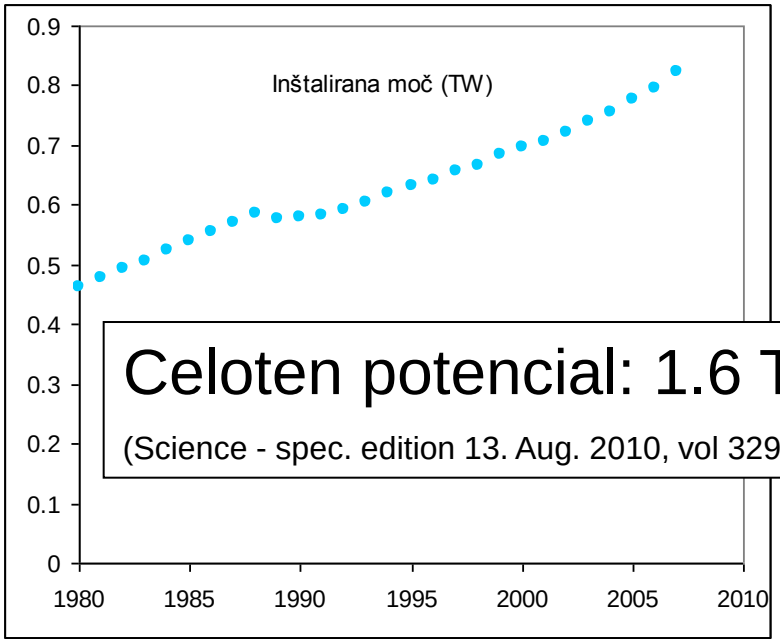
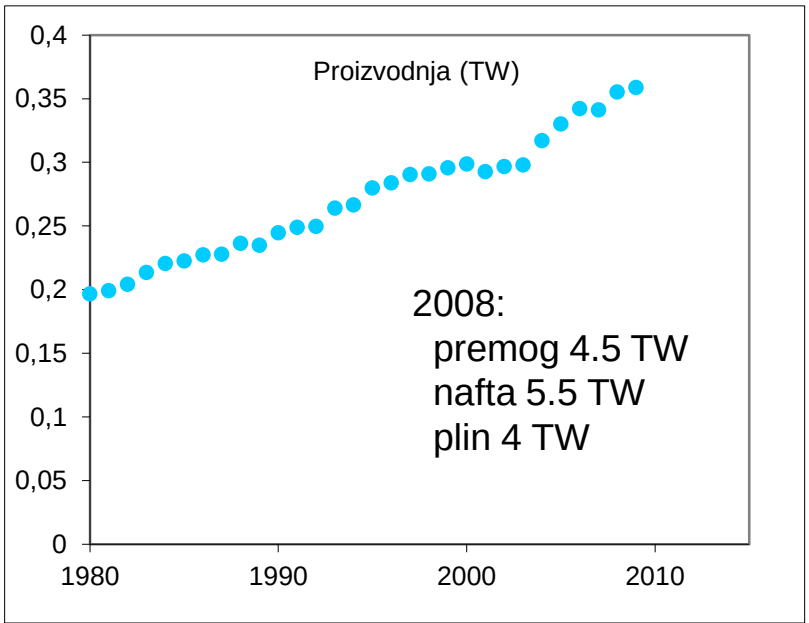
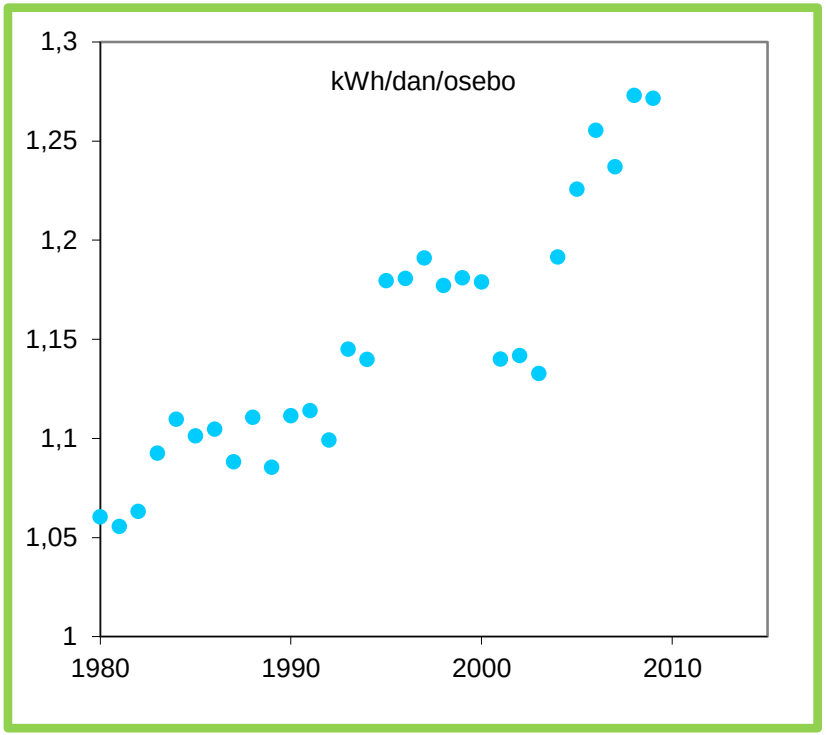
voda - reke



Celoten potencial: 1.6 TW

(Science - spec. edition 13. Aug. 2010, vol 329)

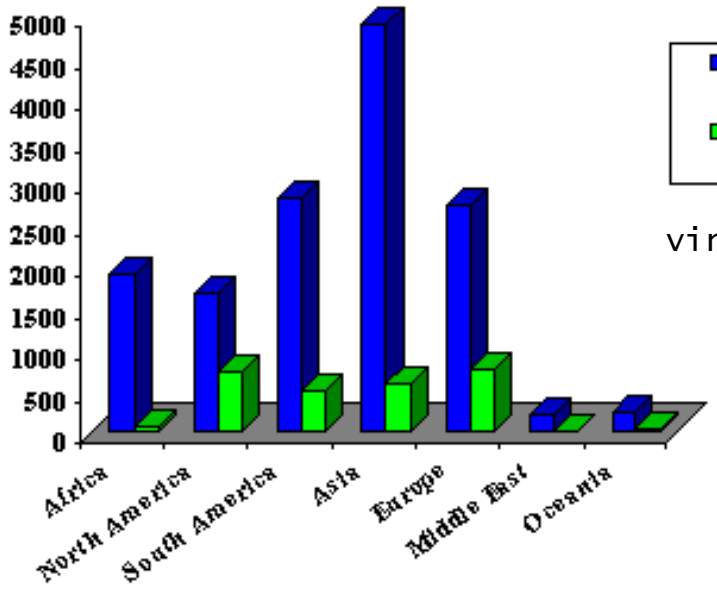




grafi: http://www.eia.doe.gov/

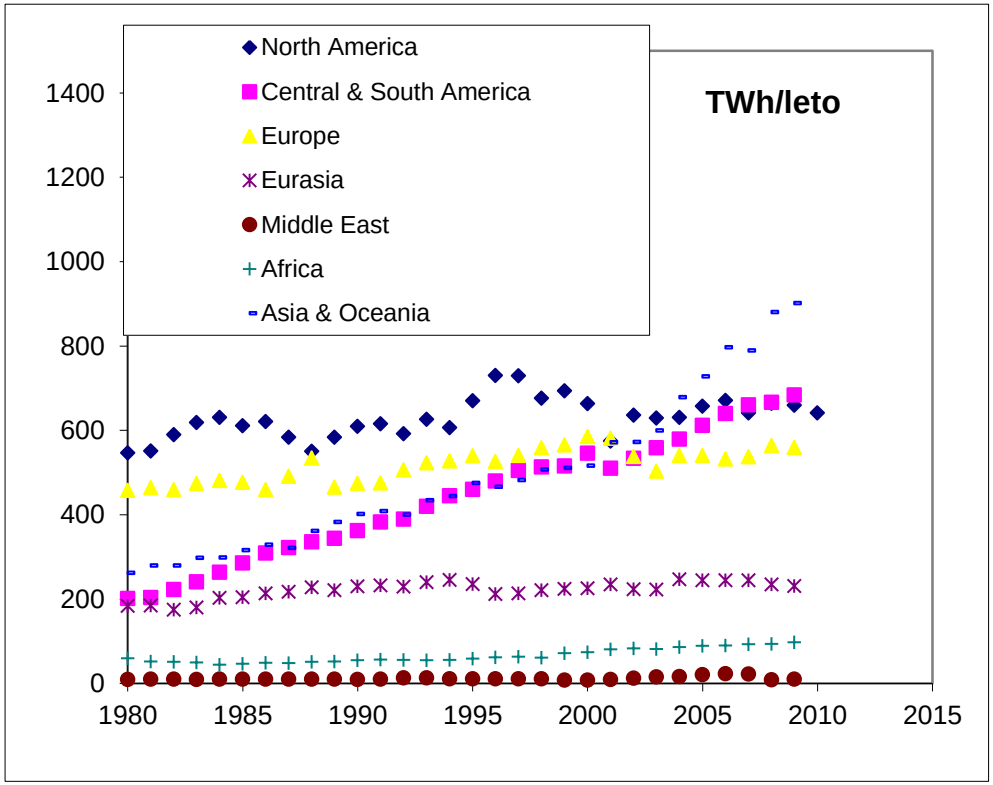
Proizvodnja po regijah

Figure 7.2: Hydropower - technically exploitable capability and 1999 generation (all schemes) - regional distribution



vir: World Energy Council, http://www.worldenergy.org/wec-geis/publications/reports/ser/overview.asp

(Opravičujem se za enote, namesto TWh raje TW ali GW)



graf - proizvodnja po regijah: http://www.eia.doe.gov/

Največje hidroelektrarne (wikipedia)

	Name	Country	Total Capacity (GW)	Electricity production (GW)	Area flooded (km^2)
1	Three Gorges Dam	People's Republic of China	22.5	9.2	632
2	Itaipu	Brazil Paraguay	14.0	10.8	1,350
3	Guri (Simón Bolívar)	Venezuela	10.2	5.3	4,250
4	Tucuruí	Brazil	8.4	2.4	3,014
5	Grand Coulee	United States	6.8	2.3	
6	Sayano Shushenskaya	Russia	6.4	3.1	621
7	Krasnoyarskaya	Russia	6.0	2.3	2,000
8	Robert-Bourassa	Canada	5.6		
9	Churchill Falls	Canada	5.4	4.0	6,988

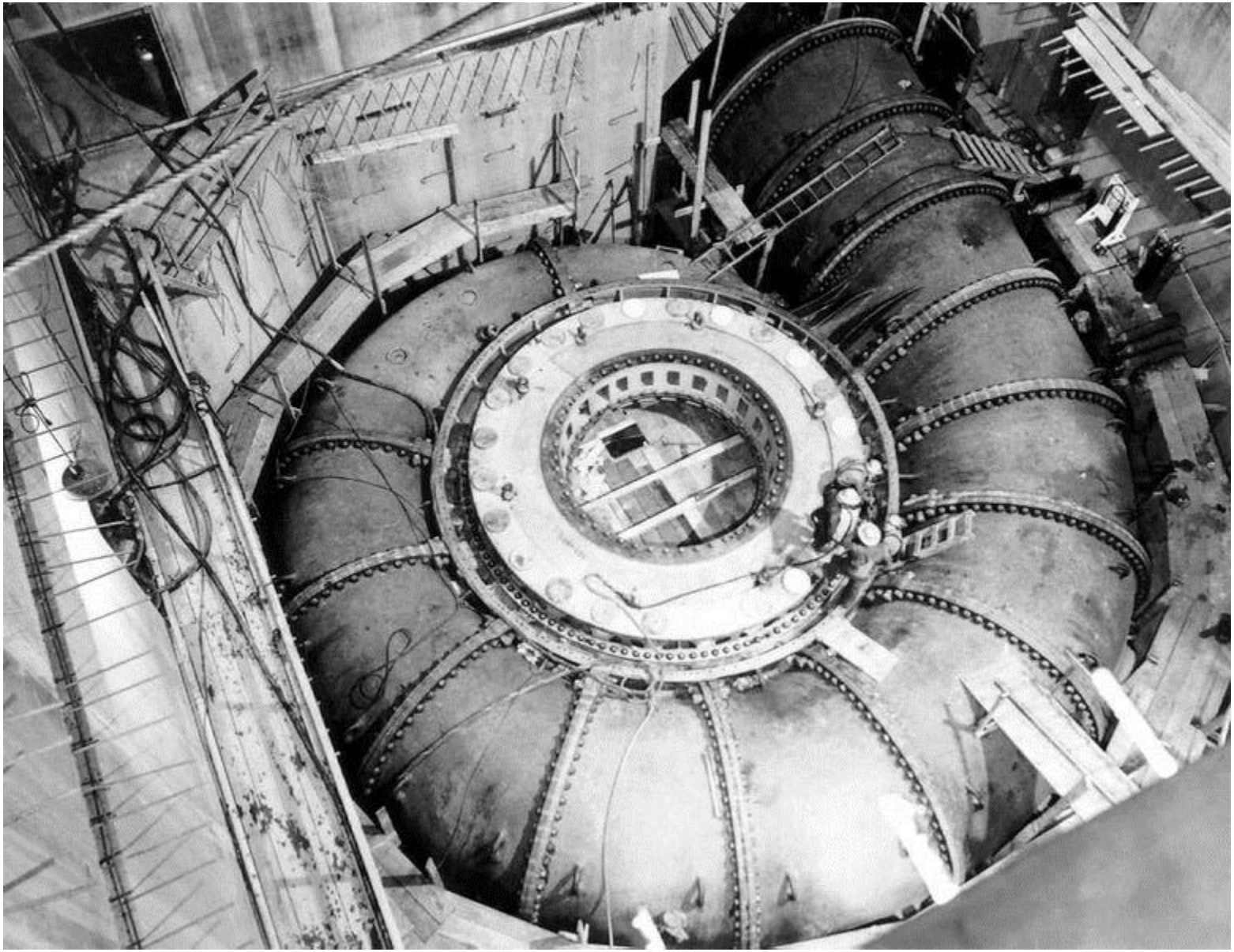
Accident at Russia's Biggest Hydroelectric

Sayano-Shushenskaya – 2009 August 17

1- Main Characteristics

- Number of Units: 10
- Turbine Type: Francis (16 blades)
- Rated Power: 650 MW each
- Rated Discharge per Unit: 358,5 m^3/s
- Nominal Speed: 142,86 rpm
- Net Head: 194 m
- Operation Date: 1978
- Runner Weight: 156 ton
- Runner Diameter: 6,77 m

Francisova turbina v Grand Coulee dam



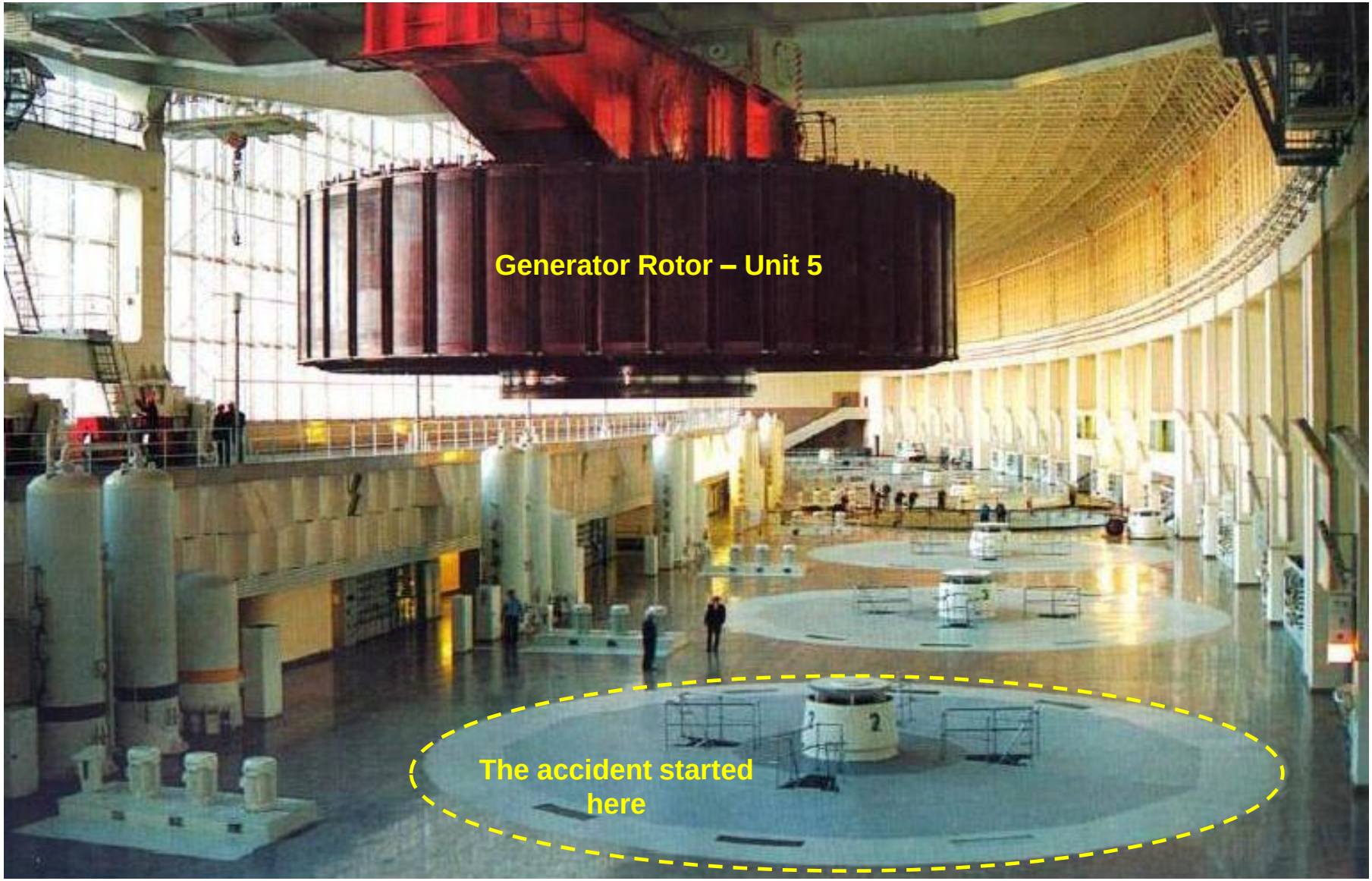
2 - Main Characteristics

One of the world's largest hydro-electric plants, its dam is 245 m (800 ft) high and stretches 1 km (0.6 miles) across the Yenisei river.

