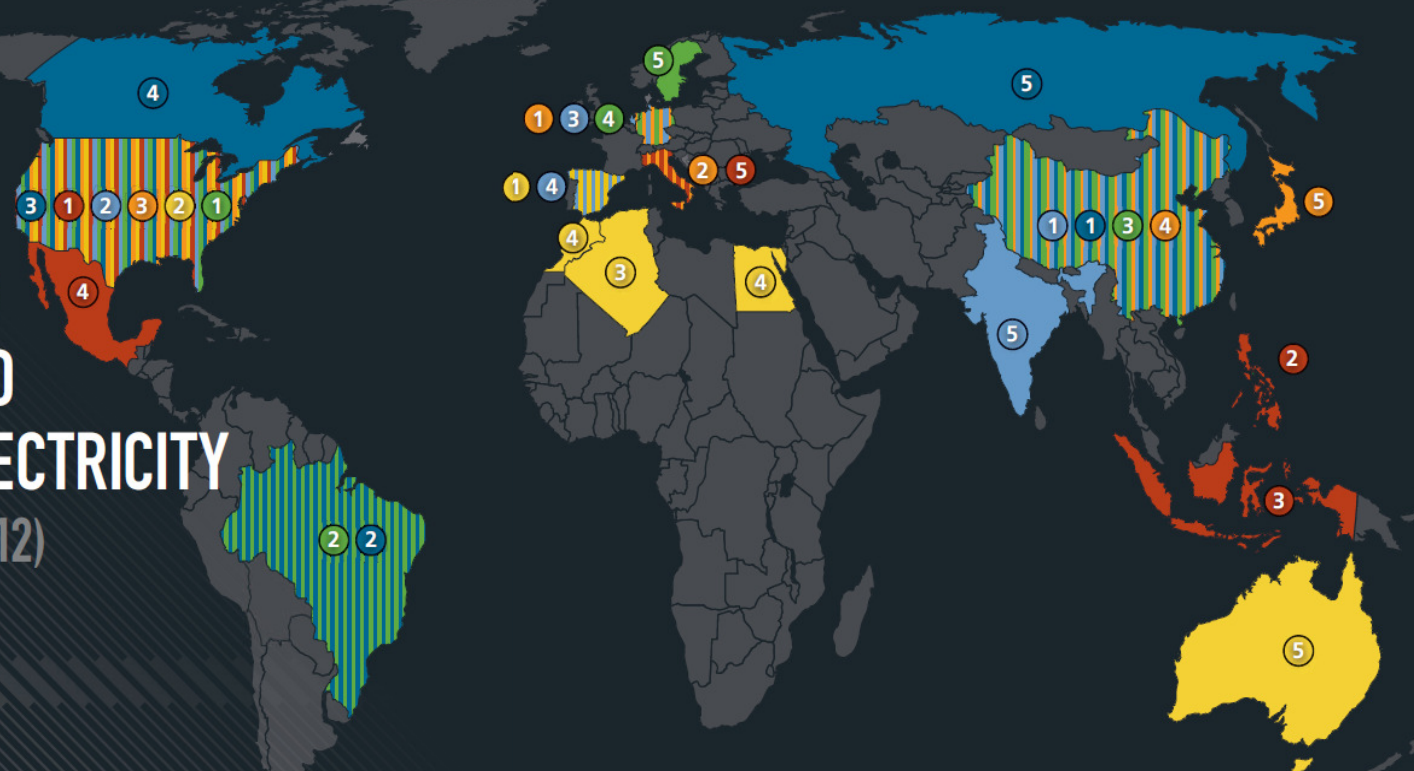




Tuuleenergeetika

Jaak Tuksam
TTÜ
Tallinn 2015

TOP COUNTRIES WITH INSTALLED RENEWABLE ELECTRICITY BY TECHNOLOGY (2012)



Hydropower
1 China
2 Brazil
3 United States
4 Canada
5 Russia

Solar PV (Grid-tied)
1 Germany
2 Italy
3 United States
4 China
5 Japan

CSP
1 Spain
2 United States
3 Algeria
4 Egypt/Morocco
5 Australia

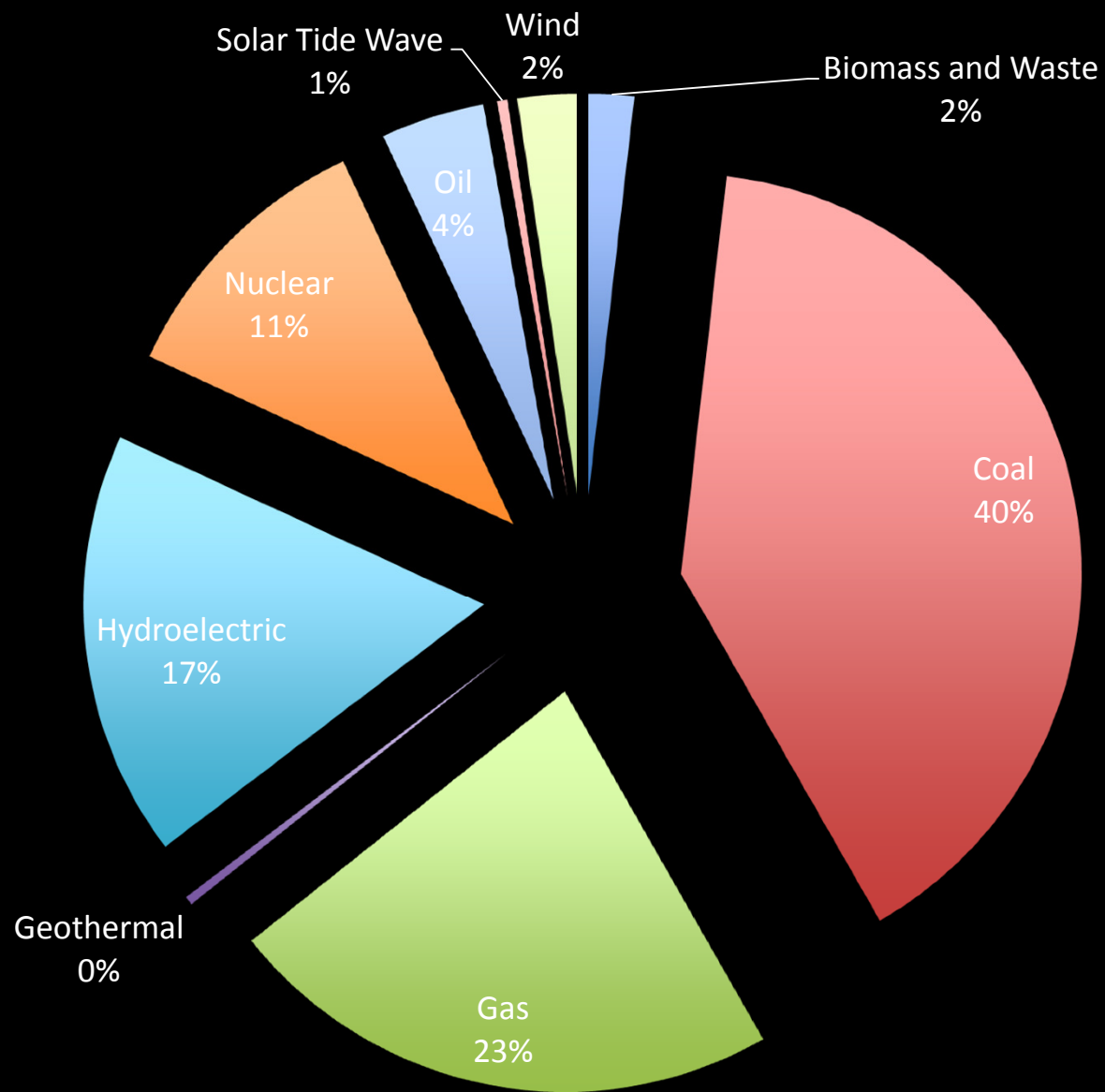
Geothermal
1 United States
2 Philippines
3 Indonesia
4 Mexico
5 Italy

