Letna strokovna
konferenca CIPRE
15.-17. september 2011
Bovec, Slovenija

**ALPE NA POTI
K ENERGETSKI
TRAJNOSTI**

Energetska oskrba in ogljična nevtralnost

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Univerza v Ljubljani
Slovenija

Poudarki- Outline

- Kaj vse lahko razumemo pod pojmi: energijska samozadostnost, ogljična nevtralnost, trajnostna energetska oskrba...
- Ali so cilji “energijsko samozadostne regije” realni (koliko energije resnično porabimo, zatečeni trendi, slabosti OVE, vpliv podnebnih sprememb na potencial OVE..)
- Kako sploh naprej

Samozadostnost

- Ekonomska neodvisnost, samooskrbnost, neodvisnost od tujine
- Celotna potreba po energiji se pokriva doma
- Samozadostnost se nanaša le na toplotno in procesno energijo, porabljeno v podjetjih, zasebnih gospodinjstvih in javnih ustanovah, ne pa tudi na energijo, porabljeno v prometu
- Energijska samozadostnost: potrebe posamezne enote po energiji se zadovoljujejo, kolikor je to mogoče, z obnovljivimi viri energije neposredno na kraju samem
- Možna je le delna samozadostnost

Kvalitativne, ne pa kvantitativne opredelitve

- **ogljična nevtralnost, nizko-ogljična družba, zero-carbon**

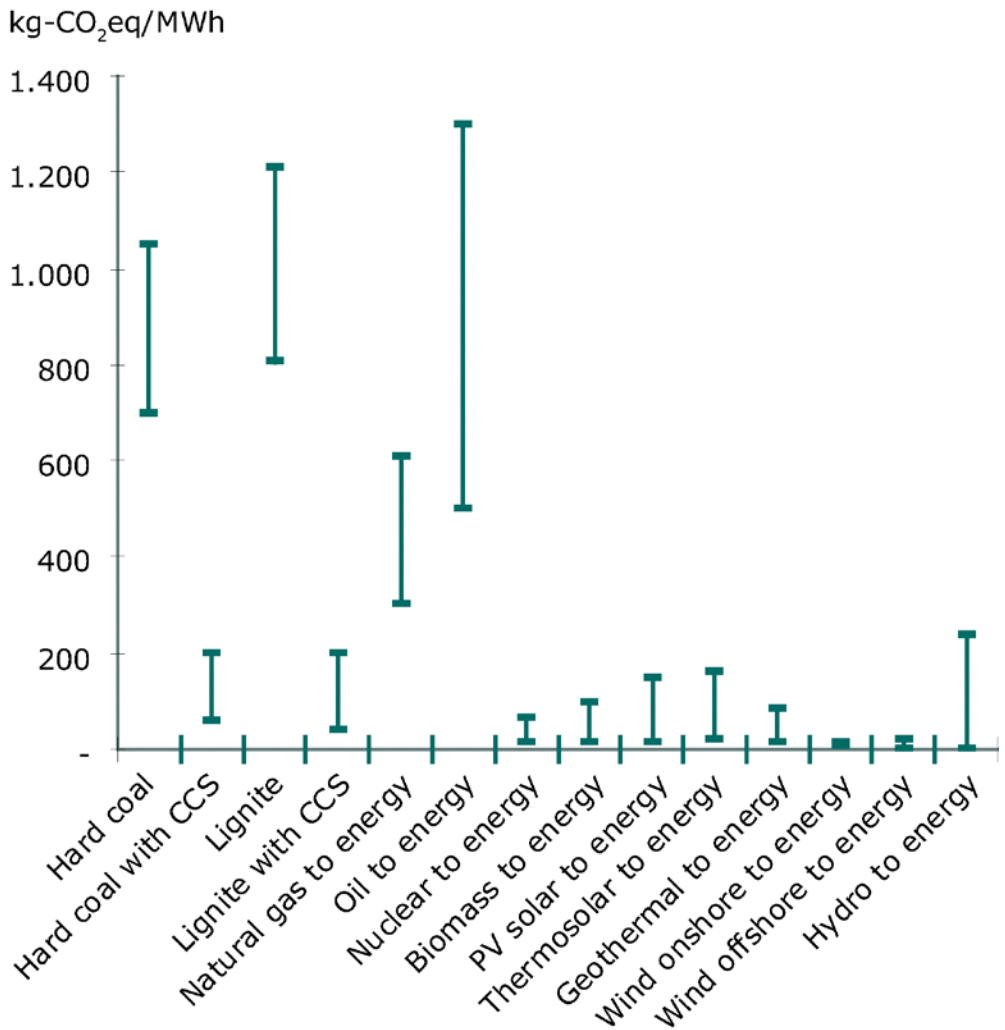
  2 t CO_2/ capita/year?

  < 2 t CO_2/ capita/year?

- **trajnostna energetska oskrba**

  Brez jedrske energije? Brez uvoza energije? Samo izbrane vrste OVE? Drastično znižanje porabe – skromnejši življenski slog?

LCA (Life Cycle Analysis) emissions of energy technologies for electricity production



So far,

zero carbon technology

does not exist

“Territorial” emissions

per-person CO2 emissions from burning fossil (production)

US:	18 tonnes	rank 2
Australia:	20 tonnes	rank 1
Canada:	16 tonnes	rank 7
Switzerland:	6 tonnes	rank 65
Finland:	10 tonnes	rank 59
Netherlands:	15 tonnes	rank 25
Belgium:	13 tonnes	rank 36
Ireland:	9 tonnes	rank 67
Cyprus:	9 tonnes	rank 69
UK:	8 tonnes	rank 70

Consumption emissions

In light of SD emissions should be measured in terms of consumption rather than production (each country's exports are excluded from its footprint, and its imports added)

top 10 for consumption emissions per capita, including all greenhouse gases:

1. US: 29 tonnes
2. Australia: 21 tonnes
3. Canada: 20 tonnes
4. Switzerland: 18 tonnes
5. Finland: 18 tonnes
6. Netherlands: 17 tonnes
7. Belgium: 17 tonnes
8. Ireland: 16 tonnes
9. Cyprus: 16 tonnes
10. UK: 15 tonnes

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Peters et al., 2010

Growth in emission transfers via international trade from 1990 to 2008

Glen P. Peters[a,1], Jan C. Minx[b,c], Christopher L. Weber[d,e], and Ottmar Edenhofer[c,f]

[a]Center for International Climate and Environmental Research–Oslo, N-0318 Oslo, Norway; [b]Department for Sustainable Engineering, and [c]Department for the Economics of Climate Change, Technical University Berlin, 10623 Berlin, Germany; [d]Science and Technology Policy Institute, Washington, DC 20010; [e]Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh, PA 15213; and [f]Potsdam Institute for Climate Impact Research, D-14412 Potsdam, Germany

Edited by William C. Clark, Harvard University, Cambridge, MA, and approved March 29, 2011 (received for review May 12, 2010)

Despite the emergence of regional climate policies, growth in global CO_2 emissions has remained strong. From 1990 to 2008 CO_2 emis-

the underlying driving forces of global, regional, and national emission trends and mitigation policies. In the context of in-

Edgar et al., 2011 *Environ. Sci. Technol.* **2009,** *43,* 6414–6420

Carbon Footprint of Nations: A Global, Trade-Linked Analysis

EDGAR G. HERTWICH*,† AND GLEN P. PETERS†,‡

Industrial Ecology Programme and Department of Energy and Process Engineering, Norwegian University of Science and Technology, 7491 Trondheim, Norway, and Center for International Climate and Environment Research-Oslo, P.O. Box. 1129, Blindern, N-0318 Oslo, Norway

Received December 9, 2008. Revised manuscript received May 8, 2009. Accepted May 12, 2009.

appropriately calculated using life-cycle assessment or input−output analysis (*3*, *4*).

Given the interest in the carbon footprint (CF) of products, services, companies, and investment portfolios, there have been surprisingly no consistent comparative studies to understand our collective carbon footprint on a national or global level. What consumption categories cause the CF? How does the contribution of different activities vary across regions and stages of development? Studies on the importance of consumption categories and product groups have been instrumental in focusing Integrated Product Policy on housing, transportation, and food. One study (*5*, *6*) is cited prominently in the European Union's (EU) "Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan" (*7*). There is, however, a lack of studies on emerging and developing economies. Cross-national comparisons are hampered by differences in methods and