Opened in 1978, the station provides a quarter of RusHydro output and is a major power supplier to at least two smelters owned by United Company RUSAL, the world's largest aluminium producer.

The hydroelectric power station is located on the Yenisei River, near Sayanogorsk in Khakassia, Russia. Before the accident, it was the largest power plant in Russia and the sixth-largest hydroelectric plant in the world.

Before the Accident



Generator Runner

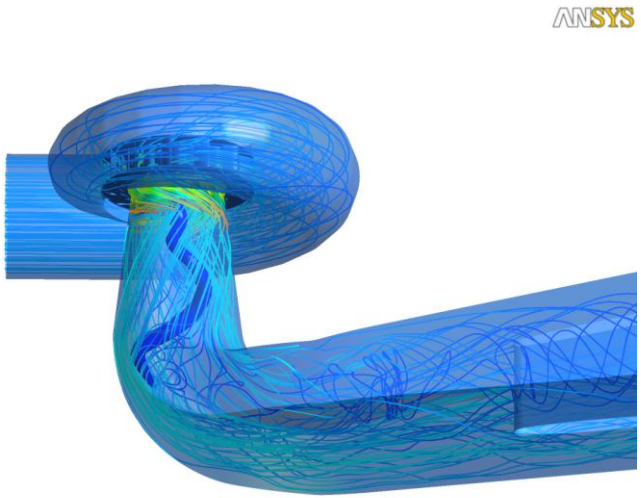
Nesreča, 75 mrtvih, najverjetneje posledica utrujanja materiala zaradi vibracij.

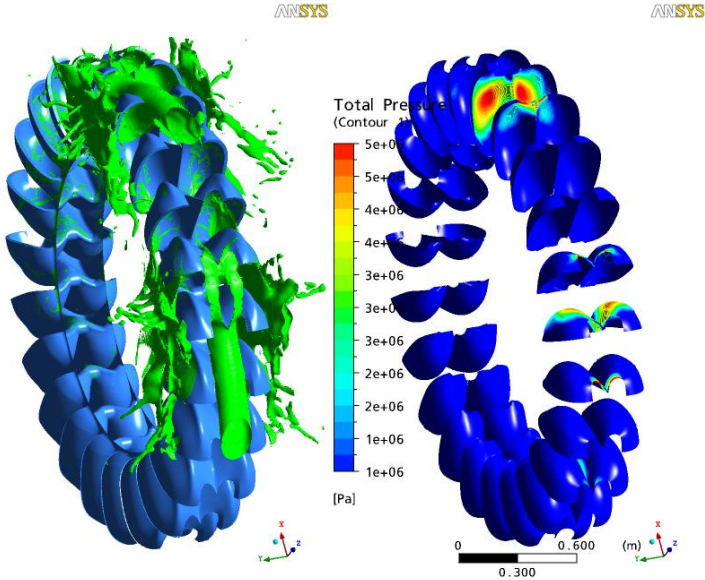
(elektrarna je začela z obratovanjem 1978)

SLO:

- Litostroj - turbine
- Računalniške simulacije na Turboinštitutu

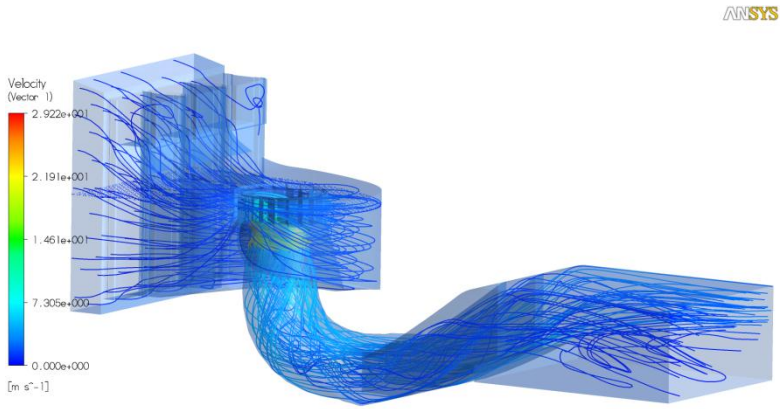
Francisova turbina





Peltonova turbina

Kaplanova turbina



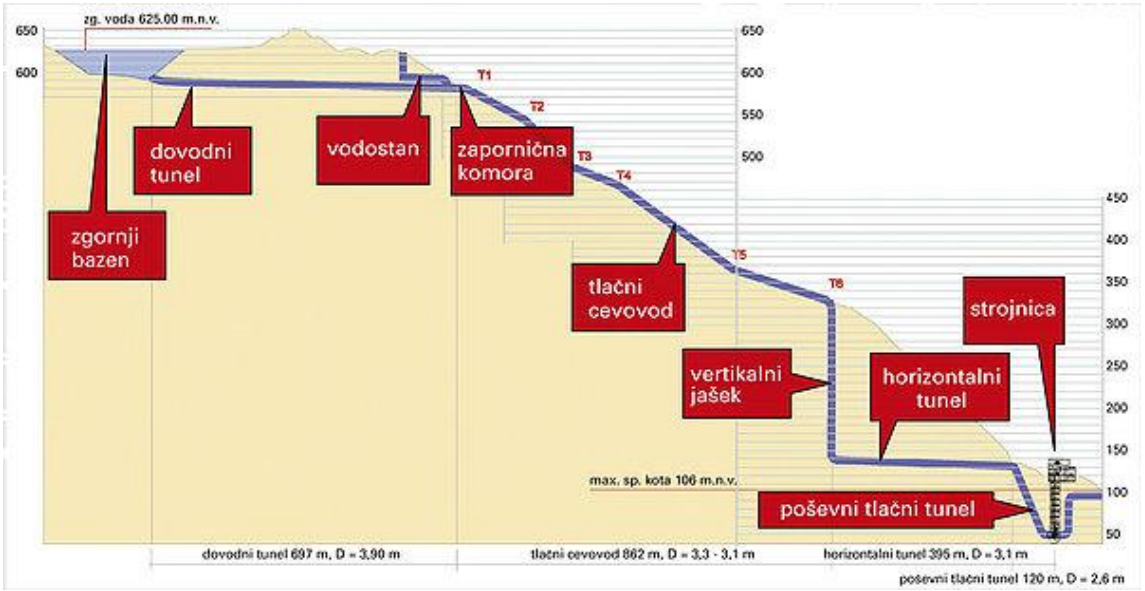
Jošt, Lipej, Mežnar: Numerical Prediction Of Efficiency, Cavitation And Unsteady Phenomena In Water Turbines, ASME Conference on Engineering Systems Design and Analysis, Israel.

Črpalne hidroelektrarne - največji zbiralniki energije

črpalne elektrarne:
črpanje vode na večjo višino ob presežku produkcije;
hidrolektrarna ob pomanjkanju;
črpalka/turbina
$W_{elek} \rightarrow W_{pot} \rightarrow W_{elek}'$

izkoristek:
- izgube zaradi izparevanja
- mehanske izgube

$h = W_{elek}' / W_{elek}$
~ 0.7-0.85
(ekonomski izk. boljši)



cena 120-130 MEUR

Črpalna HE Avče, http://www.seng.si/che_avce/

Povzeto po: Fizika energijskih virov B. Golob

Maksimalni bruto padec: Hb = 521,00 m

Koristni volumen vode: V_k = 2.170.000 m³

Spodnji bazen: aumul. jezero elektrarne Plave 416.000 m³

Instalirani pretok (turbinski režim): Q_i = 40 m³/s

Instalirani pretok (črpalni režim): $Q_č$ = 34 m³/s

Povprečni pretok Soče v Solkanu (20 km nizvodno): ~ 80 m³/s

Instalirana moč turbine: P_i = 185 MW

Instalirana moč črpanja: $P_č$ = 180 MW

Letna proizvodnja električne energije: E_i= 426 GWh

Letna poraba energije za črpanje: $E_č$ = 553 GWh

Črpalna HE Avče, http://www.seng.si/che_avce/

$\eta = W_{elek}' / W_{elek} \sim 0.77$

Efektivna gostota shranjene energije
(dW/dm ali dW/dV in izkoristek pretvorb)
za vodo shranjeno v rezervoarju 520 m nad turbino:
dW'/dV = h dW/dV = h rgh dV/dV = h rgh ~ 1 kWh/m³

skupaj Avče ~ 2GWh rezervoar elektrike (SLO dnevna poraba ~35 GWh)
2010-2011 - "proizvodnja vršne energije" ~1.5 GWh/dan (0.75 kWh/dan/o)

Valovi (po MacKay-u)

'500 kW' Limpet, Islay

Predicted average power: 200kW. Actual: 21kW.

Total incident power / population of UK

$$= \frac{40\,\text{kW/metre} \times 1000\,\text{km}}{60 \times 10^6} = 16\,\text{kWh/day}$$

teoretični potencial na prebivalca VB

MacKay predpostavi 4 kWh/dan kot bolj realno številko

Ocean Power Delivery (oceanpd.com)

Pelamis

Plima (po MacKay-u)

Zajezitev zalivov ob ustju rek.
Plima-oseka Δh ~ 5m

gostota moči 3 W/m^2

Jez elektrarne La Rance, Francija (www.edf.com)

max 250 MW, avg. 70 MW

na prebivalca UK:

←≃2 kWh/dan

~9 kWh/dan →

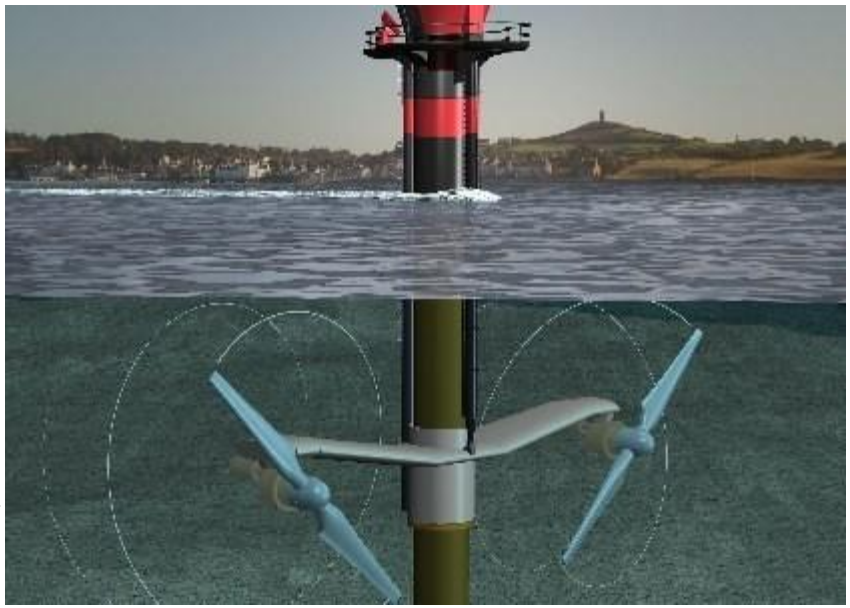
Tokovi - Podvodne turbine

gostota moči 8 W/m^2 (tok ~1 m/s) (MacKay)

SLO - Teoretični potencial:

Tržaški zaliv, povprečen tok 0.5 m/s ~ 1 W/m^2, Slovenski del 100-200 km^2 => 100-200 MW

www.marineturbines.com



HIDROENERGETSKI POTENCIAL V SLOVENIJI

Vodotok	Bruto potencial (GWh/leto)	Tehnično izkoristljiv potencial (GWh/leto)	Izrabljen potencial (GWh/leto)	Delež izrabe
Sava z Ljubljanico	4134	2794	512	18,5%
Drava	4301	2896	2833	97,8%
Soča z Idrijco	2417	1442	491	34,0%
Mura	928	690	0	0%
Kolpa	310	209	0	0%
Ostali vodotoki	7350	1114	284	25,5%
Skupaj	19440	9145	4125	45,1%

Celotna inštalirana moč v Sloveniji: 890MW (Vir : http://www.hse.si)
Produkcija slovenskih hidroelektrarn: 5,4 kWh/dan/prebivalca (2008)

Vir: http://www.geateh.si

ENERGETSKI POTENCIAL SLOVENSKIH REK

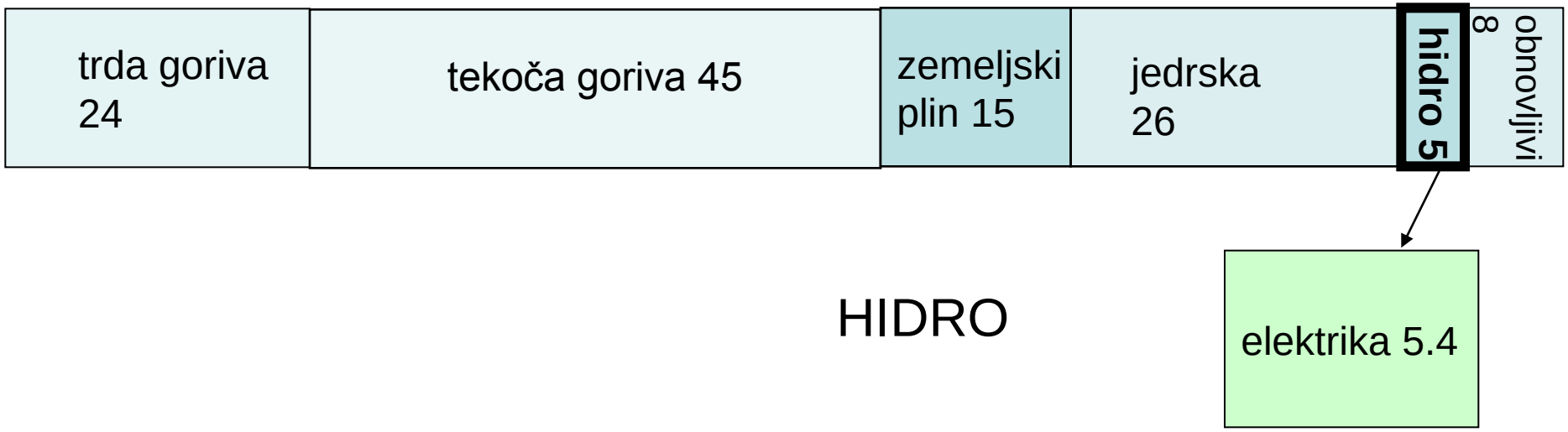
VIR: http://www.hse.si

podrobnosti: seminar JTE 2010 - voda

Energija v Sloveniji 2008 (statistični letopis 2008)

Oskrba z energijo

122 kWh/osebo/dan



Sonce

Svetovna proizvodnja elektrike 2010: 3 GW
(Hidro ~350 GW)

Vsi viri energije, razen jedrskih, geotermalnih in plimovanja izvirajo iz Sonca

Koalicijski sporazum, 2008:

Koalicijski partnerji bomo posebej spodbujali proizvodnjo energije iz **obnovljivih in okoljsko sprejemljivih virov energije** in pri tem posebej spodbujali investicije v fotovoltaične elektrarne v obsegu do 500 megavatov.