Wind
1 China
2 United States
3 Germany
4 Spain
5 India

Biomass
1 United States
2 Brazil
3 China
4 Germany
5 Sweden

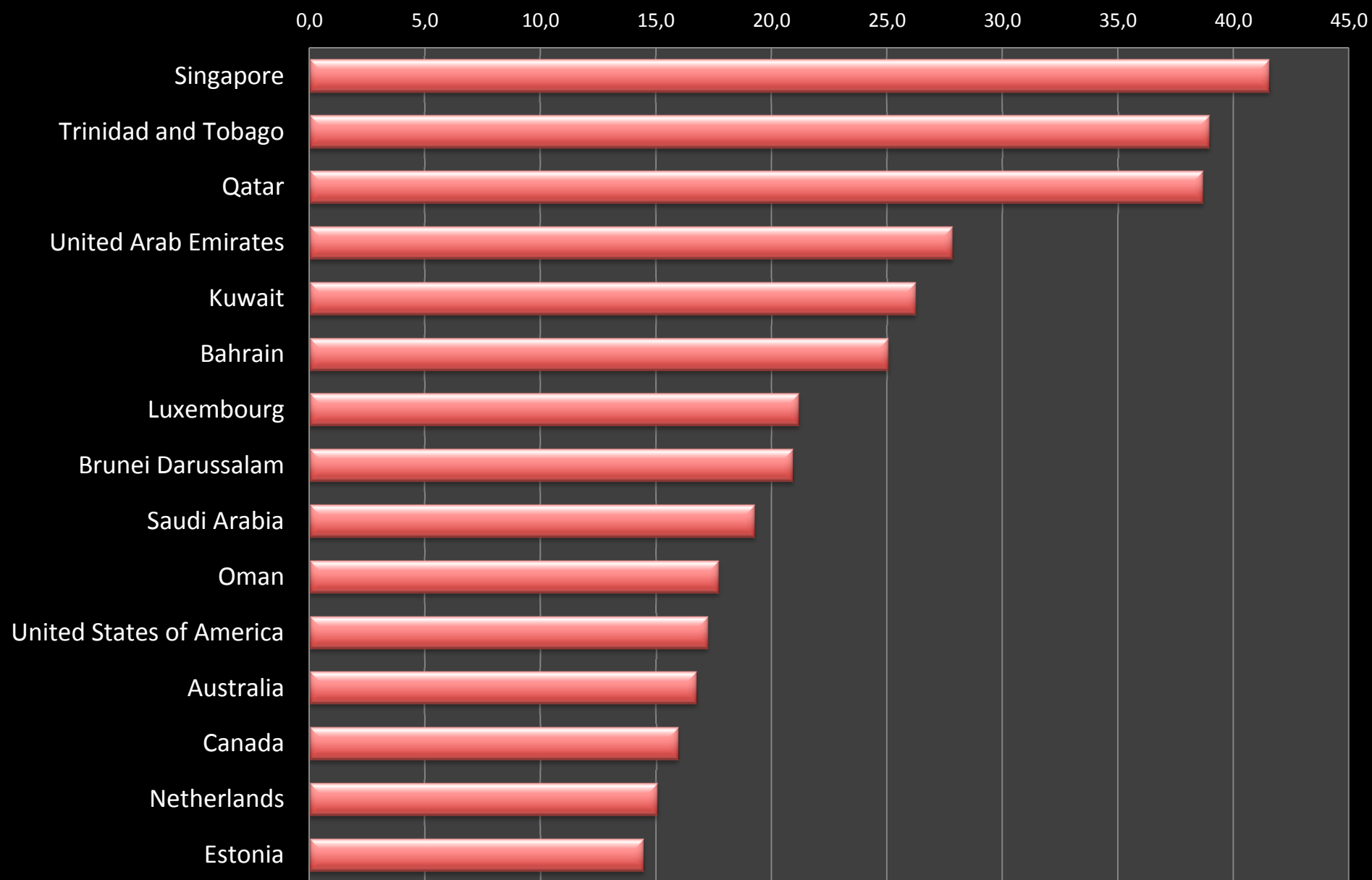
SOURCES: EIA, REN21

Maailma elektrienergia tootmine primaarenergia ressursside lõikes 2012



Allikas tsp-data-portal.org

Kõrgeima CO2 heitmega riigid per capita 2013



