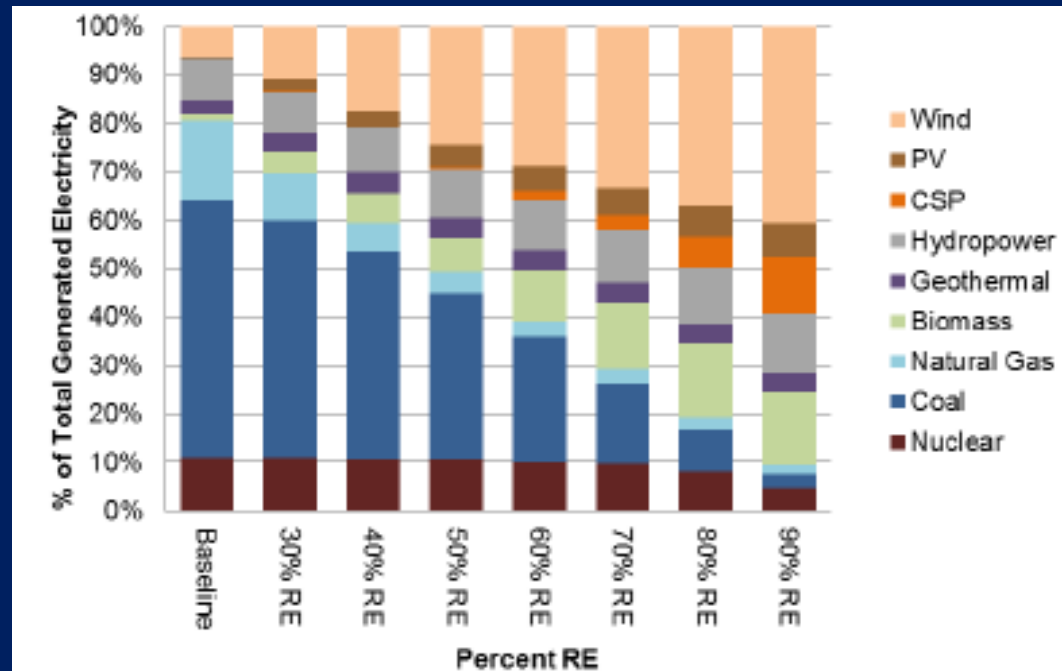
Useat kansainväliset tutkimukset ennustavat korkeita osuuksia (>80%) uusiutuville energialähteille v2050



U.S. Renewable Electricity Futures Study (RE Futures)



- **Renewable electricity is more than adequate to supply 80% of U.S. electricity in 2050;**
- Increased electric system flexibility is needed (supply- and demand-side options);
- Multiple combinations of renewable technologies possible.

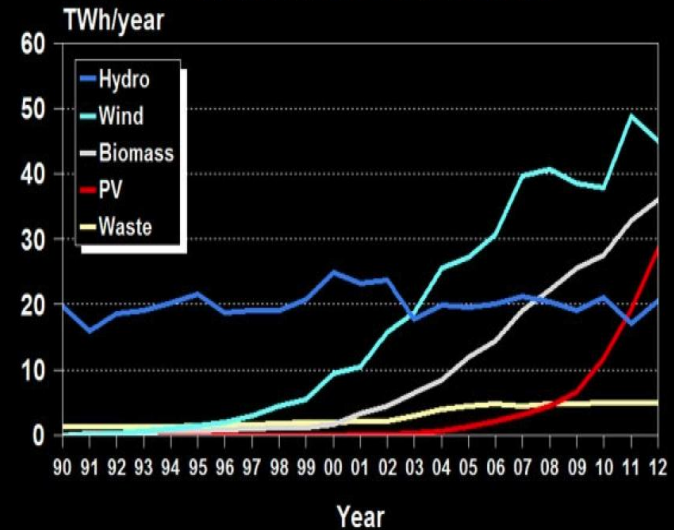


(b) Generation mix in 2050 for the exploratory scenarios

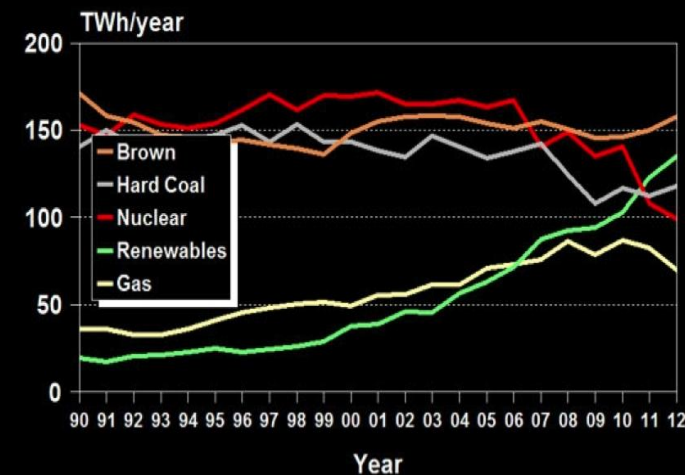
Energiakäännös (case GER)