National CO_2 footprint

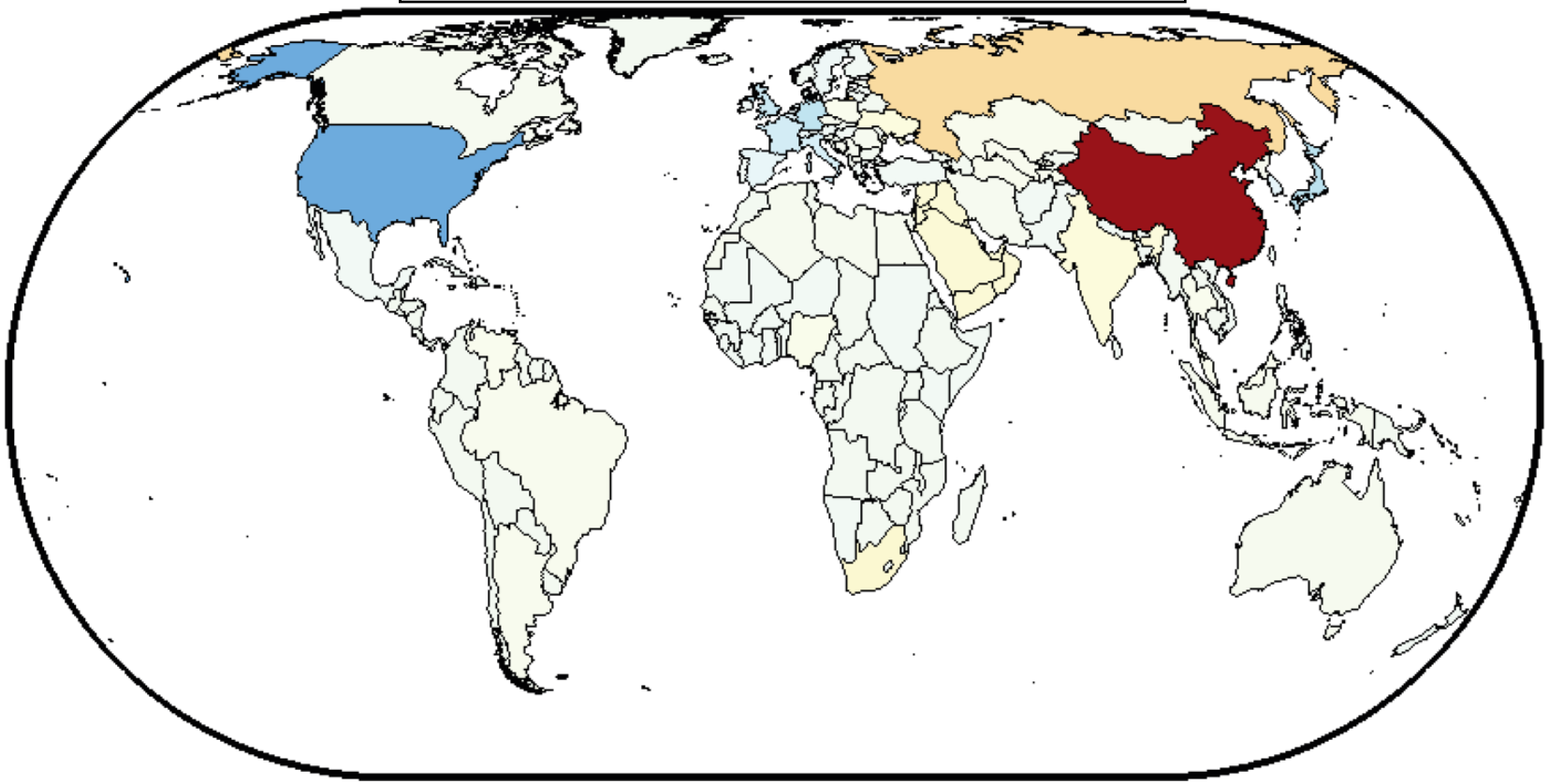
Different methodology

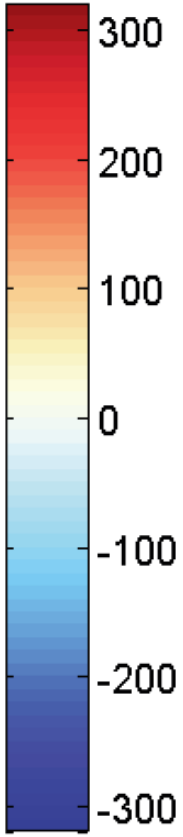
	footprint tCO_2e/p	domestic share 2001	domestic share 2008
Austria	13.8	48%	72%
France	13.1	64%	71%
Germany	15.1	63%	78%
Italy	11.7	62%	75%
Slovenia	11.9	64%	75%
Switzerland	18.4	36%	38%

Balance of Emissions Embodied in Trade (BEET)

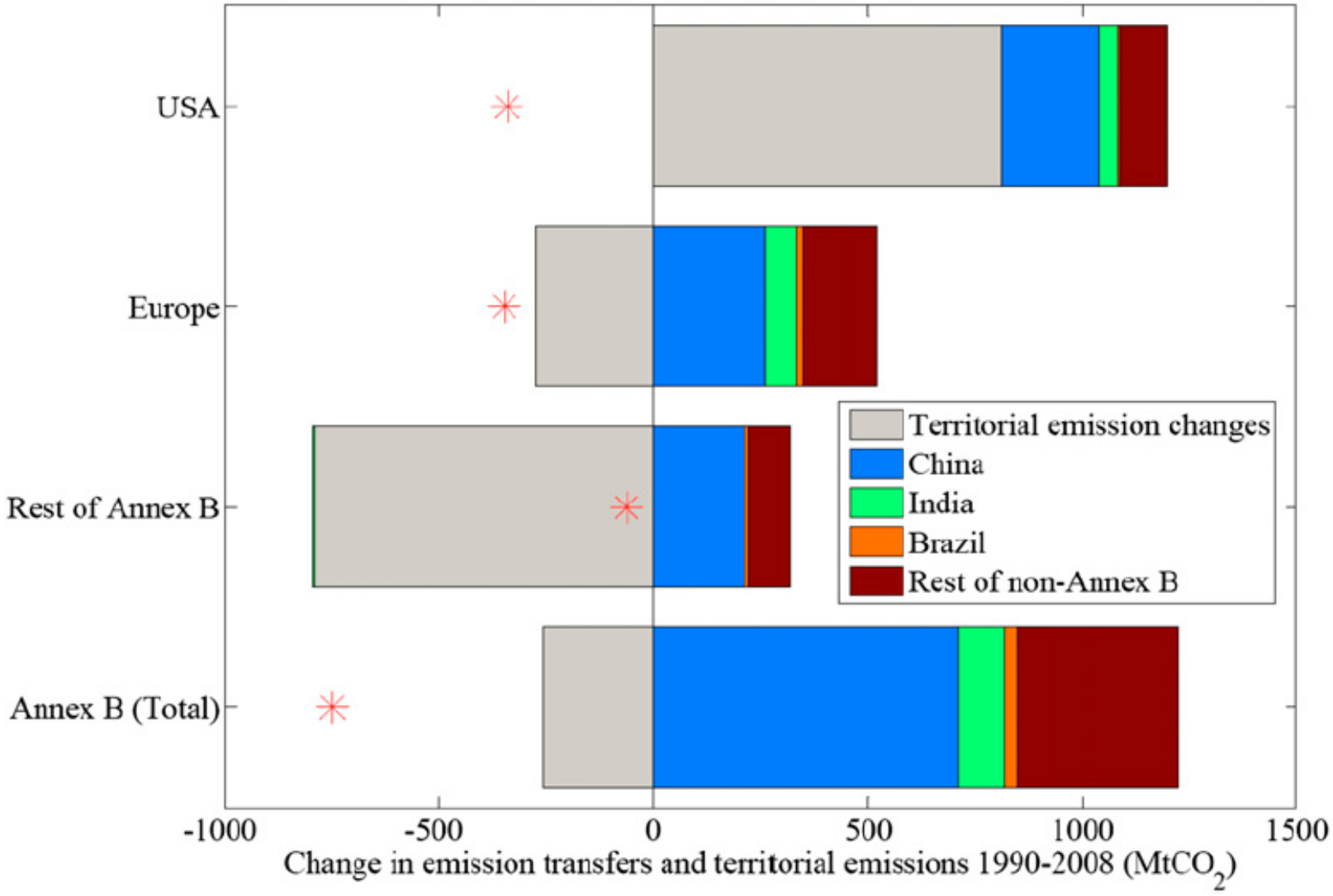
Year 2004

Warm colors → Net exporters of embodied carbon
Cold colors → Net importers of embodied carbon