■ Countries with highest CO2 emissions per capita

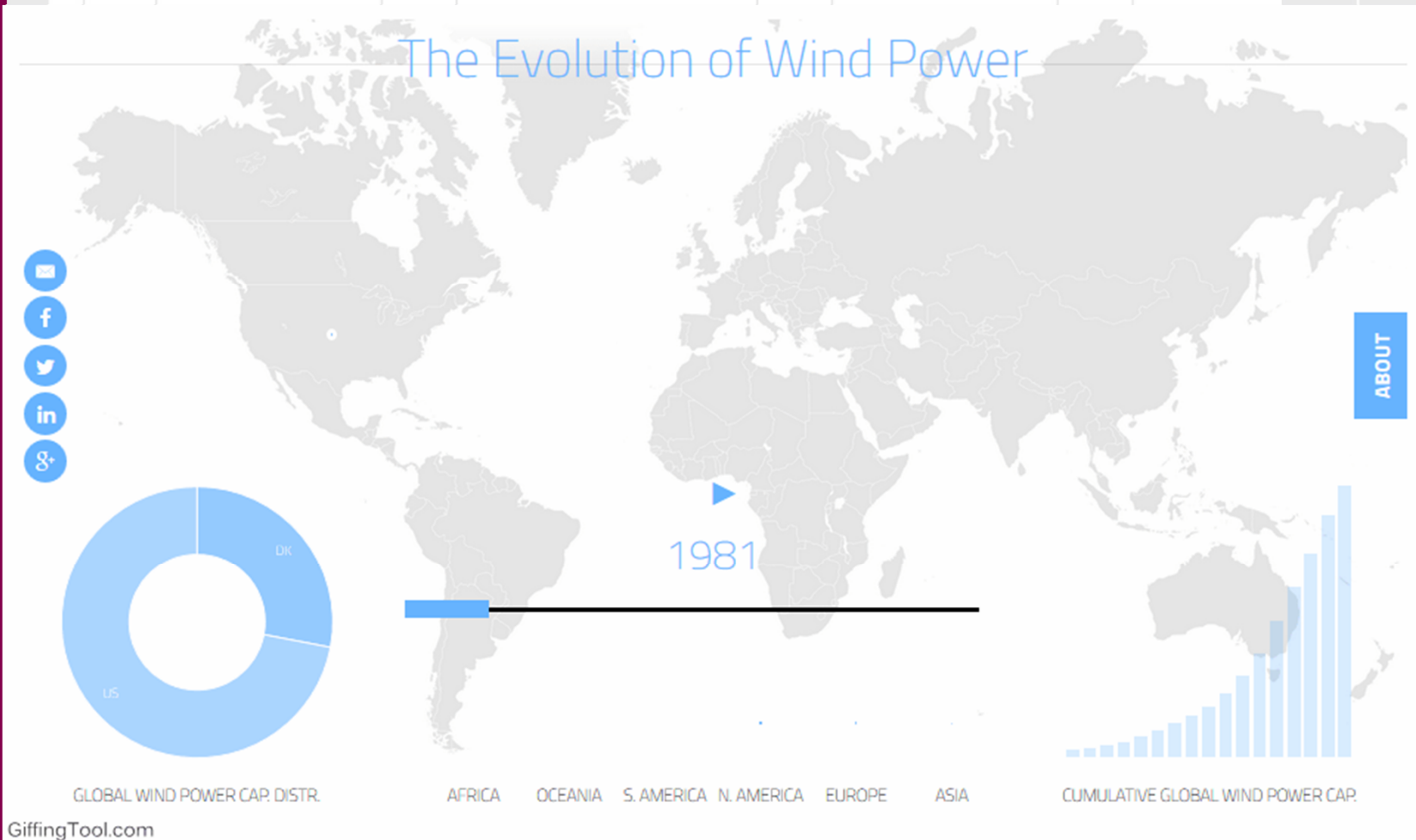


Tuuleenergeetika





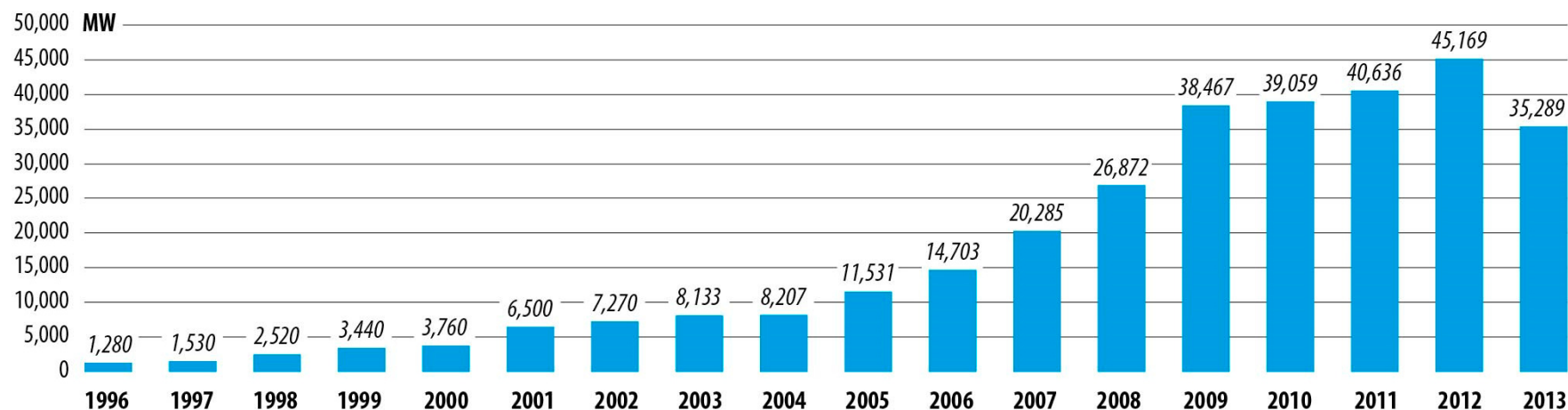
Tuuleenergia areng maailmas





Tuuleenergia tootmisvõimsused maailmas

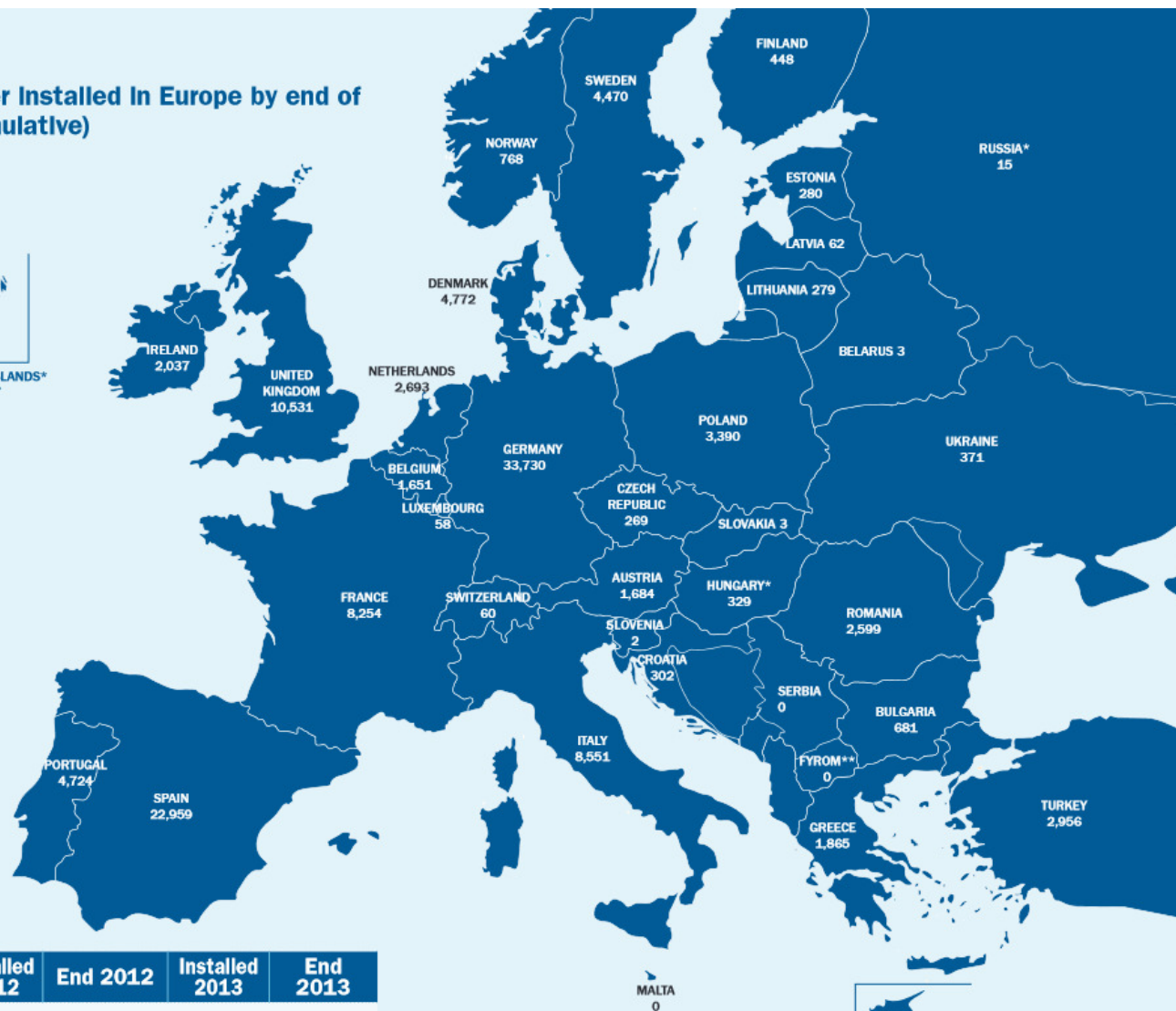
GLOBAL ANNUAL INSTALLED WIND CAPACITY 1996-2013