Slovenija 8.10.2012: 164 MW (http://pv.fe.uni-lj.si/Seseznam.aspx)

podrobnosti: seminar JTE 2010 Sonce-geotermalna energija

Sonce (sevanje) - obnovljiv vir z največjo gostoto!

(neposredna izraba sončnega sevanja)

UPORABEN POTENCIAL > 50 TW

(TEORETIČNI POTENCIAL ~ 100000 TW)

(Science, spec. edition, 13. Aug.2010, Vol 329)

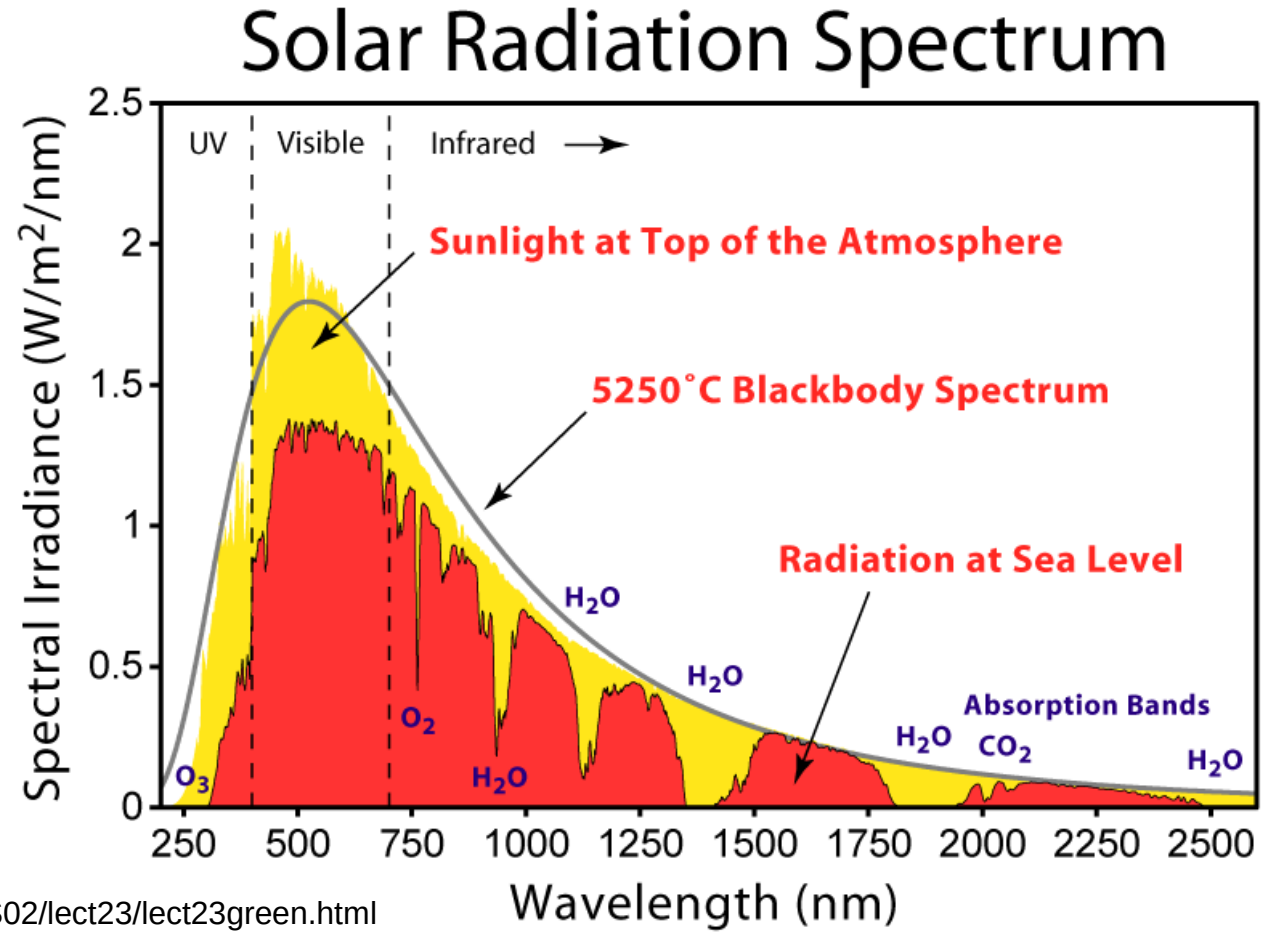
Sončno sevanje:

1367 W/m^2

albedo 0.3

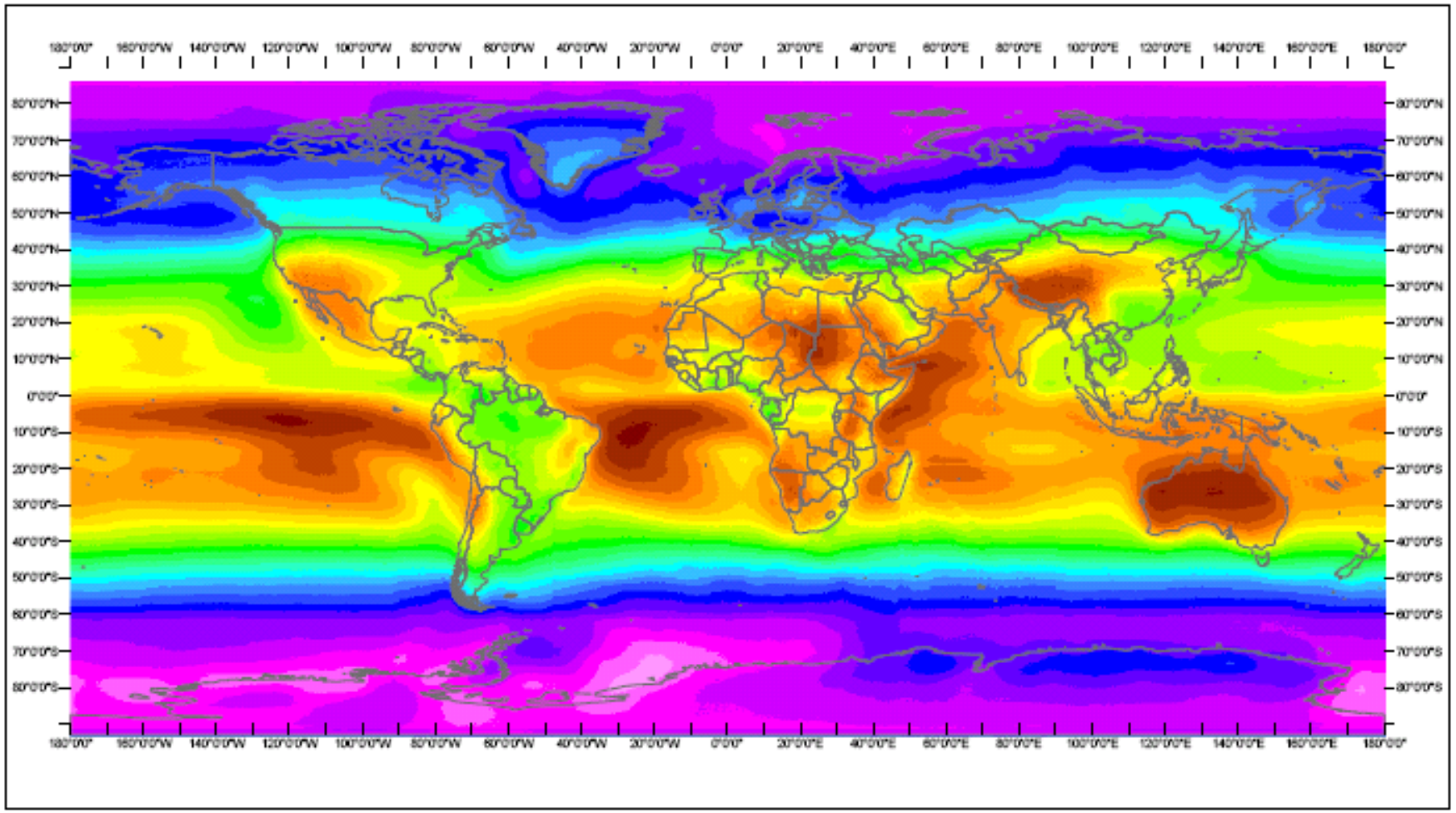
Ravnovesna temperatura površja -18 ^{o}C

Dejanska povprečna temperatura površja 15 ^{o}C



http://bouman.chem.georgetown.edu/S02/lect23/lect23green.html

Averaged Solar Radiation 1990-2004



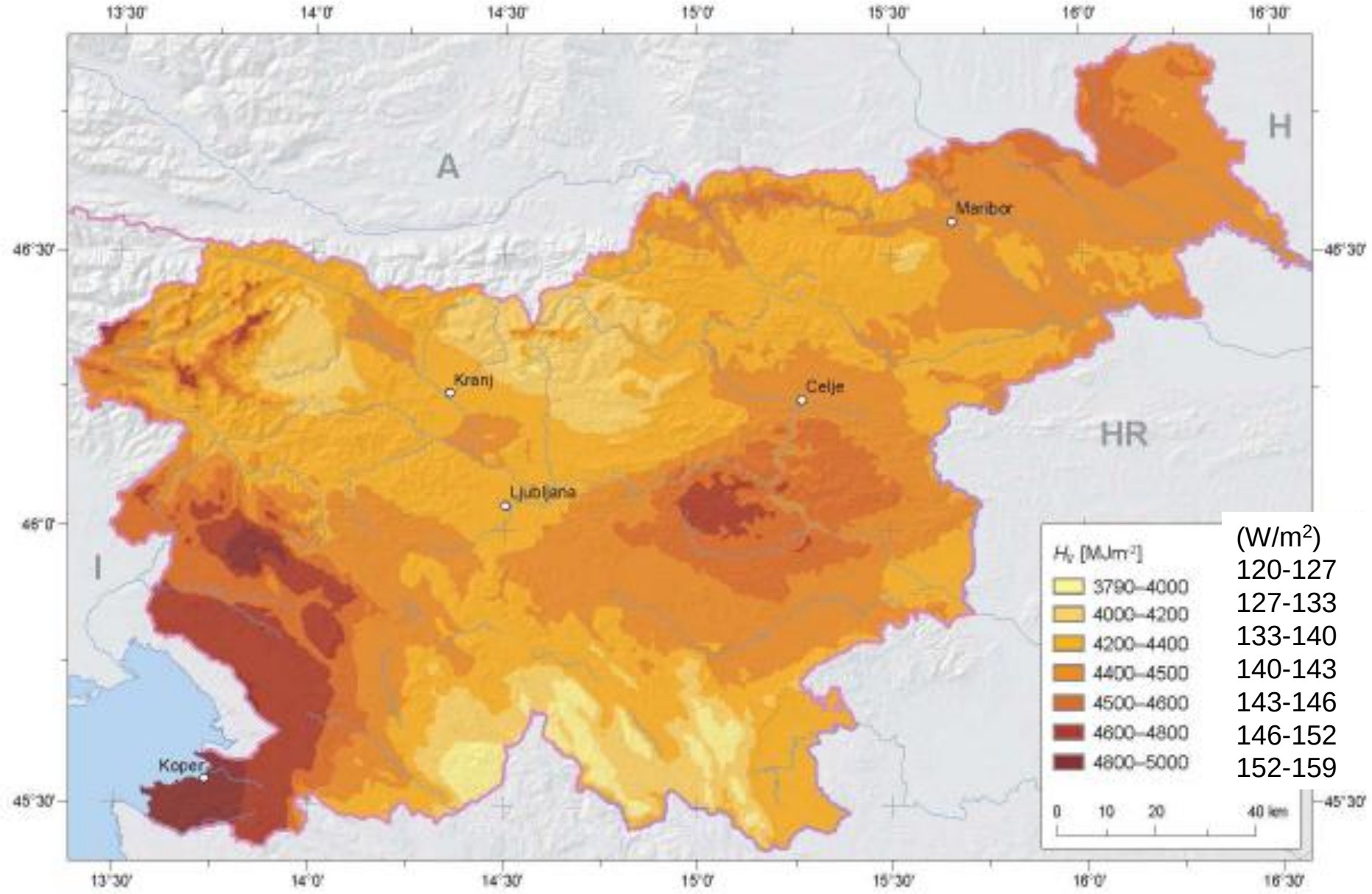
Yearly Mean of Irradiance in W/m²

0 30 70 100 150 190 240 290 W/m²

MINES PARIS

Povprečna moč sončnega sevanja

(Sončna energija v Sloveniji, J. Rakovec, D.Kastelec, K. Zakšek)



Fotovoltaika - Moura, Portugalska, Wikipedia

62 MWp (moč)

(povprečna moč 6 do 9 krat manjša – dan, noč, oblaki…)

376,000 solarnih panelov

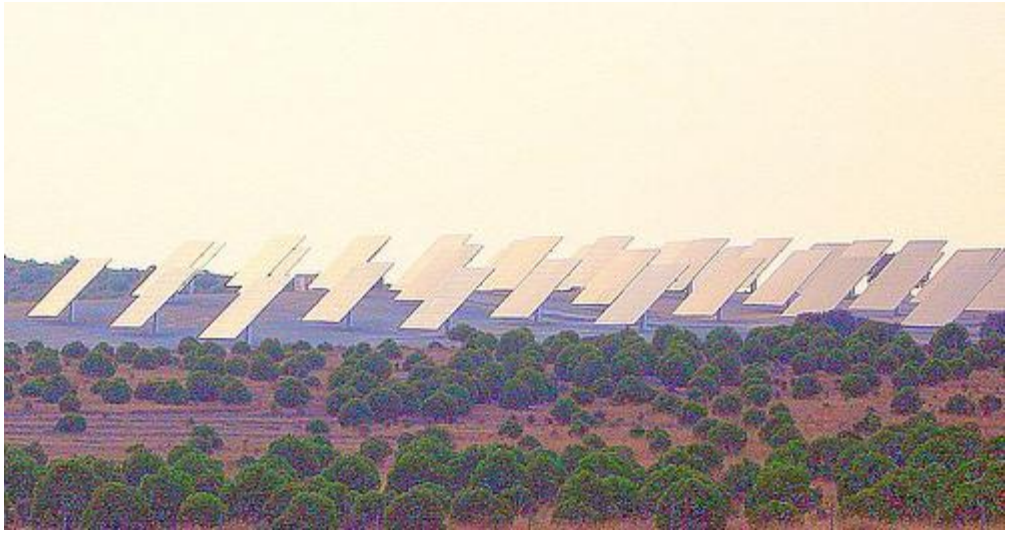
190,000 fiksnih panelov

52,000 panelov “sun-trackers”

250 hektarov

90 GWh/leto

4 W/m^2



Fotovoltaične elektrarne

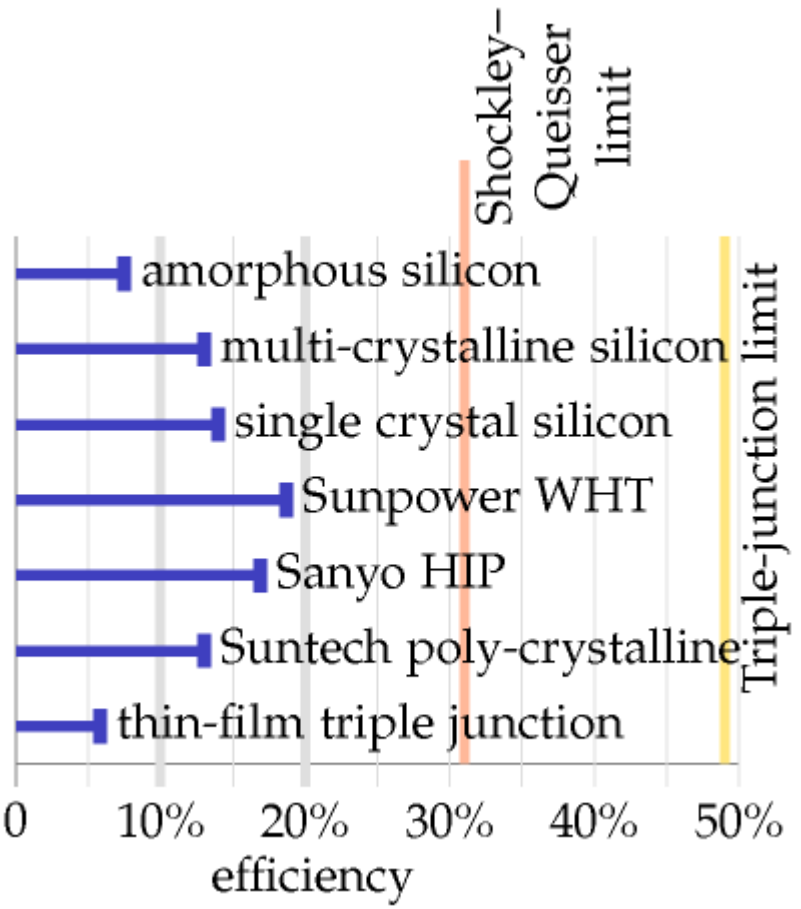
do max. ~20 W/m^2

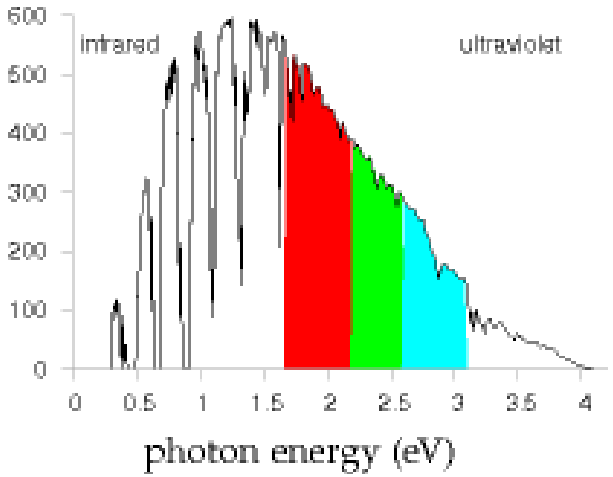
Manjši teoretični izkoristek od **termosolarnih elektrarn**, toda boljša izkoriščenost prostora