Peters and Hertwich 2008, Environ, Sci & Tech., updated

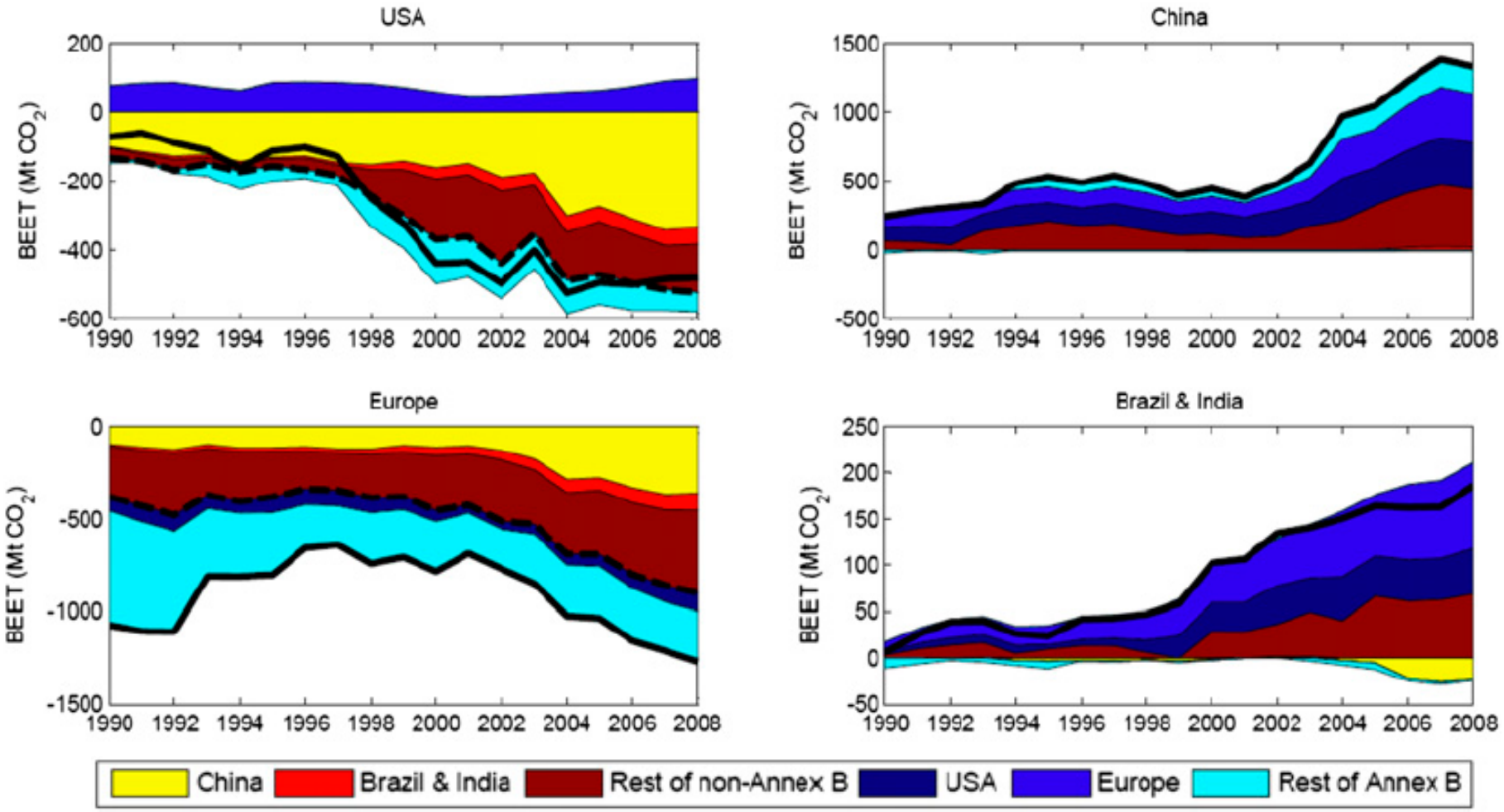


The net change in territorial emissions (1990–2008) together with the change in the net emission transfer between each country and non-Annex B countries.

The red stars represent pledged emission reduction commitments in the Kyoto Protocol.

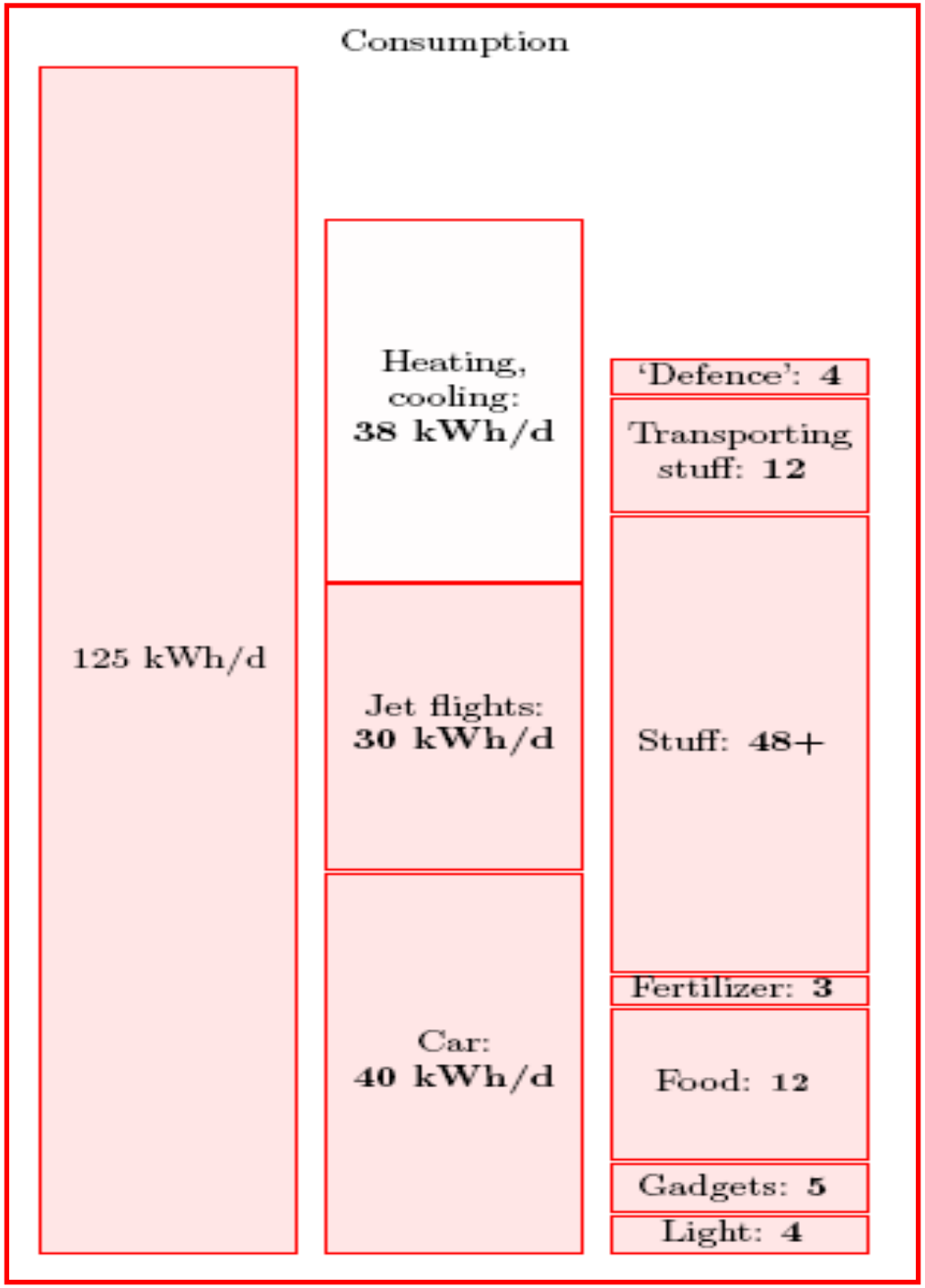
Europe (EU27 + Croatia, Iceland, Liechtenstein, Norway, Switzerland).