Allikas: Global Wind Energy Council <http://gwec.net/>



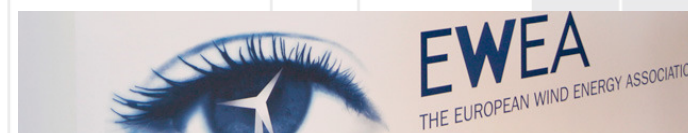
Wind power Installed In Europe by end of 2013 (cumulative)



	Installed 2012	End 2012	Installed 2013	End 2013
Capacity (MW)				
ria	296	1,377	308	1,684
ium	297	1,375	276	1,651
aria	158	674	7.1	681
itia	48	180	122	302
us	13	147	0	147

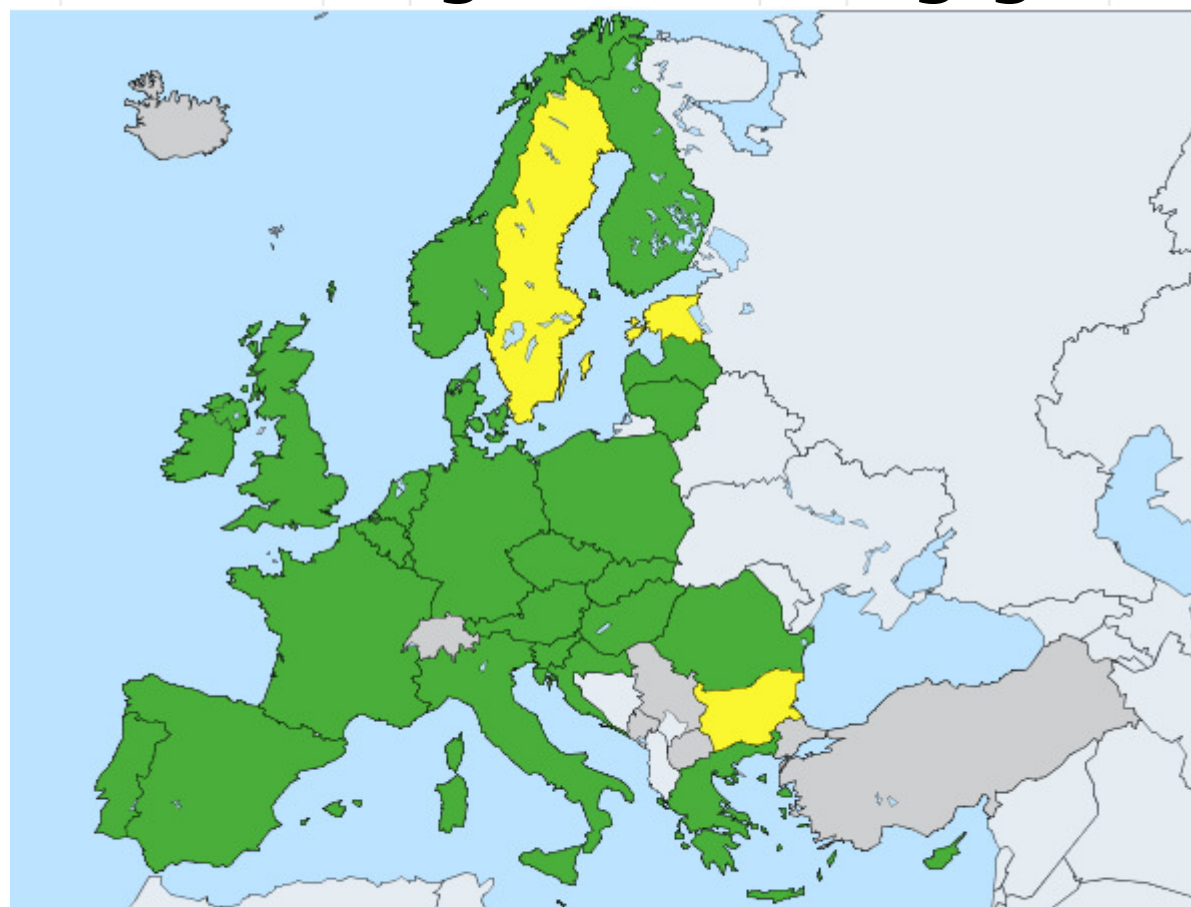
European Union: 117,289 MW
 Candidate Countries: 2,956 MW
 EFTA: 830 MW
 Total Europe: 121,474 MW

www.ewea.org





Taastuvenergia osakaal kogu energiatarbimisest võrrelduna riigi taastuvenergia eesmärgiga