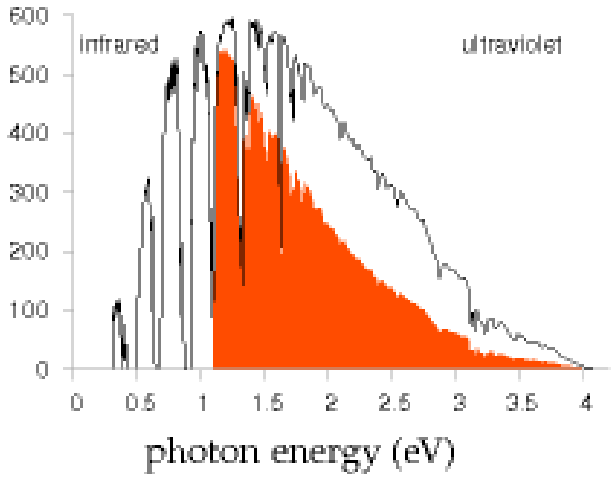
Izkoristek fotovoltaičnih panelov

po MacKay-u

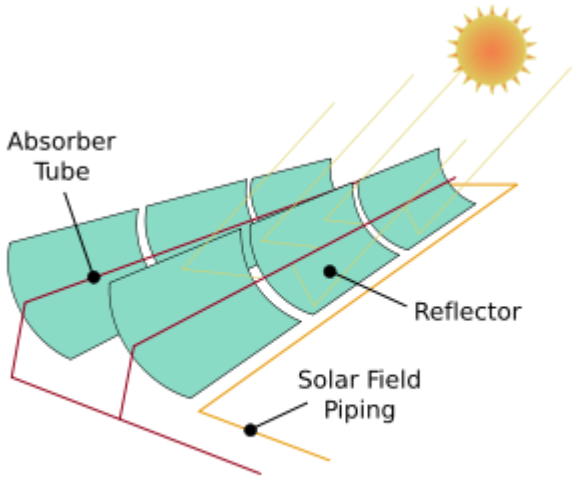
Izkoristki nad 20% so izjema...







Kramer junction, Kalifornija, 10 W/m^2



PS 10 Solucar, Španija, 5 W/m^2

Sončne termoelektrarne

načrti do max ~20 W/m^2

Boljši izkoristek sevanja kot fotovoltaika na m^2 zrcal. Slabši izkoristek prostora.

gostota moči fotovoltaične elektrarne

Vrenska gorca, 2009:

420 kW (2 MEUR)

550000 kWh/leto

1 ha travnika

za ~200 gospodinjstev :-)

gostota moči: 6 W/m²

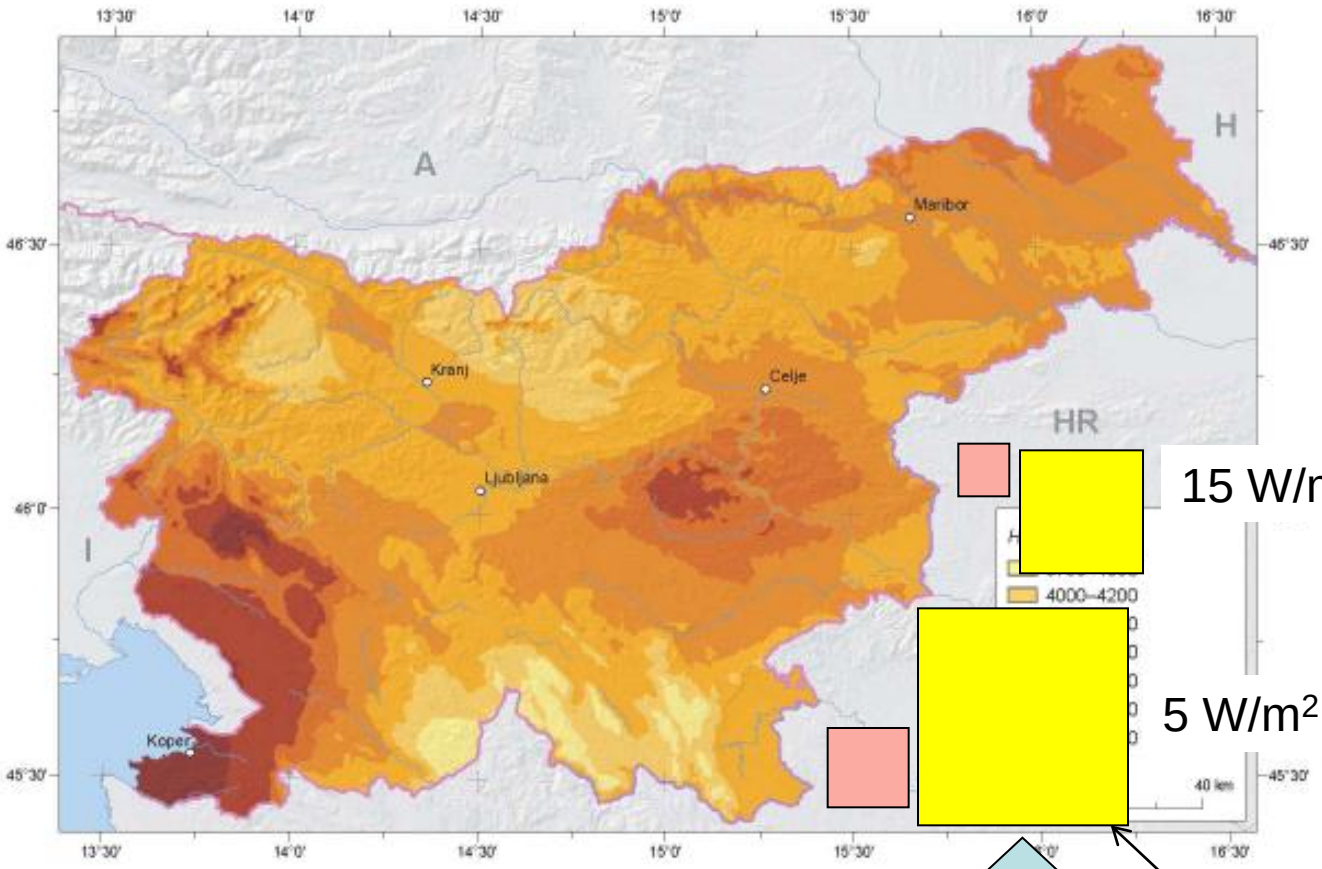
Strahinj,2007,
90 kW vršna moč, (~10 kW povprečna moč)
proizvodnja ~90000 kWh/leto,
površina ~600 m² - 80% strehe
gostota moči: ~15 W/m²

~246 kWh/dan = 2 Slovenca

<Slovenec>
potrebuje
~0.5W/m^2.

Rumeno
površina potrebna
za **100% oskrbo**
iz sončnih
elektrarn pomeni
1/30 do 1/10
Slovenije
(122 kWh/dan.o)

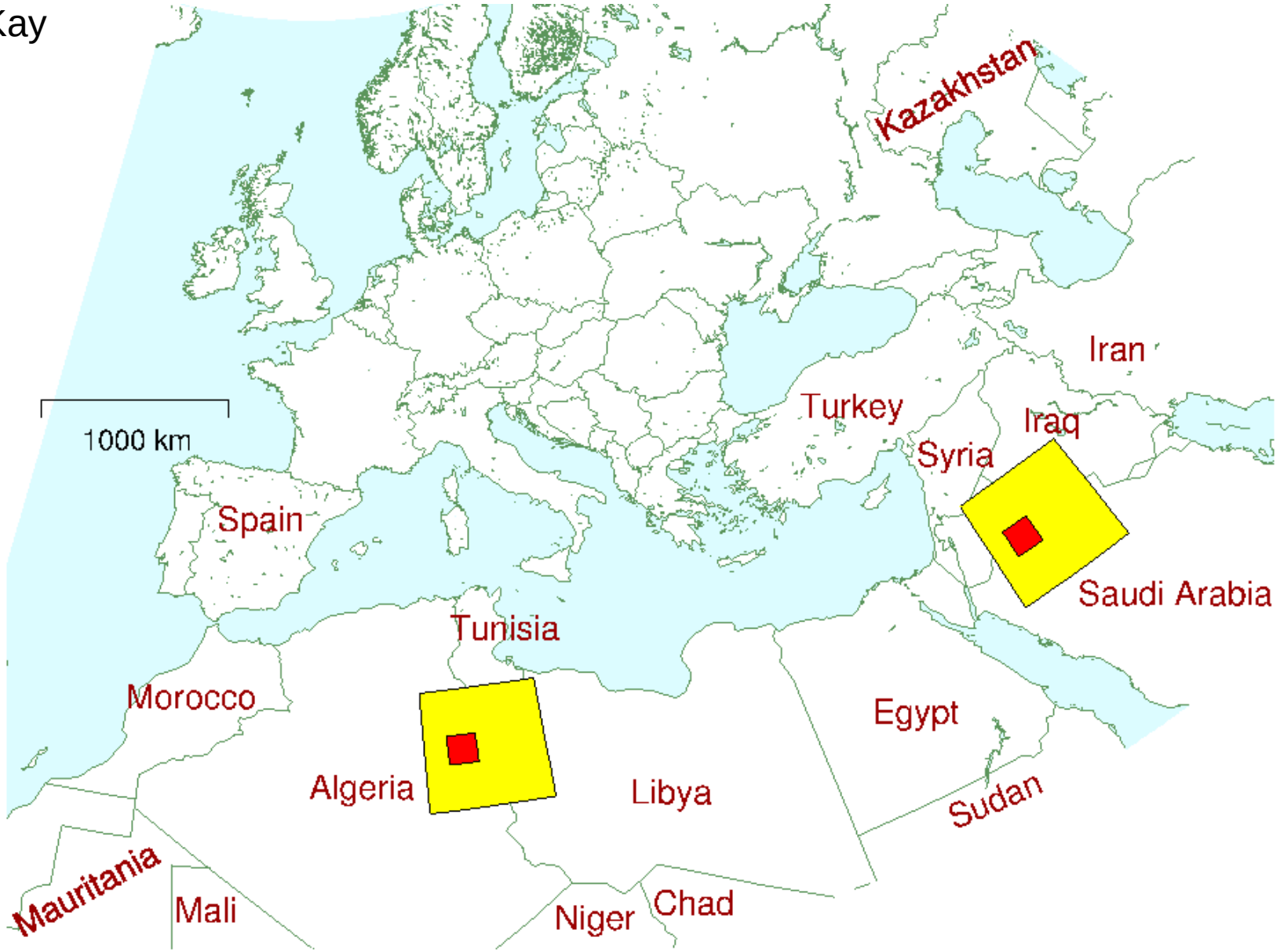
Rdeče
samo elektrika
(21 kWh/dan.o)



7. Kakšno prihodnost si želite? **8. Temno ali sončno ?**

http://stres.a.gape.org/projekti/VILI_KOVACIC/soncna_en_vili_kovacic.htm

MacKay



Yellow: 125 kWh/d/p for 1 billion people; Red: 125 kWh/d/p for 60 million people

(assuming $15\,\mathrm{W/m^2}$)

Sončna energija

delujoče elektrarne ob koncu 2011 - instalirana moč:

68 GW fotovoltaičnih elektrarn (28 GW novih v 2011)

http://www.epia.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/EPIA_docs/publications/epia/Annual_Report_2011.pdf&t=1350151521&hash=8fb08d970a4850a95a35df7808b208f3

(proizvodnja ~1/9 do 1/6 instalirane moči)

~1 GW termosolarnih

Sončni kolektorji - ogrevanje (sanitarne) vode - manj vredna energija od elektrike, MacKay za VB ocenjuje njen prispevek na 13 kWh/dan/osebo pri "Londonskem" toplotnem toku ~100 W/m^2.

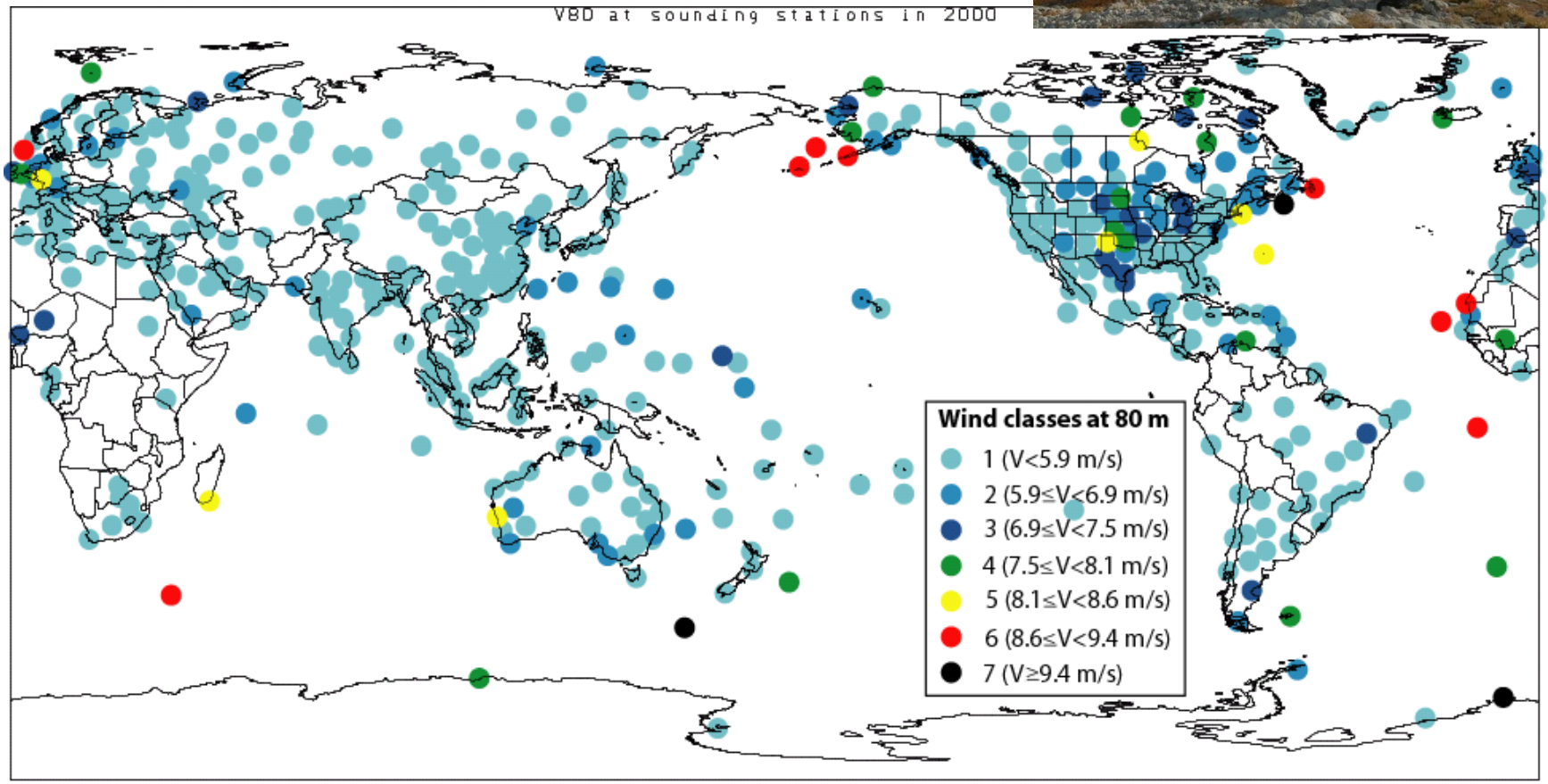
Kljub temu znaten vir energije.