Peters et al., 2011



The development of the net emission transfer via international trade between Net emission transfers represent the emissions from the production of exports minus the emissions in other countries from the production of imports

Peters et al., 2011



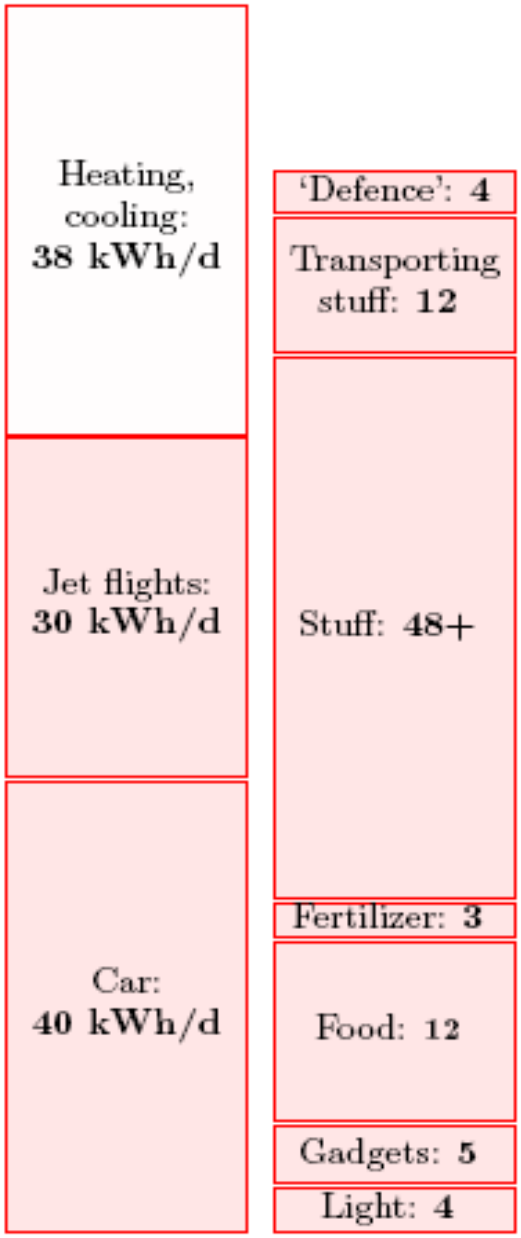
- Povprečni Evropejec 125 kWh/dan
- Povprečje za ZDA 250 kWh/dan
- Povprečni Slovenec ???

125 kWh/day≈ 12, 5 t CO_2/ year

Mac Kay, 2009
www.withouthotair.com

The significance of imported stuff

- In standard accounting of “energy consumption”, imported goods are *not* counted..
- Now Alpine region doesn’t manufacture so much (so energy consumption and CO2 emissions have dropped a bit), but we still love cars, computers.... and we get them made for us by other countries.
- Allowing for imports and exports, carbon footprint of some countries is nearly *doubled* from the official “9 tons CO2e per person” to about 18 tons.
- It is possible that the biggest item in the average Alpine person’s energy footprint is the energy cost of making imported stuff.



Simple actions	Possible saving (kWh/d/p)
Frugal heating system	20
Switch off appliances at home/work	4
Stop flying	35
Efficient transport	20
Do not replace gadgets	4
Use CFL or LED	4
Avoid clutter	20
Become vegetarian	10
Difficult actions	
Eliminate draughts	5
Double glazing	10
Improve insulation	10
Solar hot water panels	8
Photovoltaic panels	5
Replace old building with new	35
Replace fossil-fuel heating by electric heat pump	10

Before	What you can do	After
Food: **15kWh/d**	*eat vegetarian, six days out of seven*	**5kWh/d**
Heating: **40kWh/d** (keeping a leaky home and workplace at 20 °C)	*put on a sweater, be creative with the thermostats, read your meters*	**20kWh/d**
Flying: **35kWh/d** (London to Los Angeles, Rome, and Malaga, yearly)	*video-conference instead*	**1kWh/d**
Car: **40kWh/d** (averaging 30 miles per day)	*join a car club, cycle, walk, and use public transport*	**5kWh/d**