Legend

0.27 - 0.9999

0.9999 - 1.0001

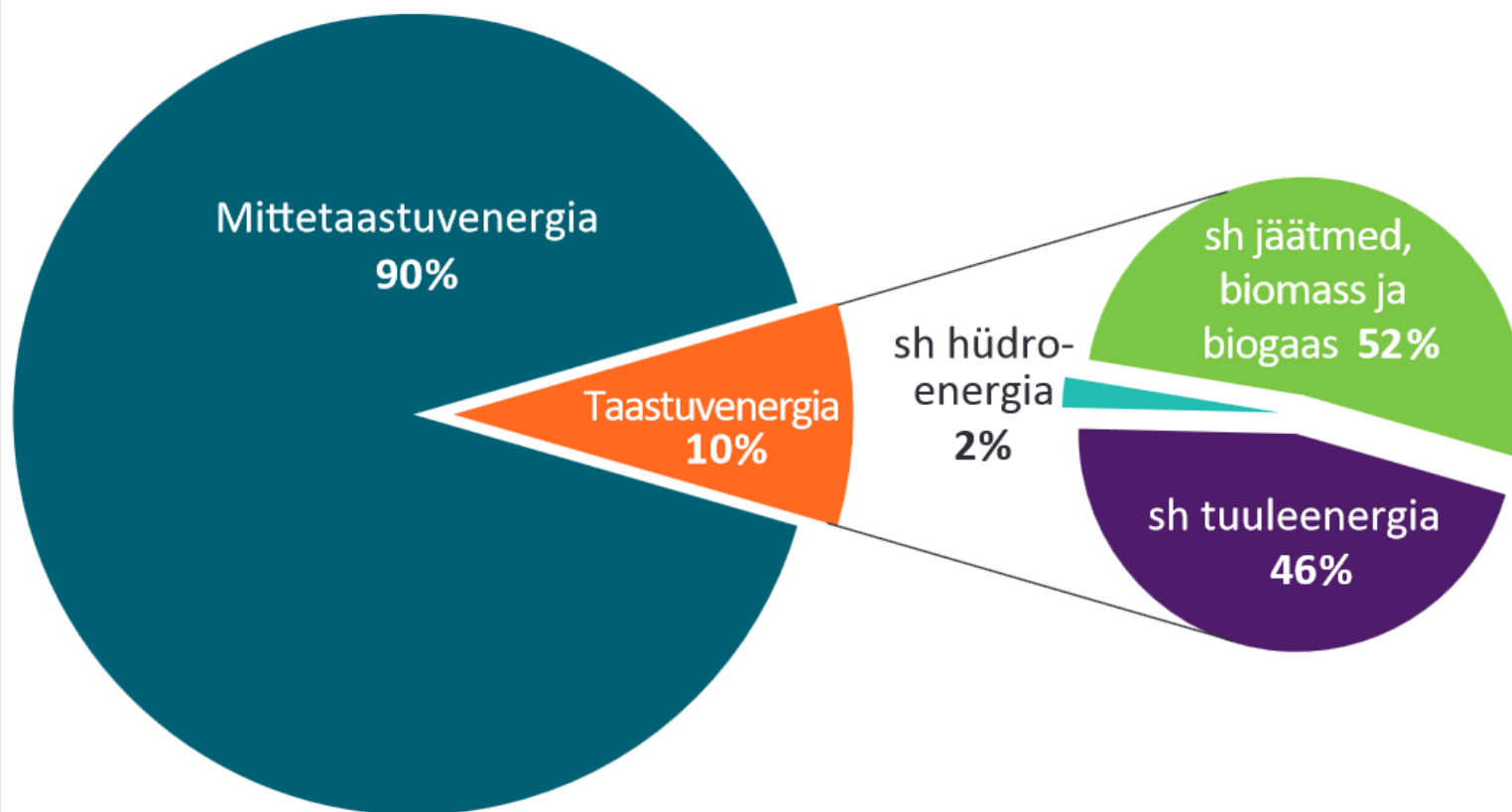
1.0000

Minimum value:0.27 Maximum value:1.041



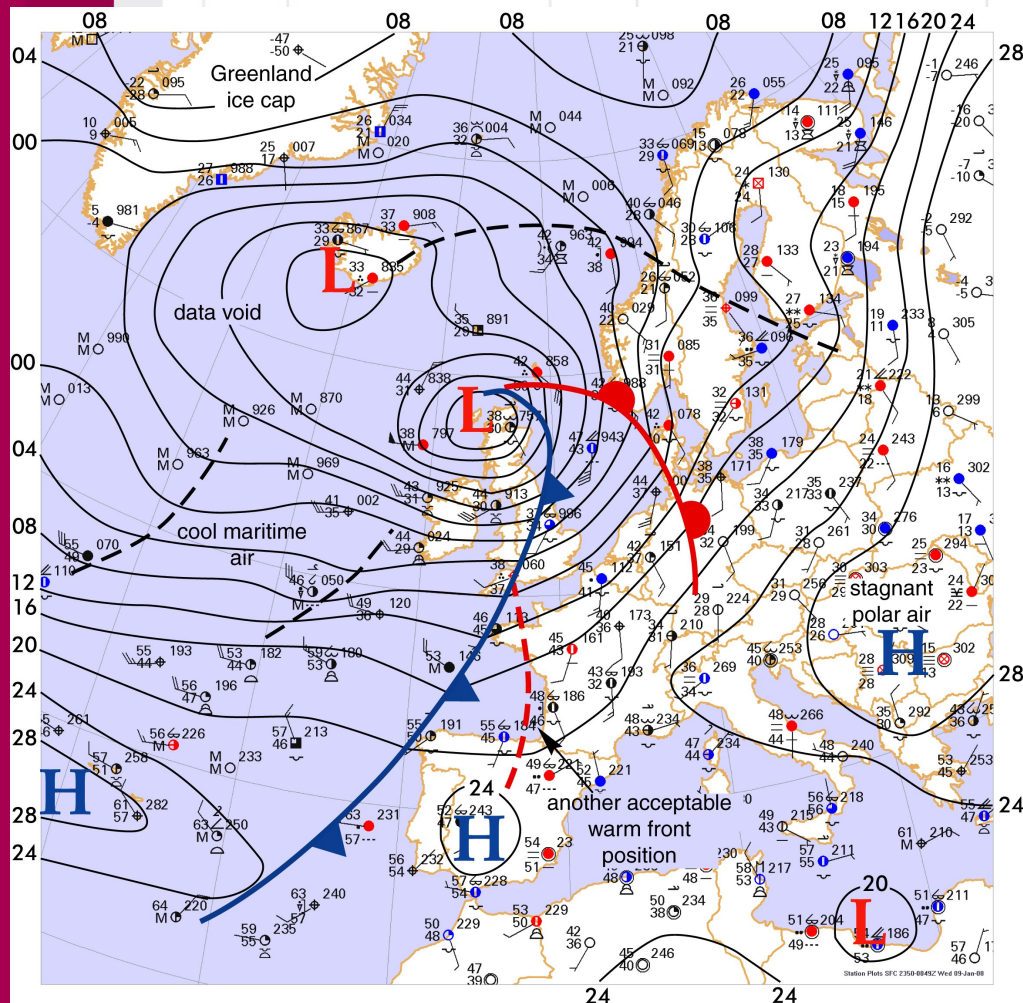
Taastuvelektri osakaal

*Taastuvenergia osakaal
kogu võrku antud
elektrienergiast ja selle
jaotus 2013. aastal*