V SLO ~20 W/m^2

Manzanares -sončni dimnik, Španija, 1982-1989: poskusni obrat, proizvajal P_{el} ~ 50 kW, gostota moči 0.1 W/m^2

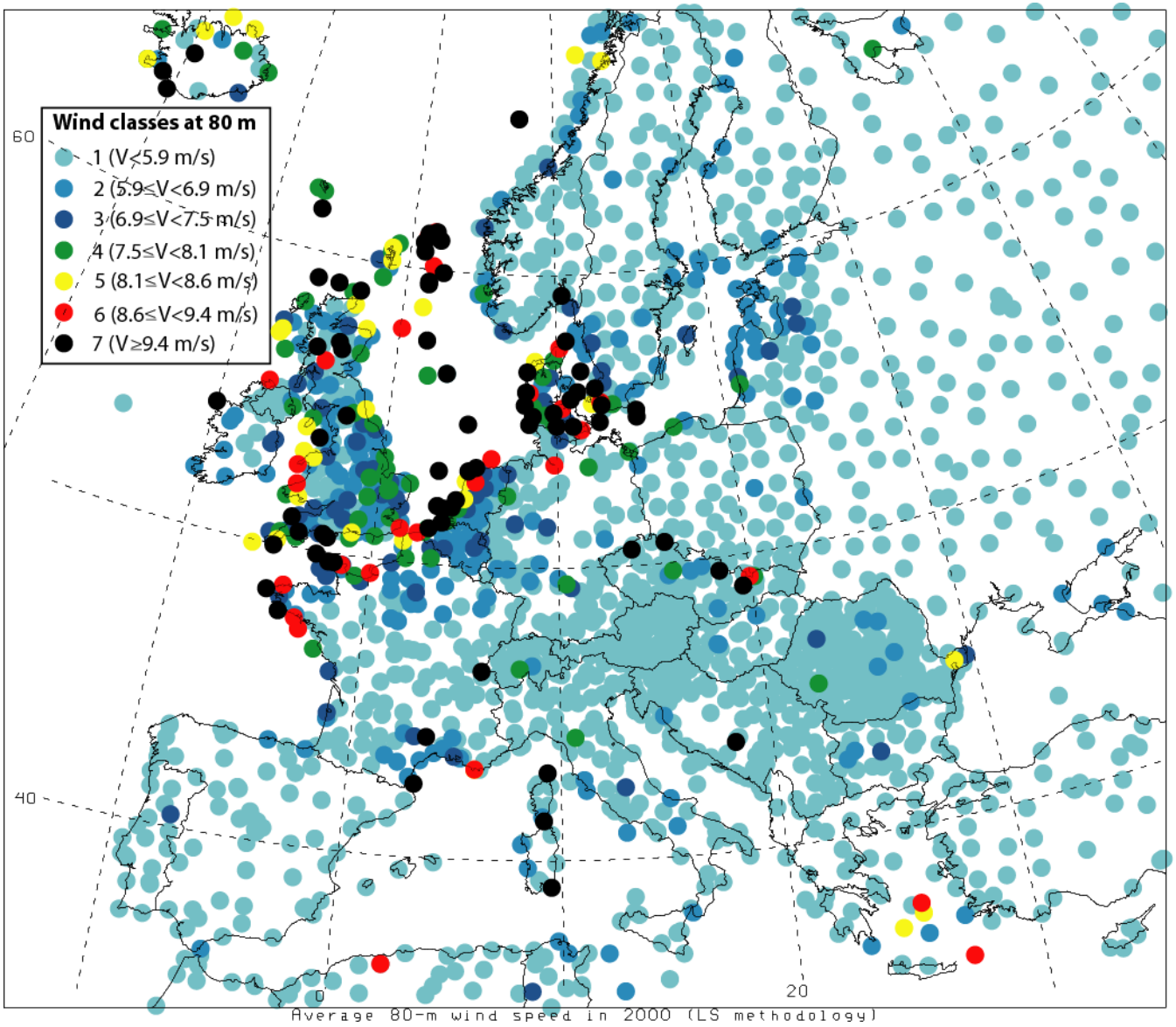
Veter

Izkoriščanje vetra za proizvodnjo elektrike se začne pri povprečnih hitrostih vetra ~6m/s (wwea)



Evaluation of global wind power C. Lozej Archer, M. Z. Jacobson (Stanford Univ.) Journal of Geophysical Research - Atmospheres in 2005

Evropa


Wind classes at 80 m
1 (V<5.9 m/s)
2 (5.9≤V<6.9 m/s)
3 (6.9≤V<7.5 m/s)
4 (7.5≤V<8.1 m/s)
5 (8.1≤V<8.6 m/s)
6 (8.6≤V<9.4 m/s)
7 (V≥9.4 m/s)
60
40
0
20
Average 80-m wind speed in 2000 (LS methodology)

Praktično uporaben svetovni vetrni potencial je ocenjen na 20 TW

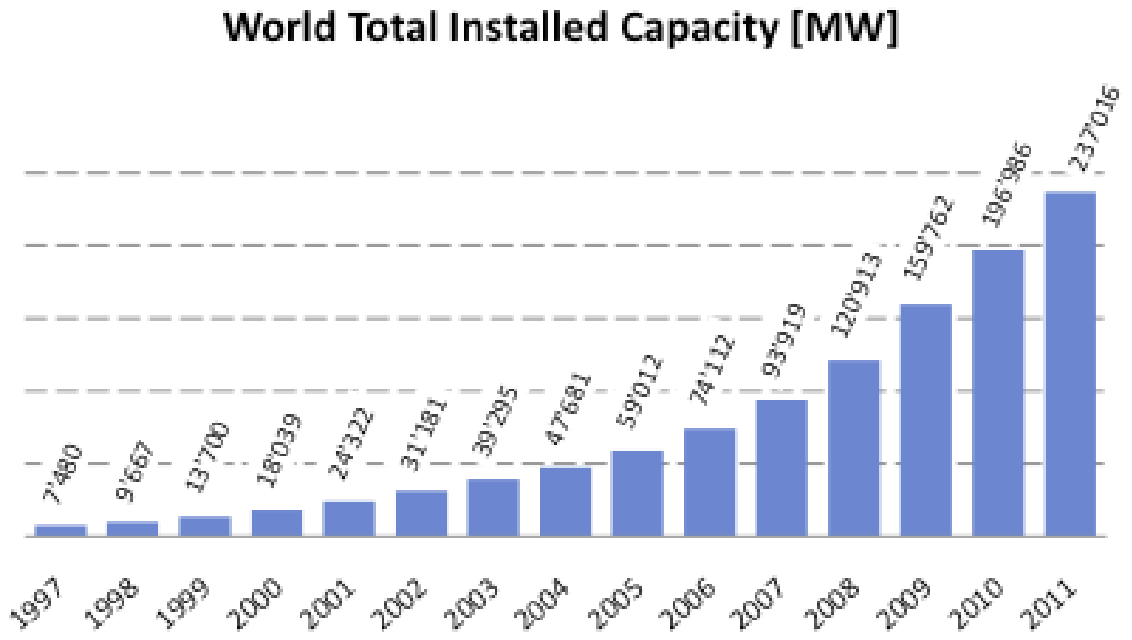
(Science. 13.Aug, 2010)

(celotna svetovna poraba vseh vrst energije 15 TW)

Pri gostoti moči 2.5 W/m^2 15 TW pomeni površino 6 Tm^2 = 6 milijonov km^2 (Evropa: 10 milijonov km^2)

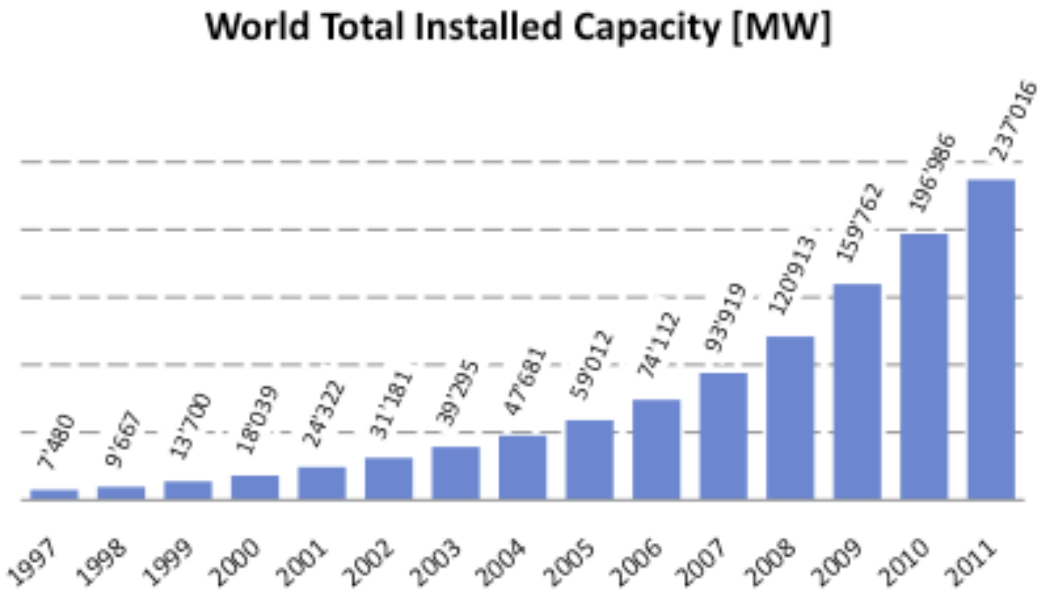
Country	Total Capacity end of 2011 [MW]	Added Capacity 2011 [MW]	Total Capacity end 2010 [MW]	Added Capacity 2010 [MW]	Total Capacity end 2009 [MW]
China *	62.733	18.000	44.733	18.928	25.810
USA	46.919	6.810	40.180	5.600	35.159
Germany	29.075	2.007	27.215	1.551	25.777
Spain	21.673	1.050	20.676	1.515	18.865
India *	15.800	2.700	13.065	1.258	11.807
Italy *	6.747	950	5.797	950	4.850
France	6.640	980	5.660	1.086	4.574
United Kingdom	6.018	730	5.203	962	4.245
Canada	5.265	1.267	4.008	690	3.319
Portugal *	4.290	588	3.702	345	3.357
Denmark	3.927	180	3.803	309	3.460
Sweden	2.816	746	2.052	603	1.450
Japan	2.501	167	2.334	251	2.083
Rest of the World*	24.200	6.000	18.201	3.191	15.010
Total*	238.604	42.175	196.629	37.642	159.766

*- Preliminary Data



WWEA

World Wind Energy Assoc



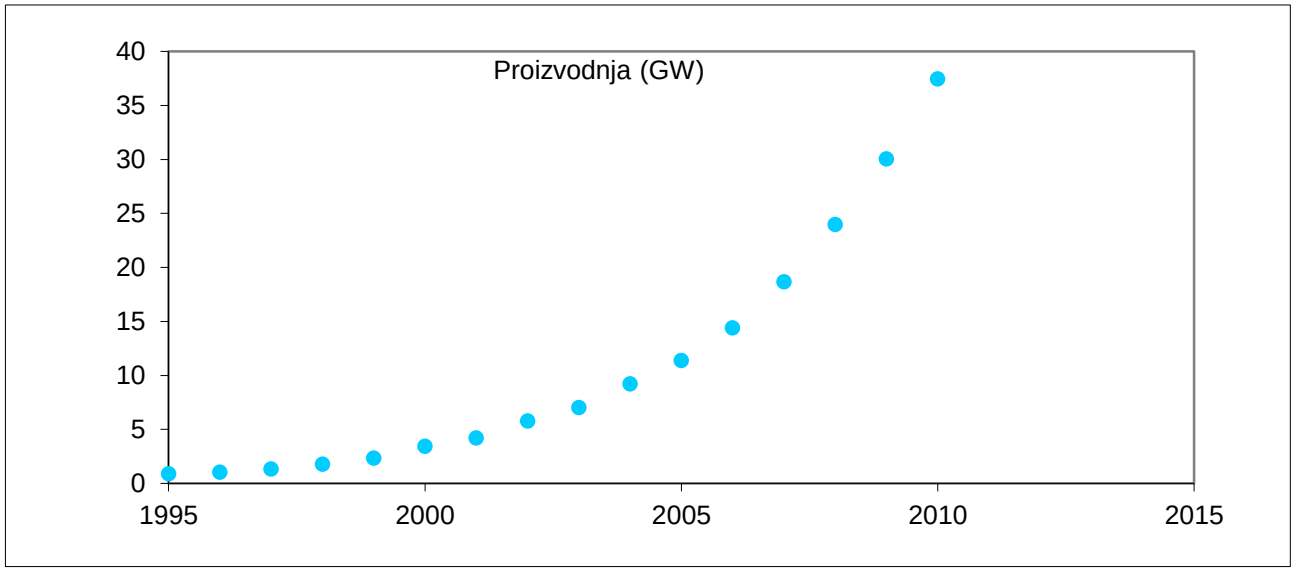
World Wind Energy Assoc

2010 (World Wind Energy Report 2010, WWEA):

instalirana moč 197 GW

povprečna proizvodnja 37 GW:

20-25 %



graf: http://www.eia.doe.gov/

Izkoriščanje virov, veter:

$$dm = \rho S v dt$$

$$dW_k = \frac{1}{2} v^2 dm$$

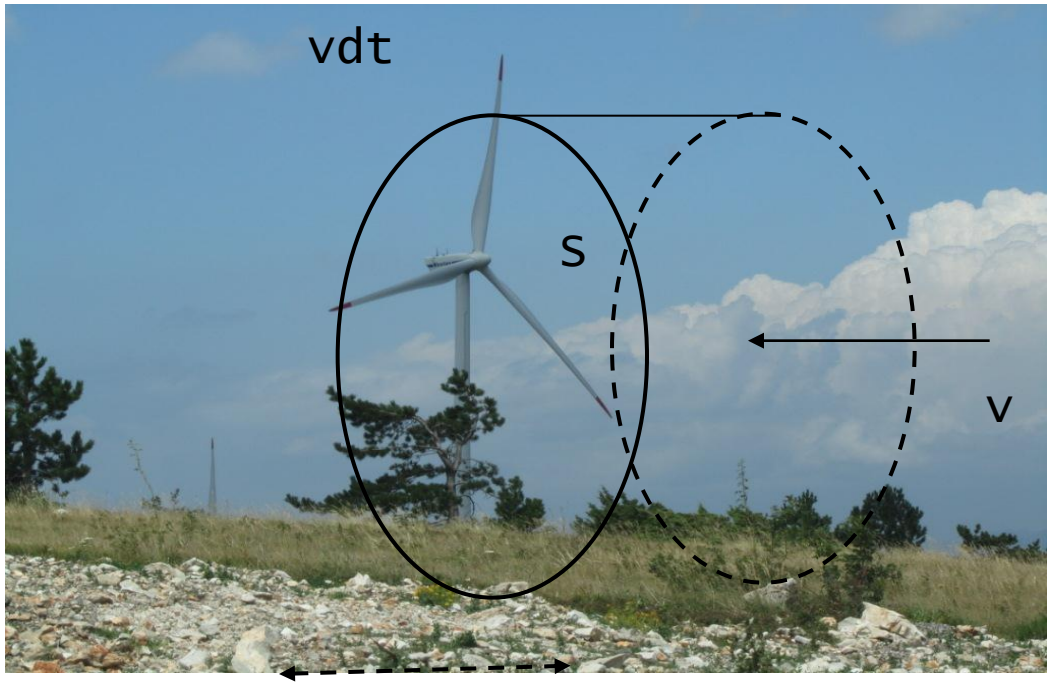
$$P = \frac{dW_k}{dt} = \frac{v^2 \rho S v dt}{2dt} = \frac{1}{2} \rho S v^3$$

moč kin. energije vetra;

$P \propto v^3$!

celotne moči ni mogoče izrabiti:

Betzova meja: $$P\max = \frac{16}{27}\left(\frac{1}{2}\rho S v^3\right)$$



Slika: Vrataruša nad Senjem 14*3 MW, Vestas turbine. Povprečna moč 25% nazivne moči v letu 2010/2011

...analiza ene same vetrnice pravzaprav ni problem...

... interakcija vetrnic ...