Share of total energy consumption by fuel in 2007

	Coal and lignite (%)	Oil (%)	Gas (%)	Nuclear (%)	Renewables (%)	Industrial waste (%)	Imports exports of electricity (%)	Total energy consumption (thousand TOE)	kWh per cap/day
Austria	11,4	41,1	20,6	0	23,8	1,4	1,7	33809	130
Switzerland	0,6	43,6	9,8	26,8	18,8	1	-0,7	26901	114
Germany	25,6	33,2	22,6	10,7	8,3	0,1	-0,4	339568	131
France	5	33,6	14,2	42	7	0	-1,8	270272	135
Italy	9,2	43,8	37,9	0	6,9	0,1	2,2	183452	99
Slovenia	21,9	35,2	12,4	20	10	0,2	0,3	7346	116

EEA, 2011

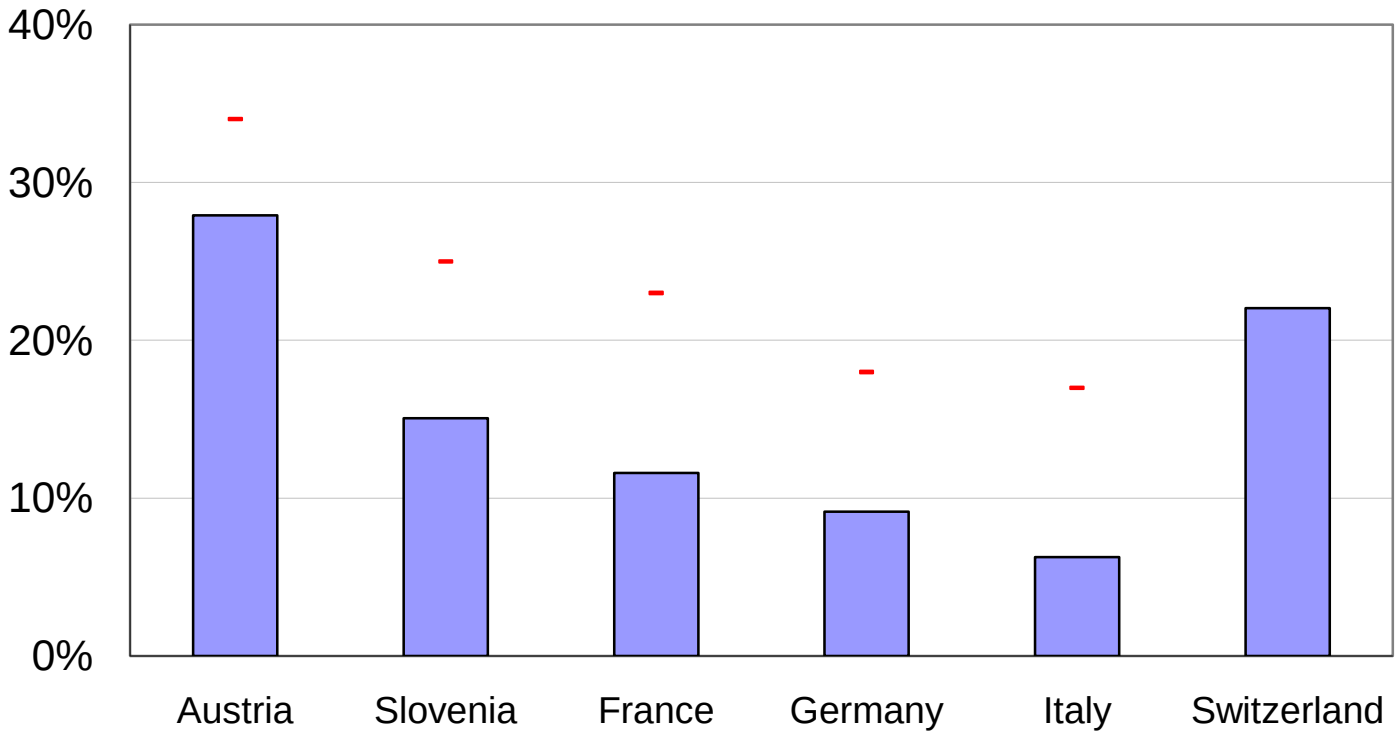
140 kWh/d

peak 25 kW

Concentrating photovoltaic by Amonix - Photo by David Faiman.

2008 Share of RE in final consumption

and new 2020 Directive target



Can Alpine countries live on their own renewables?

Most renewables offer 0.5 to 5 W/m^2

. nuclear fission 1000 W/m^2

POWER PER UNIT LAND OR WATER AREA

Wind	2 W/m^2
Offshore wind	3 W/m^2
Solar PV panels	5 – 20 W/m^2
Plants	0.5 W/m^2
Hydroelectric facility	11 W/m^2