Tuul



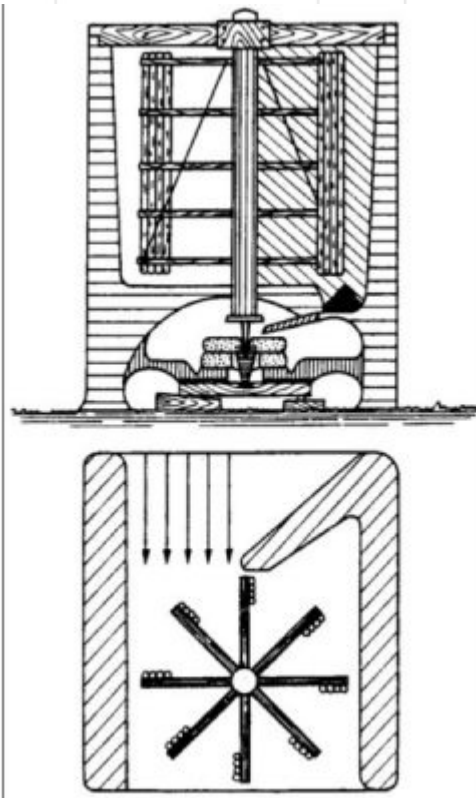
Tuul on õhu liikumine
maapinna suhtes

Tuul tekib
päikeseenergia mõjul



Tuuleenergia

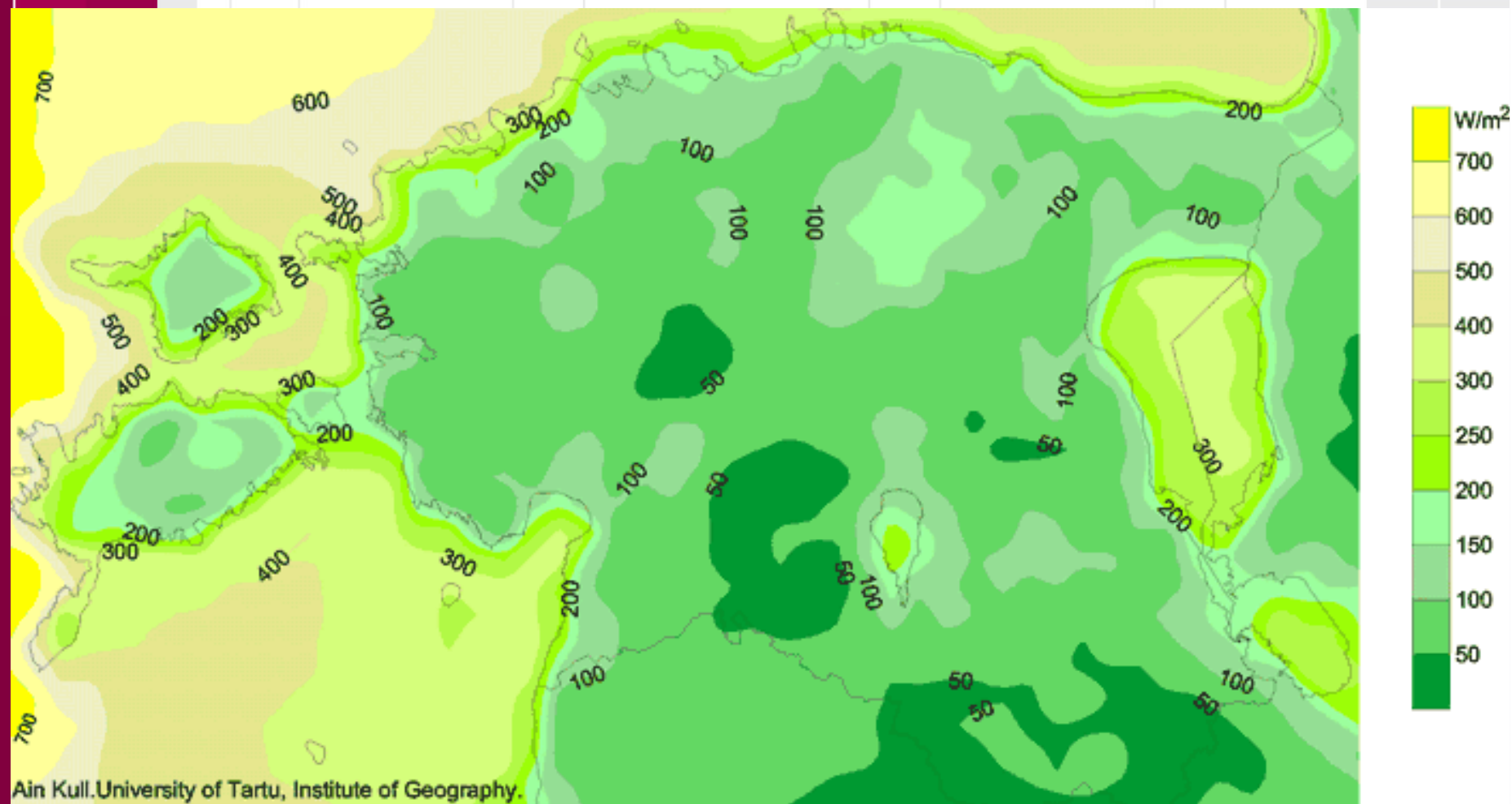
$$P_{Wind} = \frac{1}{2} * \rho * \pi * R^2 * v^3$$



Kuidas kätte saada?