Horns Rev - Danska

Wake effects at Horns Rev and their influence on energy production

Martin Méchali(1)(*), Rebecca Barthelmie(2), Sten Frandsen(2), Leo Jensen(1), Pierre-Elouan Réthoré

Razdalja med vetrnicami - vsaj petkratnik premera

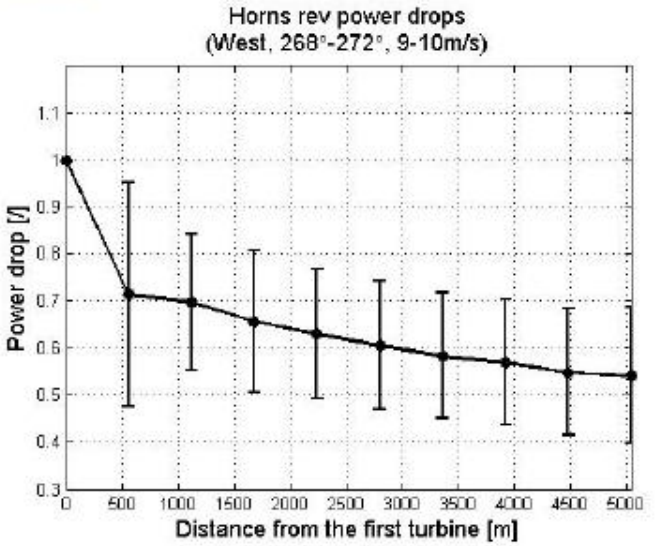
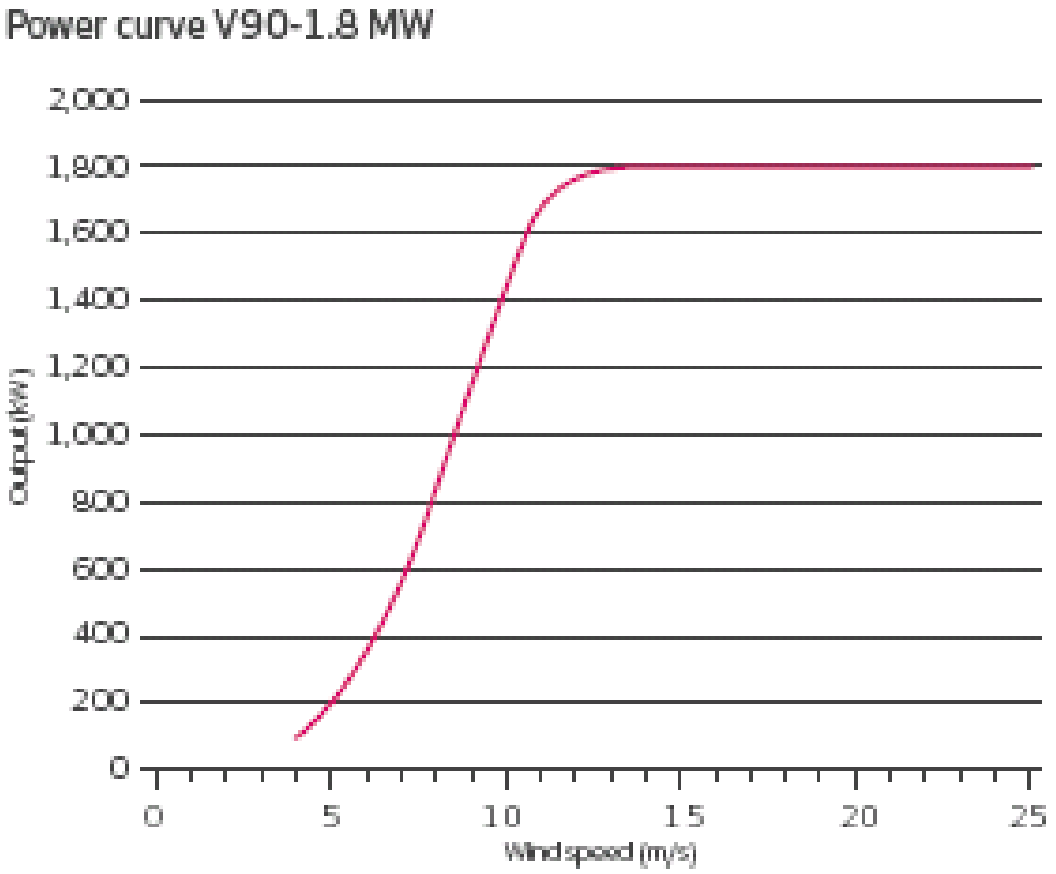


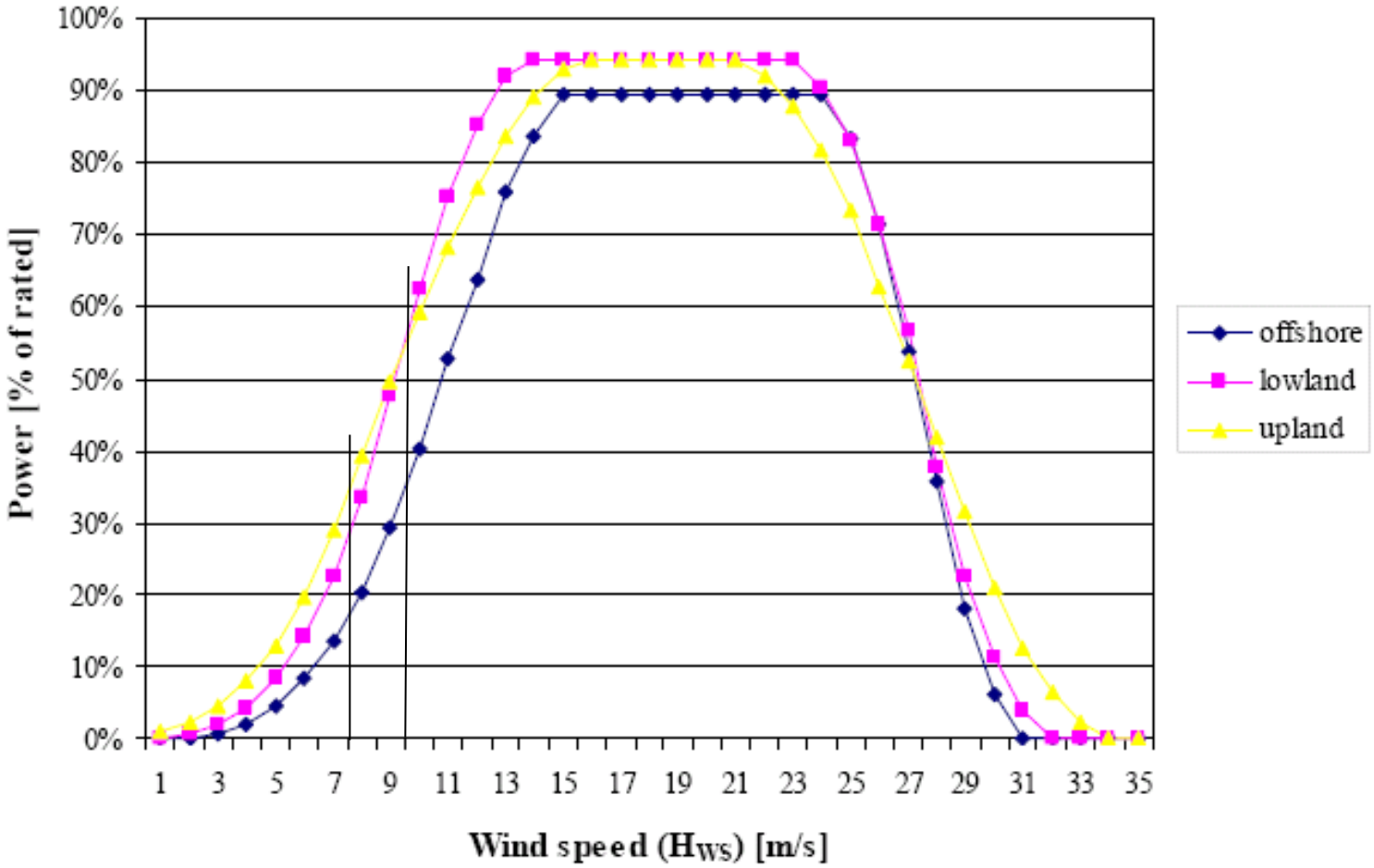
Figure 5.6 Relative power drop 9-10m/s

Vestas V90 1.8 MW/3MW (Vestas - Danska)

- > 8 m/s 103.5 dB(A) (za 1.8 MW)
- Rotor diameter 90 m
- Nominal revolutions 14.5 rpm (16.1 - 3 MW)
- Hub heights 80 m do 105 m

- 100 % moč pri vetru ~13 m/s



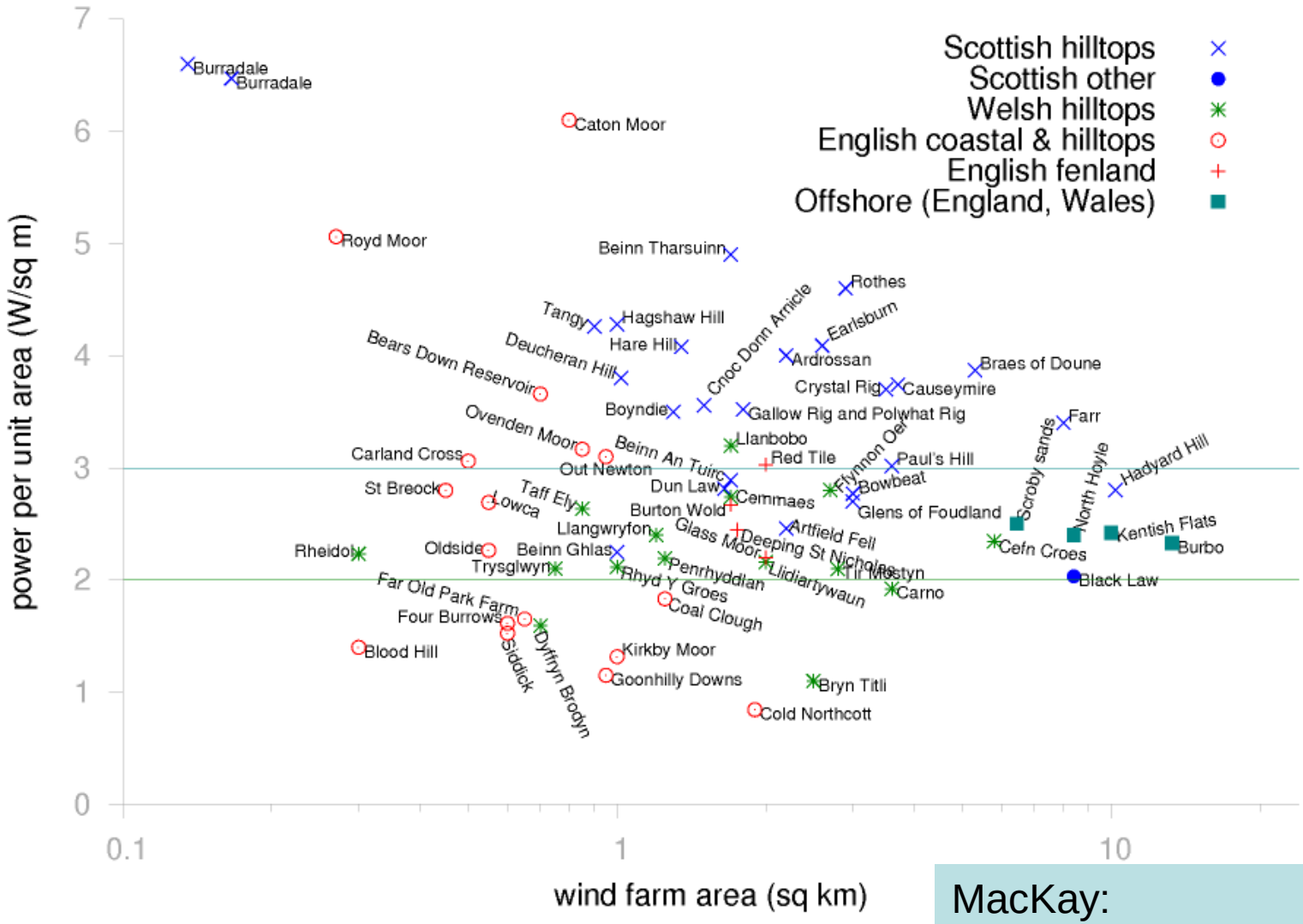


Projekcije obnašanja vetrnih turbin za 2030:

Equivalent Wind Power Curves

J R McLean, Garrad Hassan and Partners Ltd

Powers per unit area of British wind farms, v farm size



MacKay:

veter (če ga imamo): ~2.5 W/m^2

Thanet offshore wind farm (Anglija)

največja vetrna farma na svetu, odprta septembra 2010.

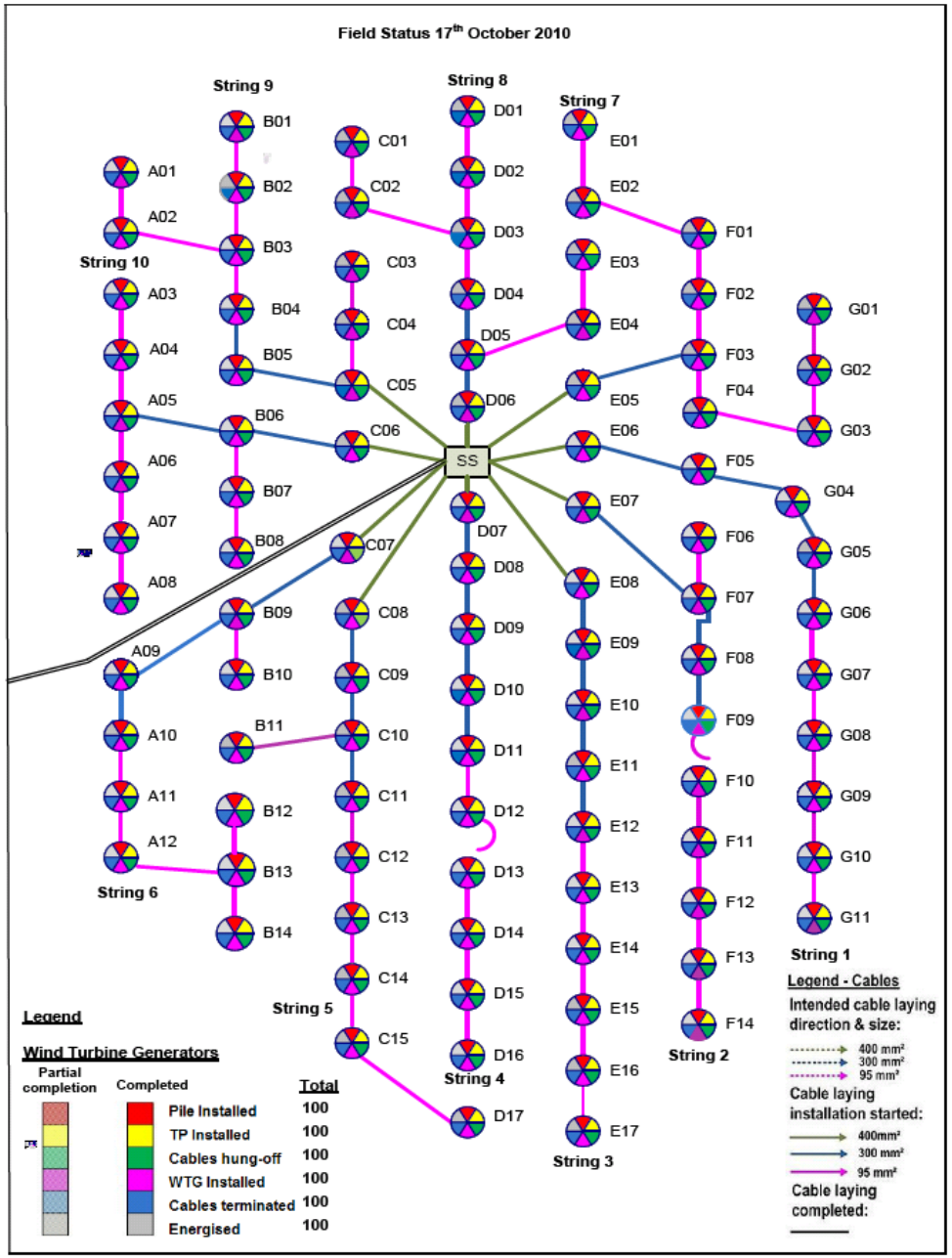
100 turbin, 35 km^2, 500 m med turbinami, 800 m med vrstami turbin

300 MW moči, napovedani output ~25-35%

(gostota moči 2-3 W/m^2)