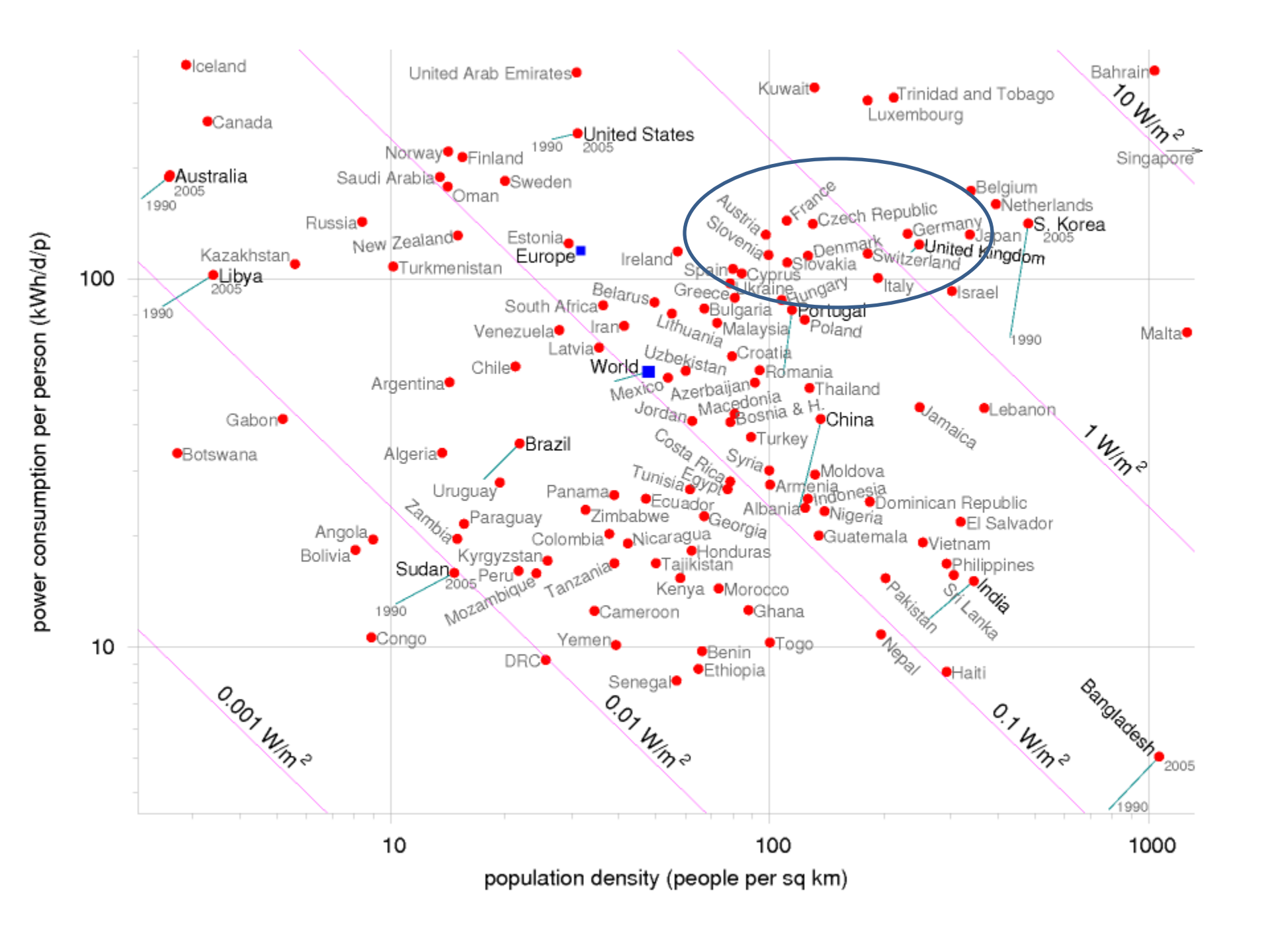
Renewable facilities have to be country-sized because all renewables are so diffuse

Most renewables offer 0.5 to 5 W/m^2

.

- Countries whose power consumption per unit area is bigger than **0.1 W/m²** are countries who should expect renewable facilities to occupy a significant *intrusive* fraction of their country, if they ever want to live on their own renewables.

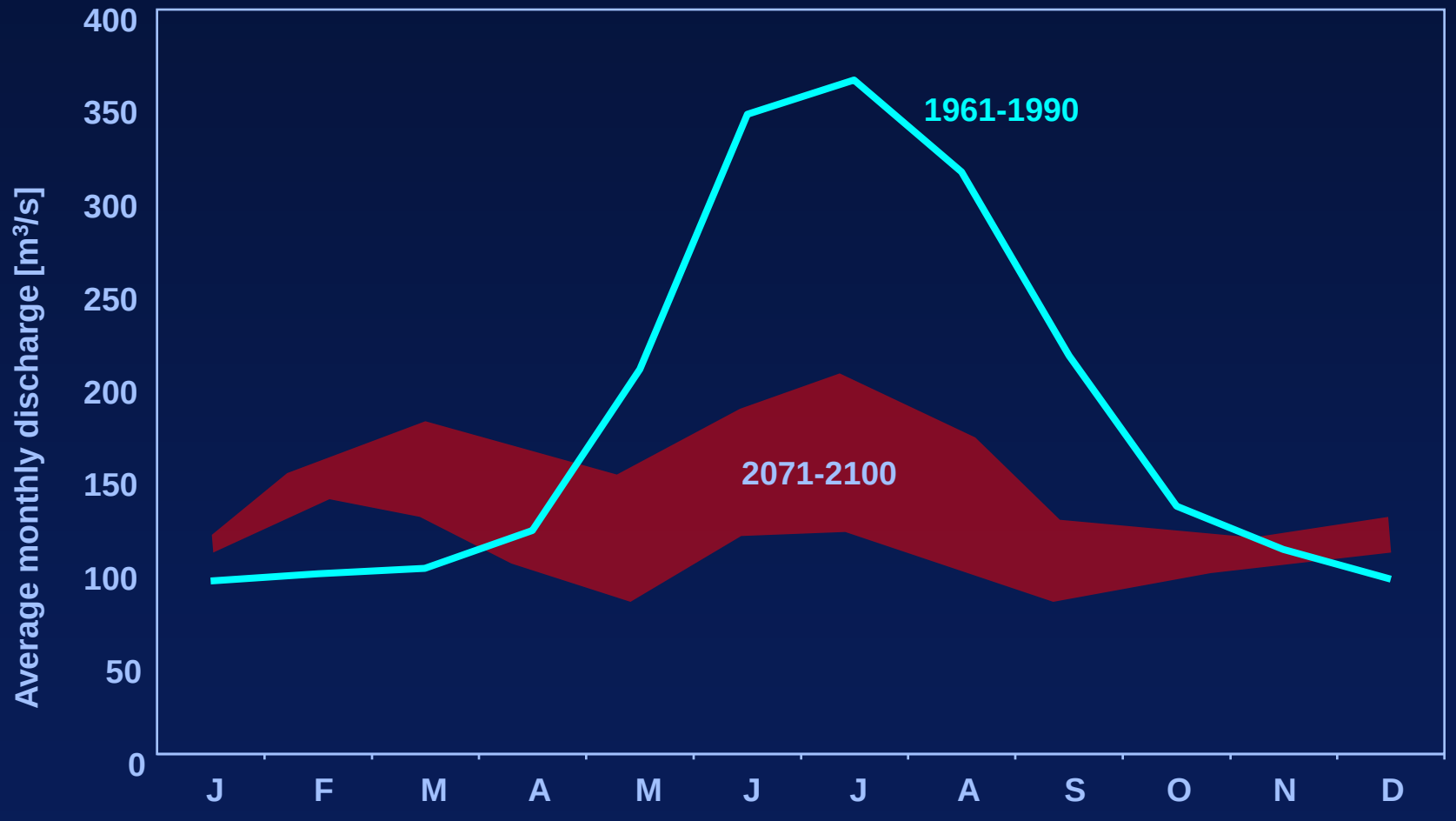
- Countries with a power consumption per unit area bigger than **1 W/m²** (eg Germany) would have to industrialize most of their countryside, if they want to live on their own renewables.