- Germany gets ~25 % of electricity from renewable energy, up from <7 % in 2000.
- Since 2004, investments in clean energy grew by 122%, creating an industry with almost 380,000 jobs. Germany has a low unemployment rate, at 5.8%.
- Since 1990, Germany has reduced greenhouse gas emissions by 25.5 %, exceeding Kyoto commitment of a 21% percent reduction by 2012.
- Germany plans to extend renewable energy to 80 % by 2050 and reduce its energy consumption by 50 % Also, to reduce greenhouse gas emissions by 40 % by 2020 and by 80-95% by 2050.
- The Energiewende is expected to create 500,000 jobs by 2020 and 800,000 by 2030

German Renewable Electricity Generation 1990-2011

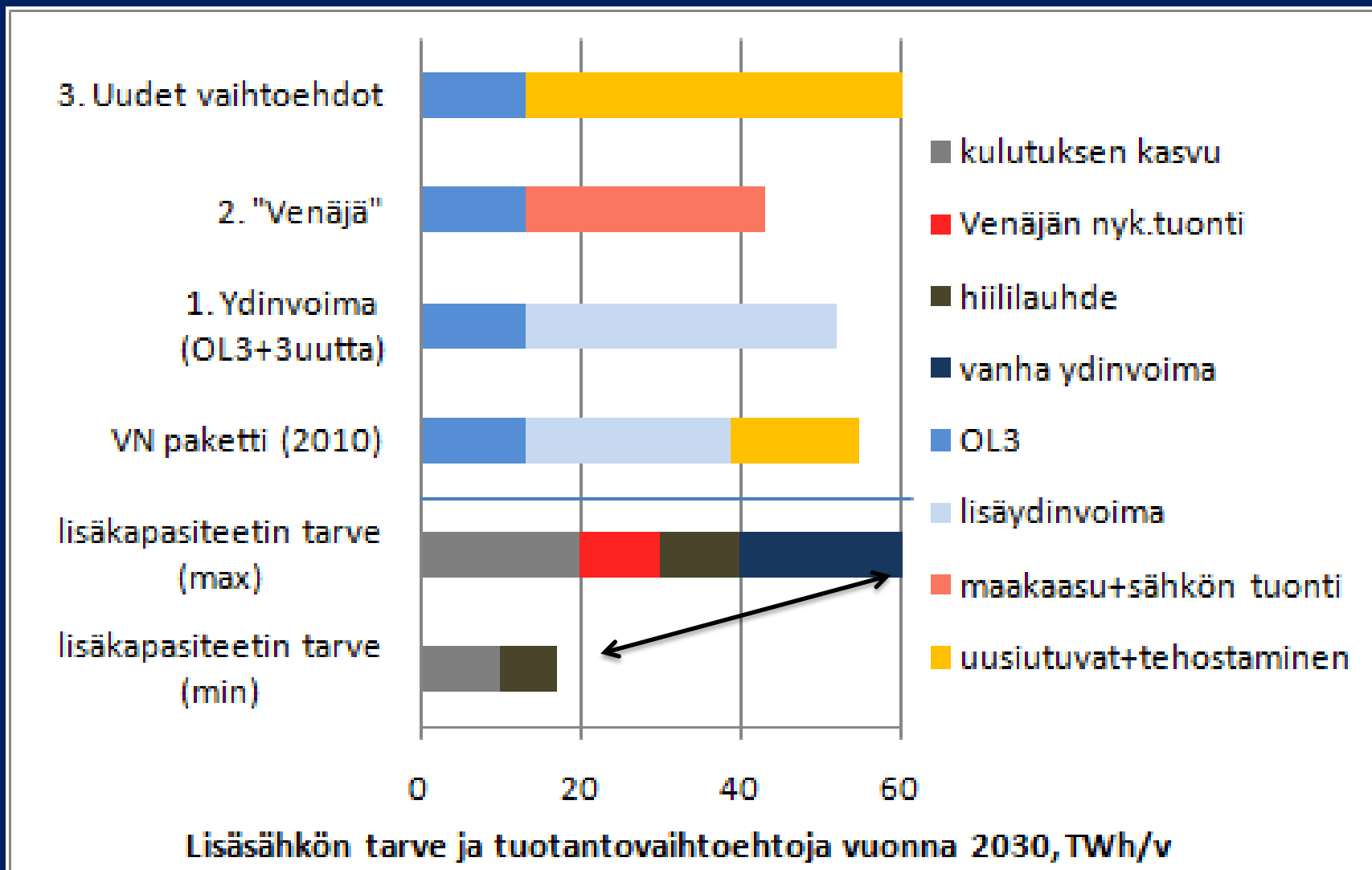


German Coal, Nuclear, Gas & Renewable Generation 1990-2012

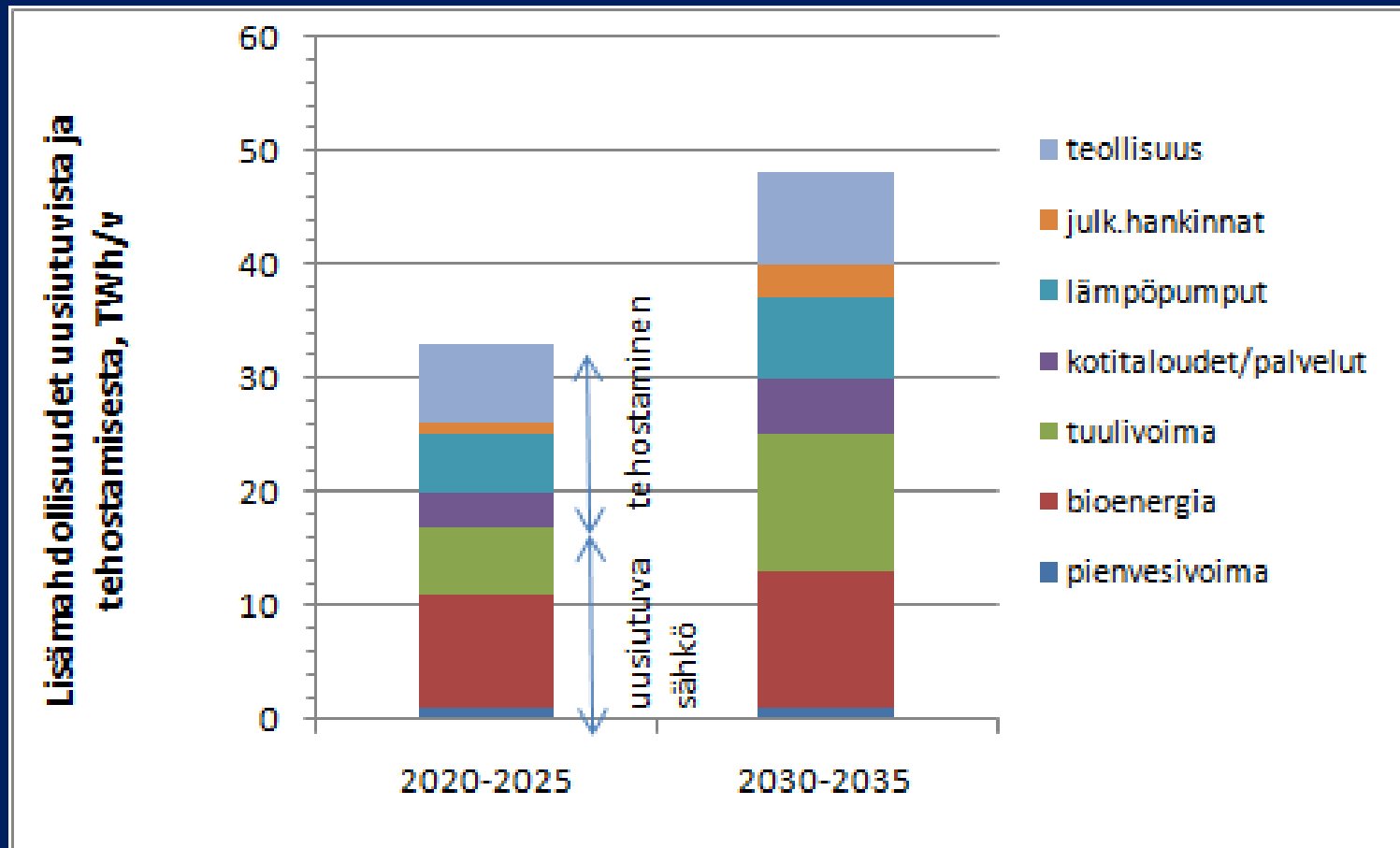


Suomi

Sähköntuotannon vaihtoehtoja Suomessa (2030)



"Suosi suomalaista energiaa" - skenaario



Kotimainen teknologia ja osaaminen+ kotimarkkinat
→ uutta vientiä kasvavilla maailmamarkkinoilla
→ 30.000-40.000 uuttatyöpaikkaa v 2020-30

Lahti

– ”cleantech” kaupunki

- Tavoite: 15-25% vähemmän energiaa 2015; 2025 CO₂ päästöt puolitettu
- Uusiutuvaa energiaa, tehokas yhdyskuntasuunnitelu, liikenne
- Jätteiden talteenotto (96%) ja kaasutus energiaksi (160 MW, \$240 miljoonaa)

Kotka

– ”vihreän energian” kaupunki

- Päästöt tippuneet 40% kymmenessä vuodessa uusiutuvan kautta (bio+jäte)
- Uutta teollisuutta: Biojalostamot, tuulivoimaklusteri
- Energiainvestointeja (bio-CHP, jätteestä energiaa, \$150 miljoonaa)

**The difficulty lies not
with the new ideas, but in
escaping the old ones...**

John Maynard Keynes