Rated Power	3000 kW
Rotor diam.	90 m
Cut In	4 m/s
Rated	15 m/s
Cut Out	25 m/s

vir: http://www.vattenfall.co.uk/en/thanet-offshore-wind-farm.htm



Vaje - veter:

- mejna plast - razlog za višje turbine
- Betzova meja - izpeljava

SLO vetrni potencial na prvi način:

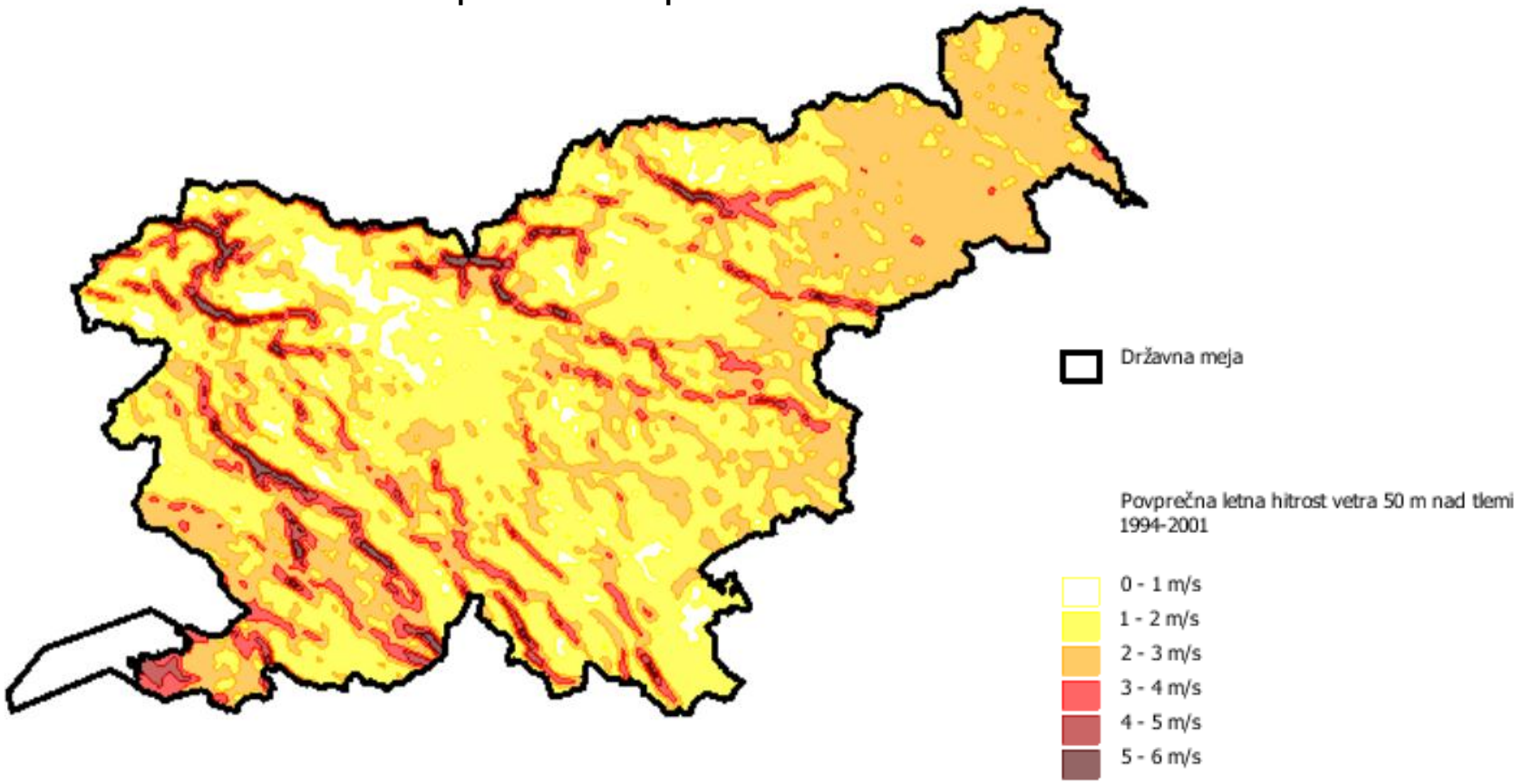
Gorski grebeni:

- Tauernwind: 13 *1.75 MW = 23 MW peak
- proizvodnja: ~40 GWh/leto=4.5 MW na 2 km grebena.
- Slovenija ~100-200 km grebenov = 250-500 MW povprečne proizvodnje (3-6 kWh/dan.o)
- Črtamo grebene v območju Natura 2000 ostane nekaj 10 MW do morda 100 MW - to pomeni 0.5-1 kWh/dan/osebo...

SLO vetrni potencial na drugi način:
Po MacKay-u: vetrne elektrarne proizvajajo 2-3 W/m^2 površine (v_{veter}>=6m/s)
Površina "z rjavo barvo" (v>5 m/s) na zemljevidu je 100-200 km^2, torej je slovenski vetrni potencial ~200-600 MW. To je 2.5-7 kWh/dan.o.

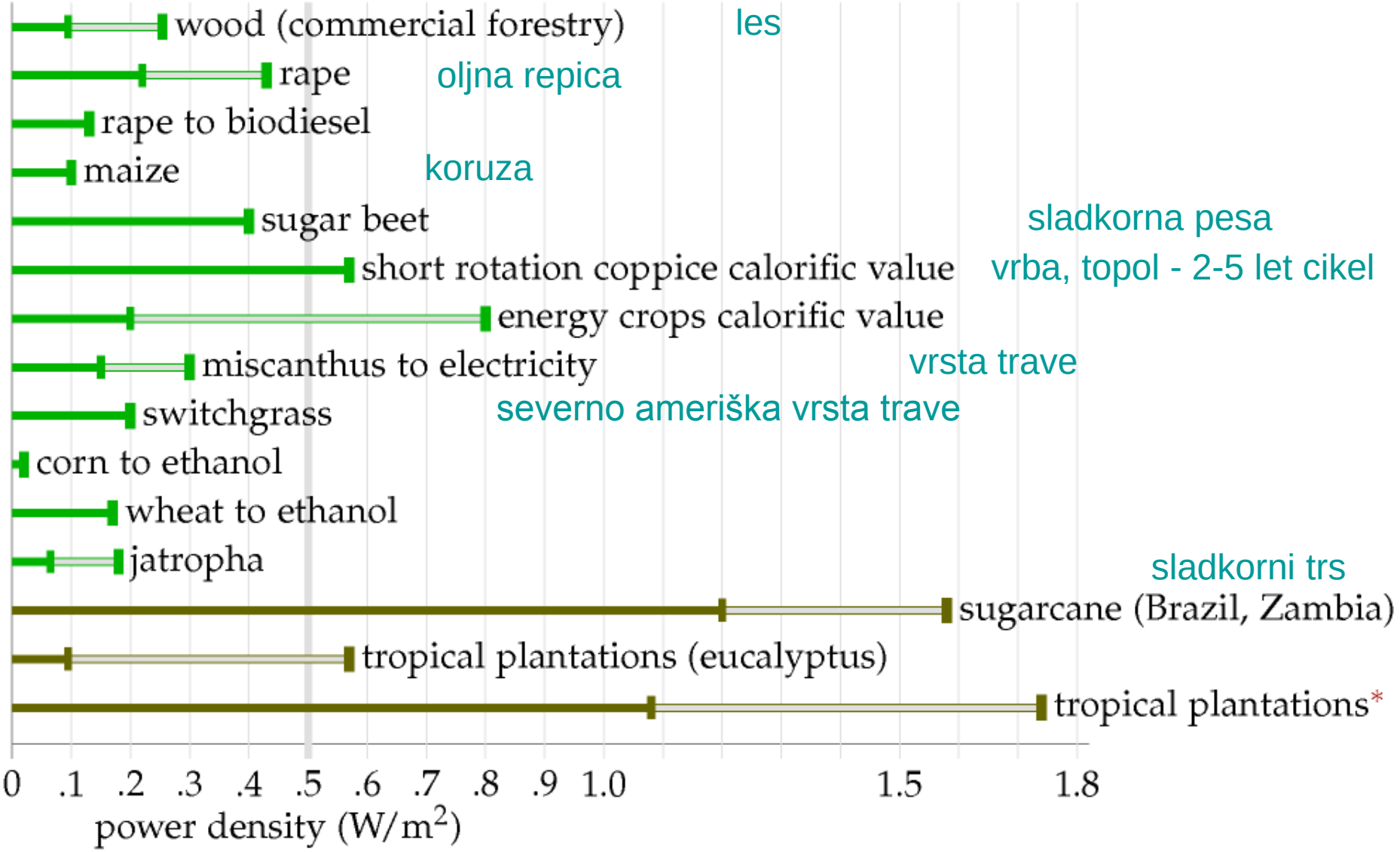
Približno enak rezultat kot pri prvi oceni.

Seminar o vetru iz 2010 - pretirano optimistična ocena : 15 kWh/dan.o



Plant power per unit area

BIOMASA MacKay



http://www.biofuelstp.eu/crops.html

* assumes genetic modification, fertilizer application, and irrigation

For sources, see D J C MacKay (2008) Sustainable Energy - without the hot air

Biomasa

Glej podrobnosti v seminaru
JTE 2010- biomasa

Slovenski gozdovi:

0.2 W/m^2 ~2 GW primarne energije pri letnem prirastku 7 Mm^3/leto in sežigni toploti 2500 kWh/m^3 in 10000 km^2 površine.

Poraba goriva za sečnjo in spravilo 1.5 litrov/m^3 = 15 kWh/m^3 (brez odvoza iz gozda)

Ustni vir - skupaj ~6 litrov/m^3 = 60 kWh/m^3

je ~25 kWh/dan/osebo
(ce sežgemo ves les!!!)

Realno - posekamo le pol prirastka, sežgemo pol posekanega.

Les danes ~5 kWh/d.o, (toplote)

potencial:
10 kWh/dan/osebo

biomasa

Bioplin:
iz komunalnih deponij odpadkov:
0.5 ton odpadkov/leto/predivalca Slovenije, ~100 (20-800) m^3 plina iz tone odpadkov - 5 kWh/m^3 (CO_2 + metan). = 1 kWh/dan/osebo
(v praksi: deluje LJ, MB, CE 0.1 kWh/dan/preb)
(http://www.electrigaz.com/faq_en.htm in
w*ww.energap.si/uploads/dep_%20**plin**.pdf*)

iz živalskih odpadkov: 1 krava (bik) ~0.4m^3 plina/dan, 70% metan ~5kWh/m^3 (po World Cow Resource Center) Slovenija 500000 glav govedi (stat. letopis). Je 0.5 kWh/dan/osebo (če zberemo VSE odpadke!!) (prašiči 500000, perutnina...)

iz čistilnih naprav kanalizacije: podatek za govedo/10 (zaradi mase) * 4 (Zaradi števila) =0.2 kWh/dan/osebo (če zberemo VSE odpadke!!!)

iz ostankov poljščin:

žita, koruza 700000 ton/leto pridelanih na ~130 km^2 - suho brez zrnja ~10% 4000 kWh/tono = ~0.5 kWh/dan/osebo (statistični letopis)

(10% mase upoštevam, ker večino pojedo domače živali in ljudje)

biomasa

Biodizel

oljna ogrščica:

2008: 4442 ha in 10949 ton pridelka (statistični letopis 2009, pogl. 16.8)

1000 litrov/ha/leto = 0.1 l/m^2/leto~ 0.1 W/m^2
(http://www.energap.si/uploads/biodizel_ok.pdf)

Bioetanol

sladkorna pesa:

2006: Slovenija .. 6684 ha in 262031 ton pridelka (v 2008 ni pridelka, stat. letopis 2009, 16.8)

= 4 kg sladkorne pese/m^2/leto =0.33kg etanola/m^2/leto
= 10 MJ/m^2/leto = **0.3 W/m^2**

Podatki:

Tovarna Wissington VB: 55,000 ton bioetanola/leto iz 650,000 ton sladkorne pese.
(http://www.britishsugar.co.uk/RVE29c095ba629149d391ce49792e8ab37b,,.aspx) Metanol 29.7 MJ/kg

Težava: Poraba energije pri proizvodnji ~30-50% končne energije goriva !

01/12/2011

WASHINGTON – The U.S. Environmental Protection Agency (EPA) is announcing its plan to defer, for three years, greenhouse gas (GHG) permitting requirements for carbon dioxide (CO_2) emissions from biomass-fired and other biogenic sources. The agency intends to use this time to seek further independent scientific analysis of this complex issue and then to develop a rulemaking on how these emissions should be treated in determining whether a Clean Air Act permit is required.

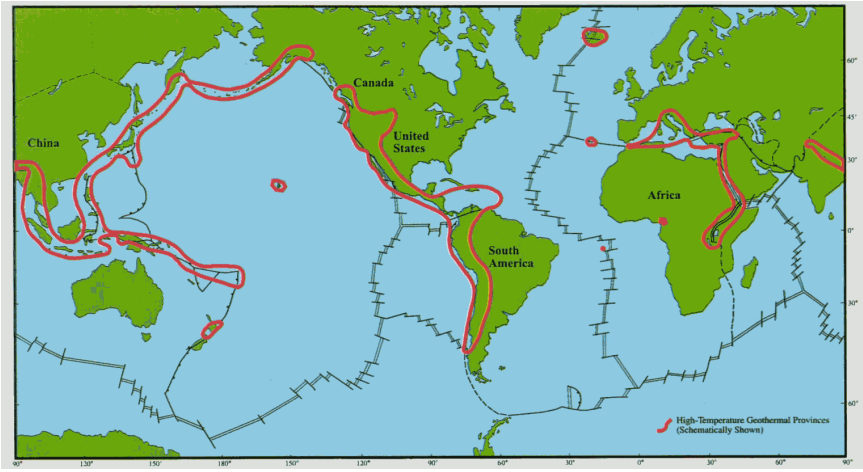
.....

EPA will also further consider the more than 7,000 comments it received from its July 2010 Call for Information, including comments noting that burning certain types of biomass may emit the same amount of CO_2 emissions that would be emitted if they were not burned as fuel, while others may result in a net increase in CO_2 emissions. Before the end of the three-year period, the agency intends to issue a second rulemaking that determines how these emissions should be treated or counted under GHG permitting requirements.

Geotermalna energija: svetovna proizvodnja 0.01 TW elektrike in 0.03 TW toplote

toplotna energija Zemlje, ki se sprošča ob razpadih radioaktivnih izotopov v zemeljski notranjosti

večina “nahajališč” na področjih močne tektonske aktivnosti



področja z ekonomsko smiselnim izkoriščanjem podzemne vode T>200ºC

vir: World Energy Council, http://www.worldenergy.org/wec-geis/publications/reports/ser/overview.asp

Potencial:

zemeljski konduktivni toplotni tok 0.1 W/m^2 v smeri površja.

Napovedi: 0.035 do 2 TW elektrike - odvisno od globine vrtin.