power consumption per person (kWh/d/p)
population density (people per sq km)
100
10
10
100
1000
10 W/m 2
1 W/m 2
0.1 W/m 2
0.01 W/m 2
0.001 W/m 2
Iceland
United Arab Emirates
Bahrain
Kuwait
Trinidad and Tobago
Luxembourg
Canada
United States
1990
2005
Singapore
Norway
Finland
Australia
2005
1990
Saudi Arabia
Oman
Sweden
Belgium
Netherlands
Russia
Austria
France
Slovenia
Czech Republic
Germany
S. Korea
2005
Japan
New Zealand
Estonia
Europe
Denmark
United Kingdom
Switzerland
Kazakhstan
Libya
2005
1990
Turkmenistan
Ireland
Spain
Cyprus
Slovakia
Ukraine
Hungary
Italy
Israel
Belarus
Greece
South Africa
Bulgaria
Portugal
Malaysia
Poland
Venezuela
Iran
Lithuania
Malta
Latvia
Uzbekistan
Croatia
Chile
World
Romania
Argentina
Mexico
Azerbaijan
Thailand
Macedonia
Jordan
Bosnia & H.
China
Jamaica
Lebanon
Gabon
Turkey
Botswana
Algeria
Brazil
Costa Rica
Syria
Tunisia
Egypt
Moldova
Uruguay
Panama
Armenia
Indonesia
Albania
Dominican Republic
Ecuador
Zambia
Zimbabwe
Nigeria
Paraguay
Georgia
El Salvador
Angola
Colombia
Nicaragua
Guatemala
Vietnam
Bolivia
Honduras
Kyrgyzstan
Philippines
Sudan
2005
1990
Peru
Tajikistan
Tanzania
India
Pakistan
Sri Lanka
Kenya
Morocco
Mozambique
Cameroon
Ghana
Congo
Yemen
Togo
Benin
Nepal
DRC
Ethiopia
Haiti
Senegal
Bangladesh
2005
1990

The impact of climate change on renewable energy sources

- RE production is highly susceptible to changes in the resource base (e.g. hydroelectric power generation, wind and solar energy)
- even modest impacts in key resource areas could substantially impact the cost competitiveness
- biomass power and fuel production impacts are less certain in short term (drought?)

Possible future discharge by 2100 (m^3/s, River Rhone)



Beniston, 2010: Journal of Hydrology

Problems with hydropower?

- In the short term, hydropower production could benefit from additional water from the melting glaciers. In the long term considerable changes for hydropower production are expected
- Switzerland might be more negatively affected than other alpine countries. Hydropower production is projected to fall by 7 % by 2035 , by 11 % by 2050 and by 22 % by 2100 (Ecoplan/Sigmaplan, 2007)
- The impacts can be more pronounced for some power stations. Annual hydropower production at the Mauvoisin Dam in Switzerland may drop 36 % by 2070–2099 compared to 1961–1990 (Schaefli *et al.*, 2007).
- A preliminary study on two basins with hydropower production in the Italian Alps also suggests a reduction in run-off in the future (Barontini *et al.*, 2006).

The impact of climate change on renewable energy sources

- Studies on hydropower indicate future production losses due to decreasing river flows,
- Too few studies on power plants that consider climate changes as well as variations in demand.
- No studies on impact of water scarcity on other energy sources such as biomass.
- Problems with extreme weather events (wind energy?)

There is a need for further research into the impact of climate change on the energy sector.

Use of RE is unfortunately limited

Great potential for renewable energy sources

In regions that have 3 things:

a) low population density
b) large area
c) a renewable power supply with high power density

Alternatively, options are

- to radically reduce consumption,
- use nuclear power,
- and/or to buy renewable power in from other countries
- ?

Efficiency and technology – wining combination?

- Jevons' paradox

"as technological improvements increase the efficiency with which a resource is used, total consumption of that resource may increase, rather than decrease."

For example, from 1900 to 2000, passenger transportation in the USA became 5 times more energy-efficient; but nowadays, the average person travels 50 times further.

Final remarks

- Energy self-sufficiency, autonomy etc.: these declarations should be used much more in a scientific sense; not just as result of a political decision-making process.
- The drastic reduction of energy use and general consumption in the Alpine area is a first step towards energy self-sufficiency
- Conversion to renewable energies next step, but only if this change is connected with a fundamental restructuring of energy supply.
- Significantly greater efforts in the field of research and development
- Some vision hold great fascination – but we have to be realistic and honest!