(0.035 TW = 0.1 kWh/dan/prebivalca)

(2 TW = 7 kWh/dan/prebivalca Zemlje)

~ 2 TW toplote

http://www.geothermal-energy.org

Geotermalna energija

Svetovna proizvodnja:

11 GW inštalirana električna moč, 67 TWh/leto (70% inštalirane moči)

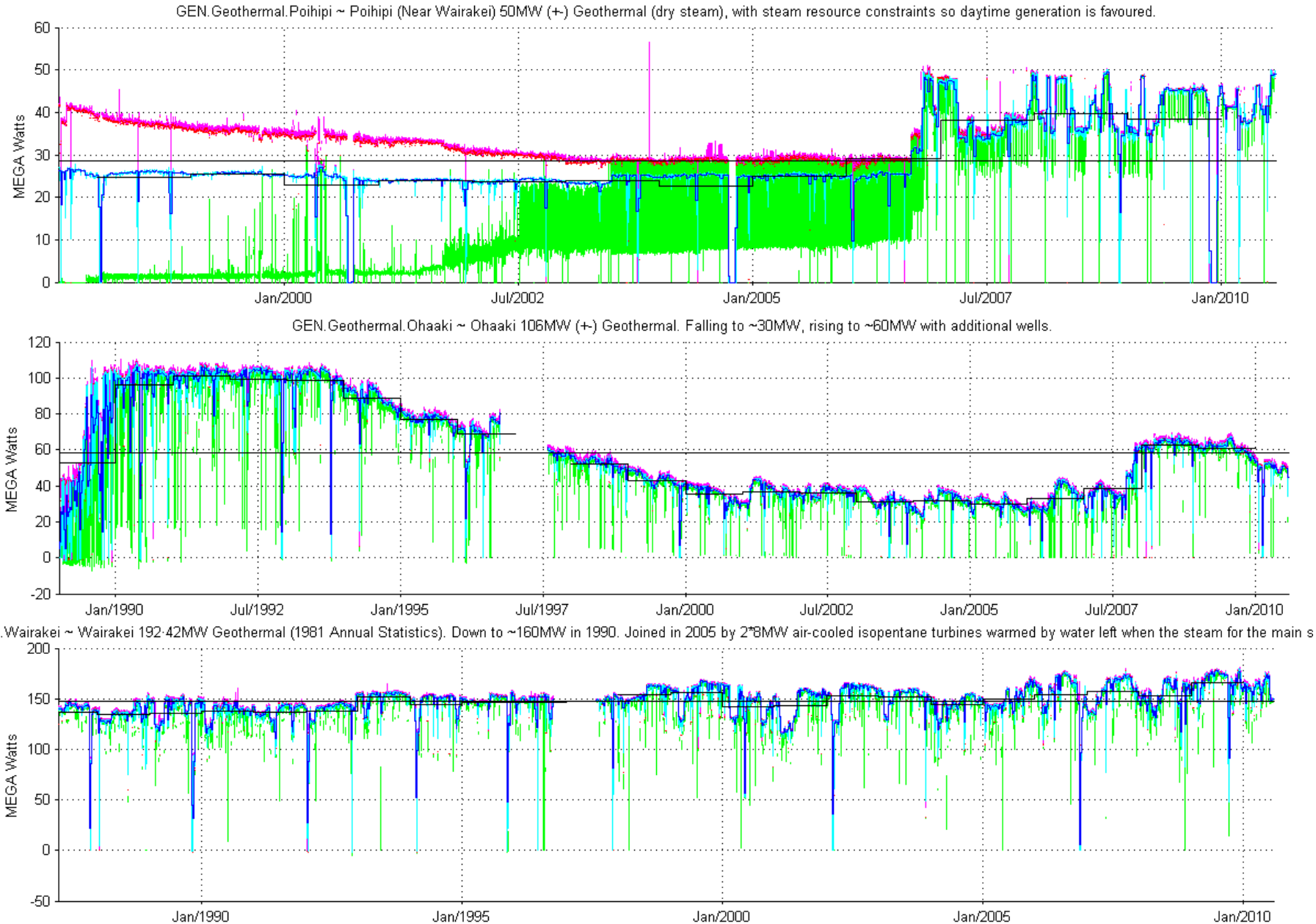
28 GW toplote

Pamukkale

Country	Electric Capacity (MW)
USA	2687
Philippines	1969.7
Indonesia	992
Mexico	953
Italy	810.5
Japan	535.2
New Zealand	471.6
Iceland	421.2

Geotermalna energija - obnovljiv vir? DA in NE - mogoča je lokalna "izraba".

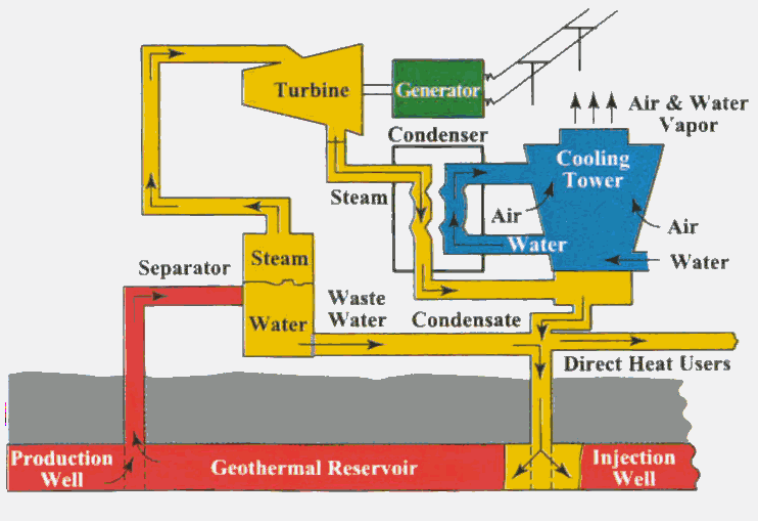
Proizvodnja treh geotermalnih elektrarn na Novi Zelandiji.



Geotermalna energija

načini izkoriščanja

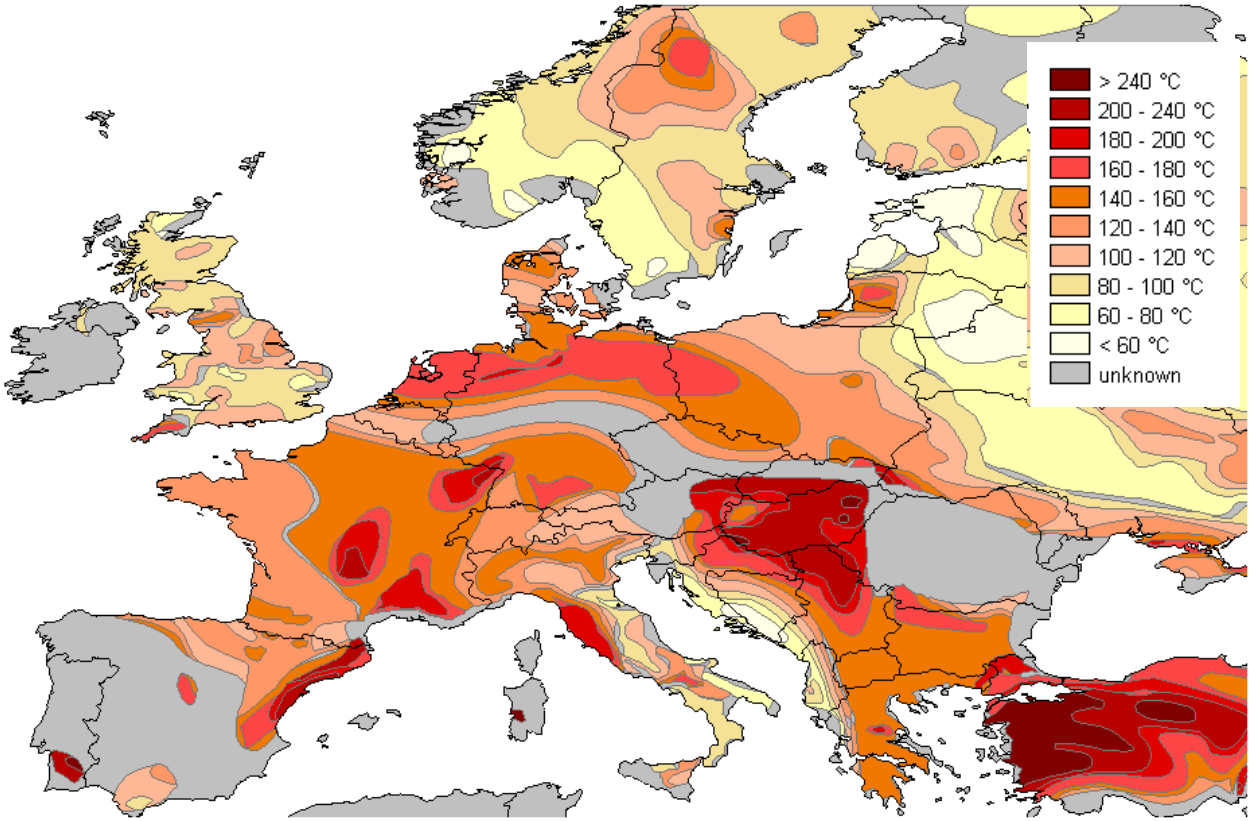
- hidrotermalni sistemi; neposredna izraba tople vode, ki prejme toploto od kamnin
- geotermalne toplotne črpalke; neposredno izkoriščanje toplote
- HDR (hot dry rock) sistemi; drobljenje segretih kamnin in umetni tok vode preko le-teh



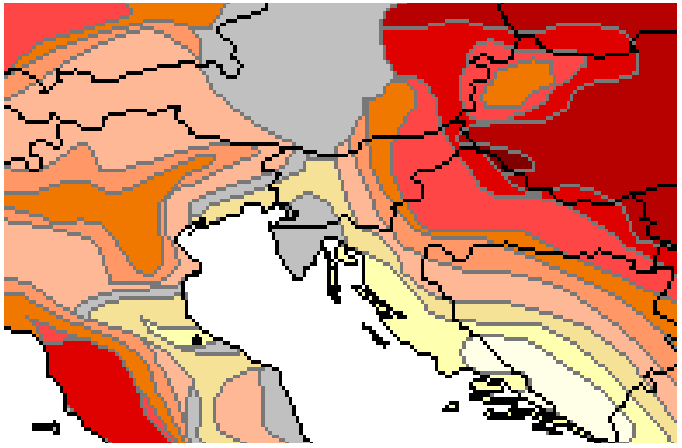
shema tipične geotermalne elektrarne, ki izkorišča podzemno vodo temp. >150ºC; 0.1 – 150 MW

vir: World Energy Council, http://www.worldenergy.org/wec-geis/publications/reports/ser/overview.asp

Slovenija



Terme Ptuj



EU-MENA report:

Figure 3-8: Temperature at 5000 m Depth for Hot Dry Rock Geothermal Power Technology /BESTEC 2004/

Slovenija

teoretično:

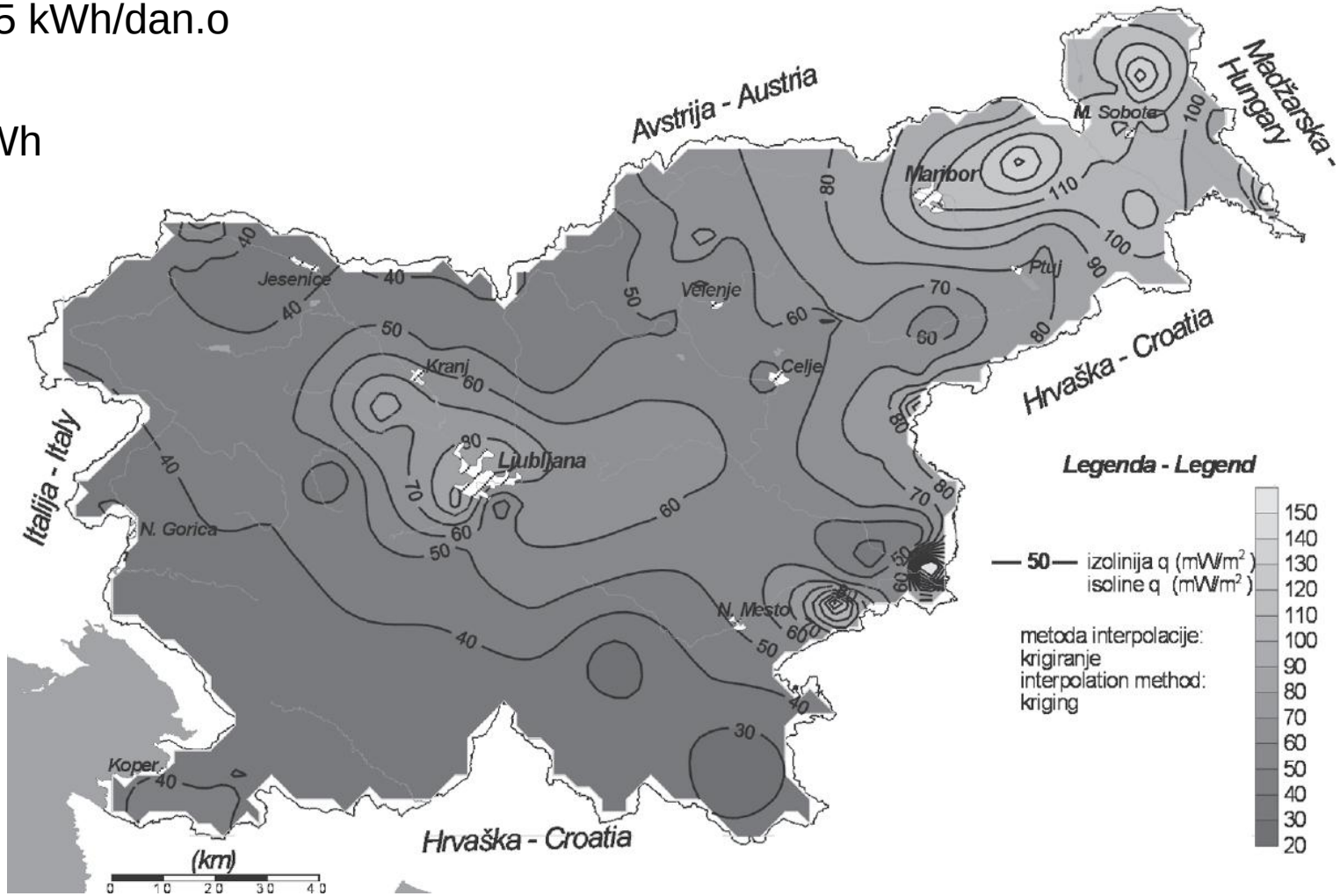
0.1 W/m^2 ~ 25 kWh/dan.o

realno

med 0 in 1 kWh

Rajver, Ravnik, **Geotermična slika Slovenije-....** GEOLOGIJA *45/2,* 519–524, Ljubljana 2002

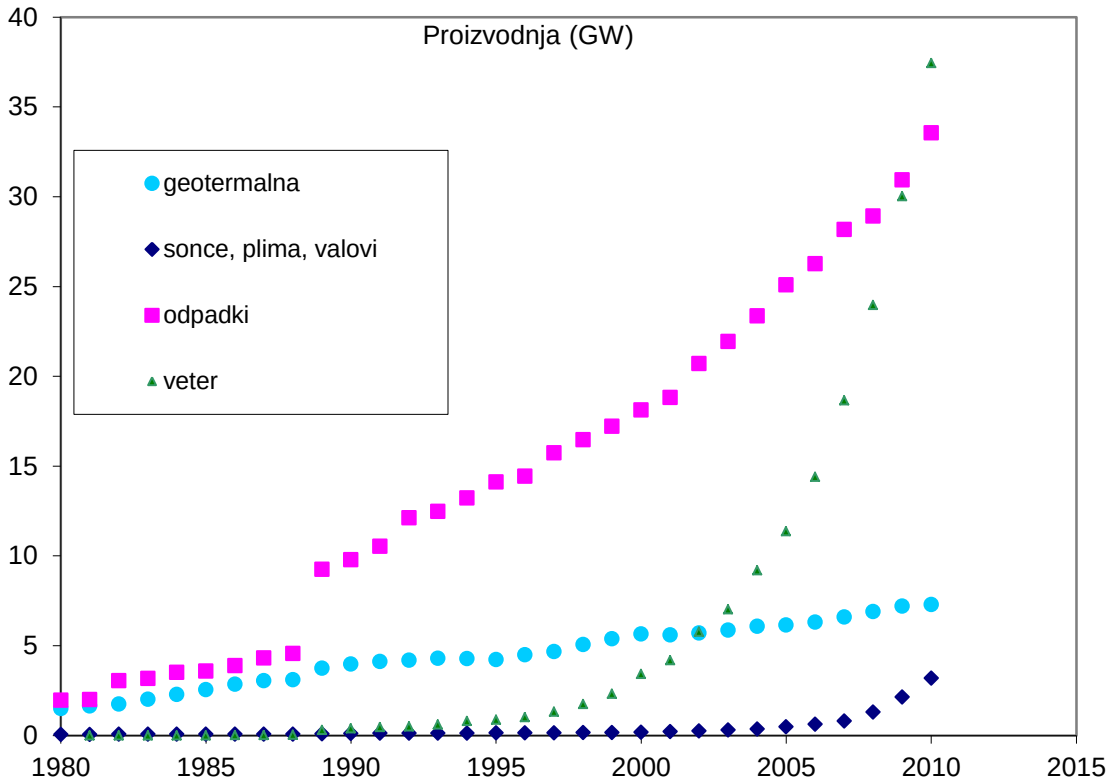
Glej še seminar JTE 2010: sonce-geotermalna energija



površinska gostota toplotnega toka mW/m^2

planet - elektrika iz obnovljivih virov

eia.doe.gov



2007:

Premog ~4 TW topl.

Nafta 5.5 TW topl.

Plin ~4 TW topl.

Fosilna elektrika ~1.5 TW

Hidro ~0.35 TW

Jedrska ~0.3 TW

sonce, plima, valovi 2010

~3 GW

planet – Sprememba 2009-2010

eia.doe.gov

Premog	+300 topl.
Nafta	+170 topl.
Plin	+210 topl.
Fosilna elektrika	+80
Hidro	~0
Jedrska	~0
Veter	+7
Sonce	+1
Odpadki, biomasa	+2

Spremembe povprečne moči v GW

Energija v Sloveniji 2008 (statistični letopis 2008)

Oskrba z energijo

122 kWh/osebo/dan