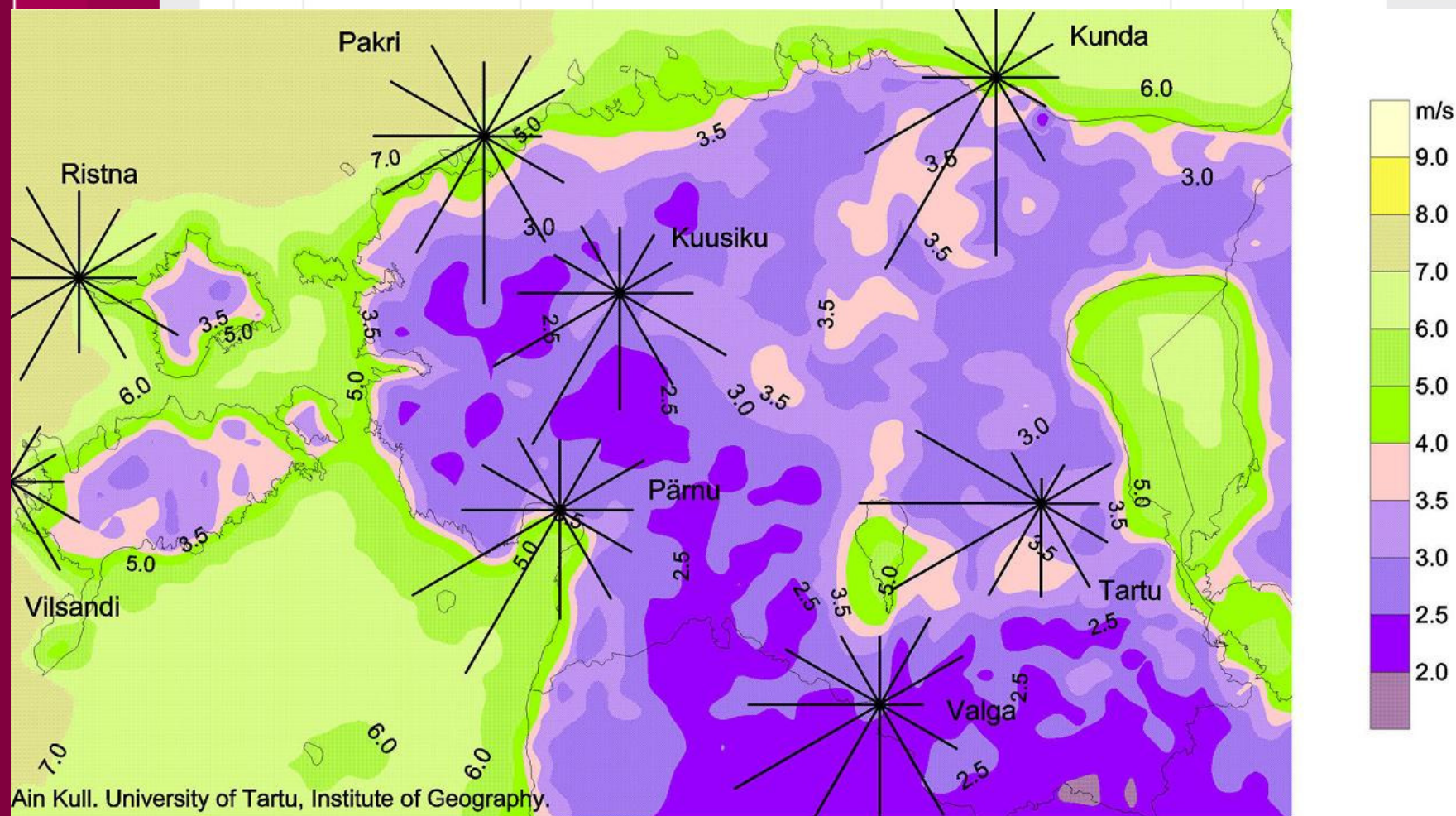


Eesti tuuleressurss



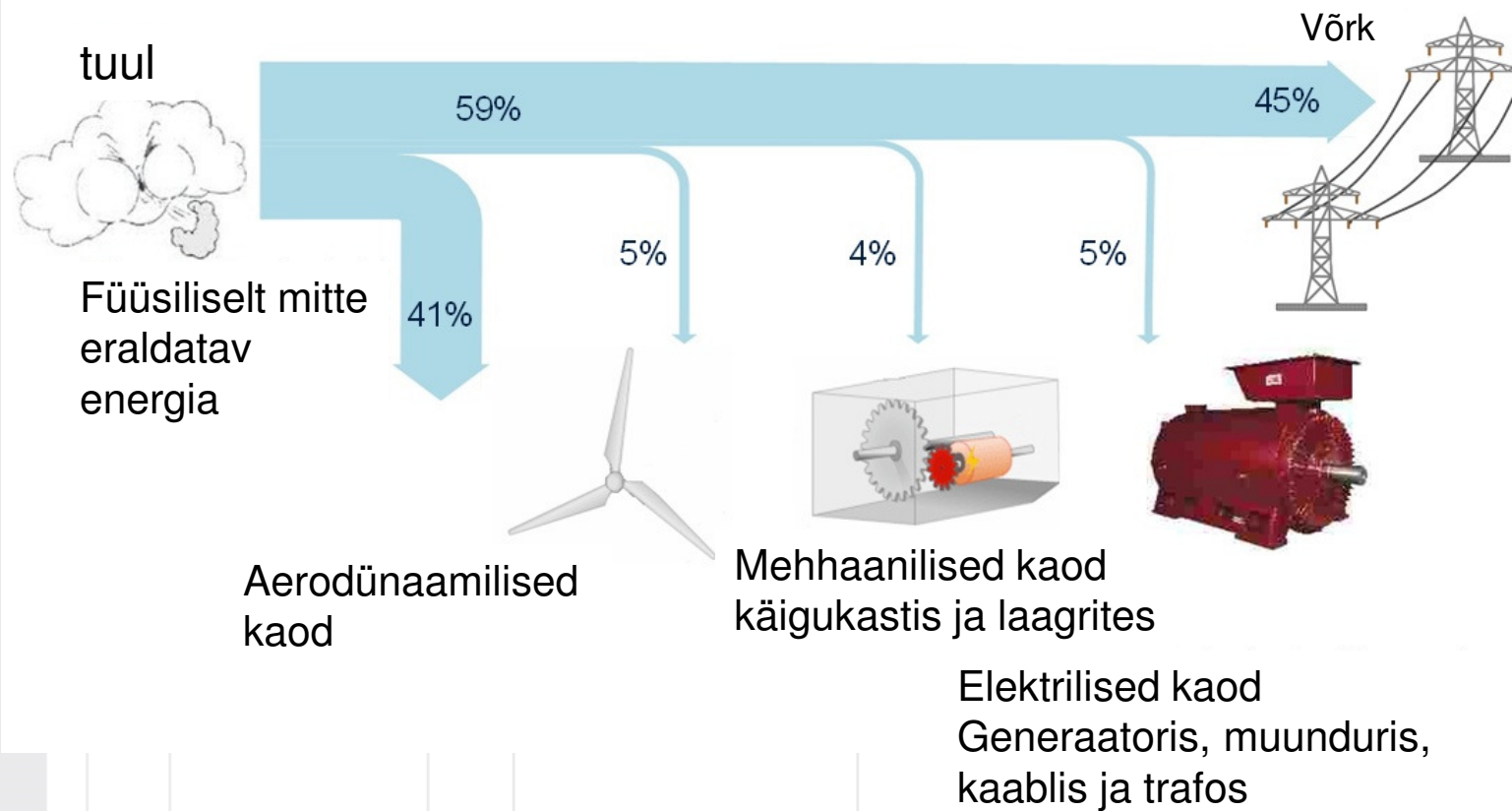


Tuulekiirus 10 meetri kõrgusel





Tuule „kasutegur“

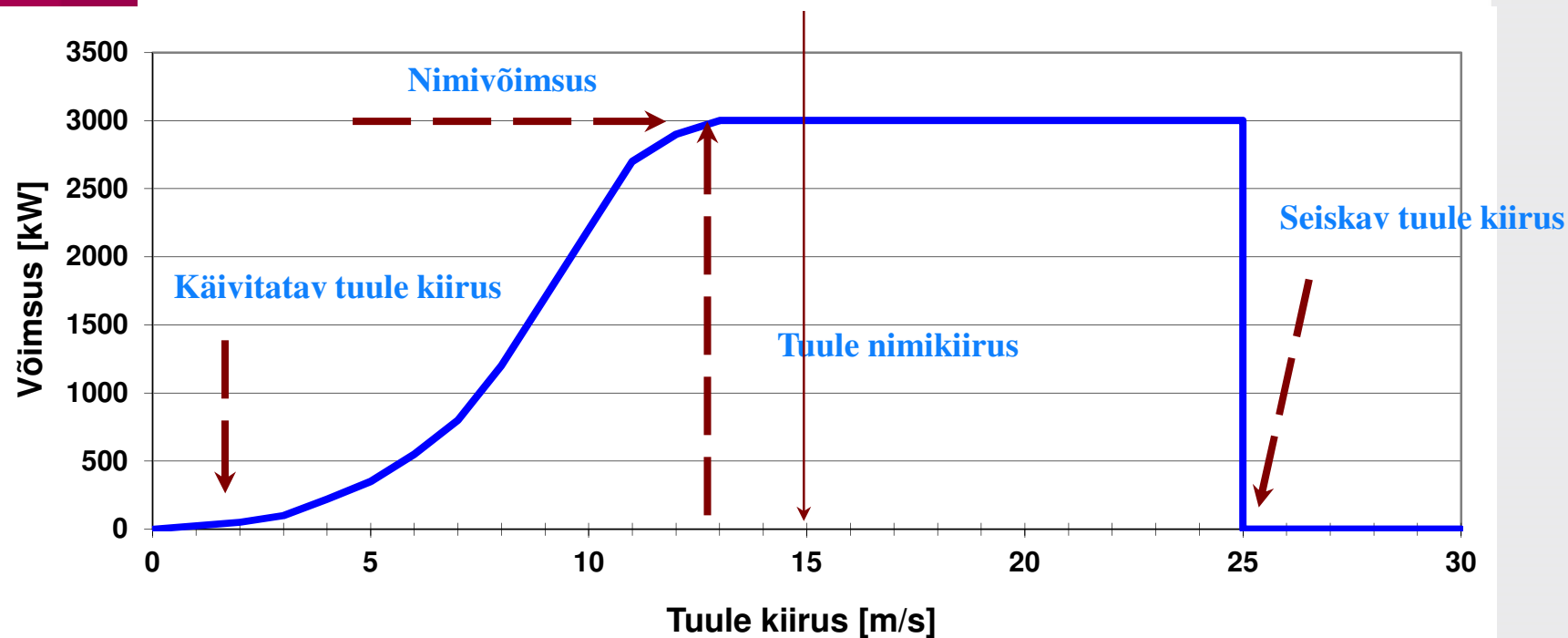


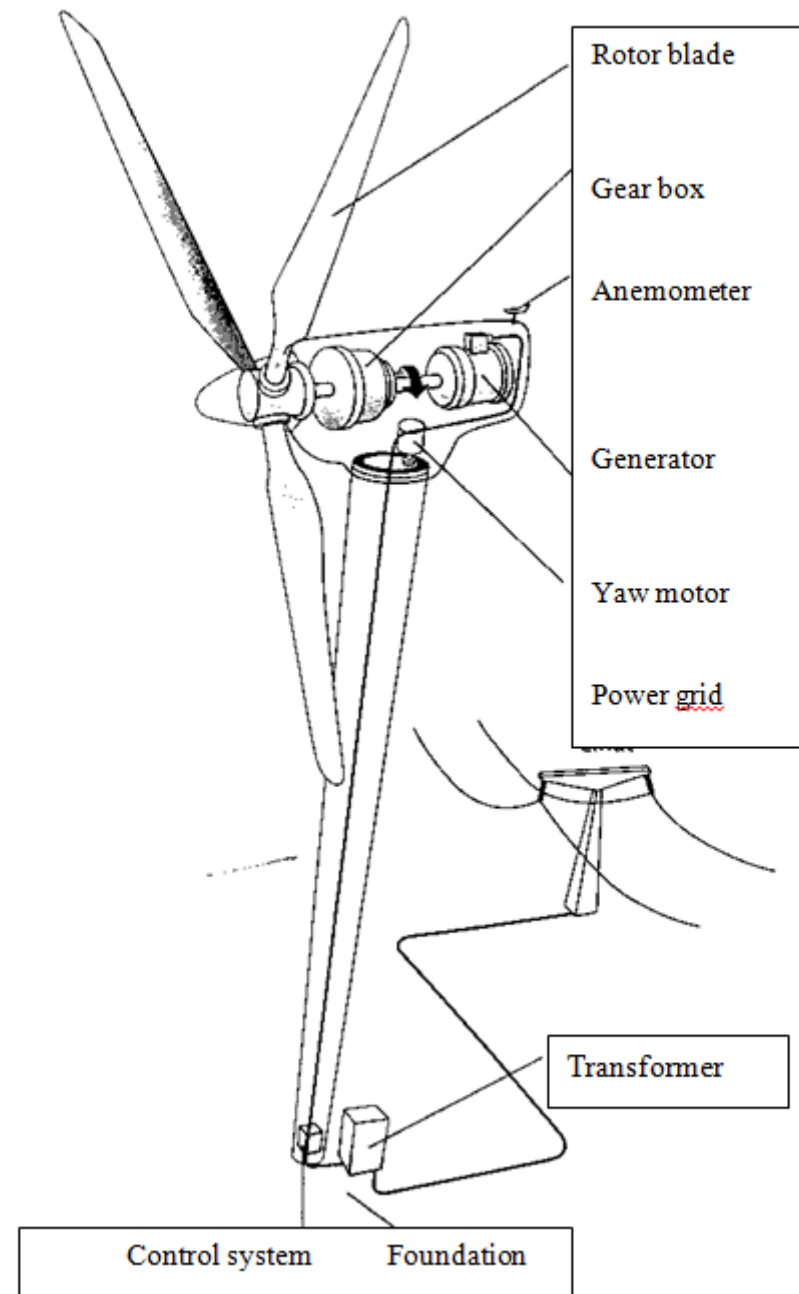
Ilmateenistus koostab hoiatusi järgmiste kriteeriumite alusel.

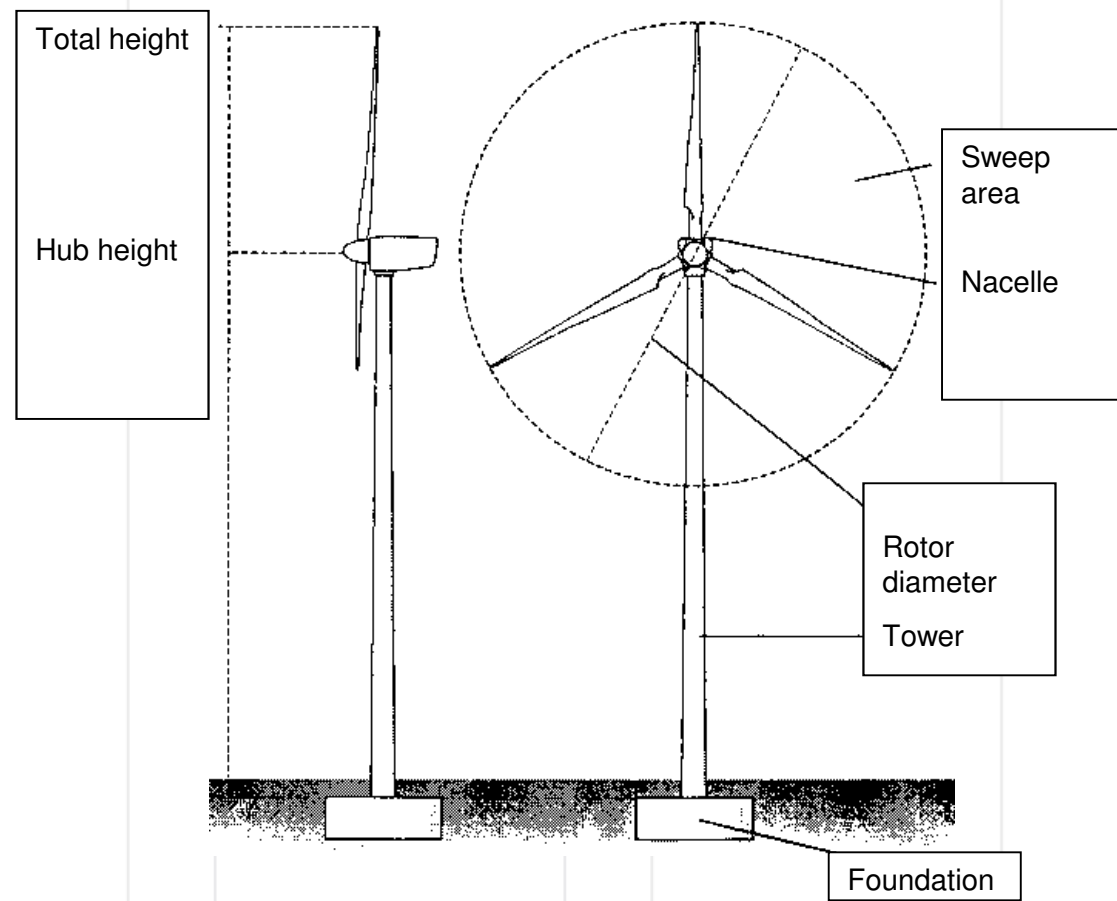
Tuul

Ohtlik	Tuule kiiruse suurenemine sisemaal 15 m/s ja üle selle (haaratud 30% territooriumist)
Kordushoiatus	Tuule kiiruse suurenemine puhanguti 25 m/s ja üle selle (haaratud 30% territooriumist)
Eriti ohtlik	Tuule kiiruse suurenemine puhanguti 33 m/s ja üle selle (haaratud 30 % territooriumist)

Eriti ohtliku nähtusega kaasnevad keskkonnakahjustused – murduvad suured puud või kistakse juurtega välja, hoonetel suured purustused, orkaani tugevusega tuulega (32,7 m/s) võivad kaasneda katastroofilised purustused

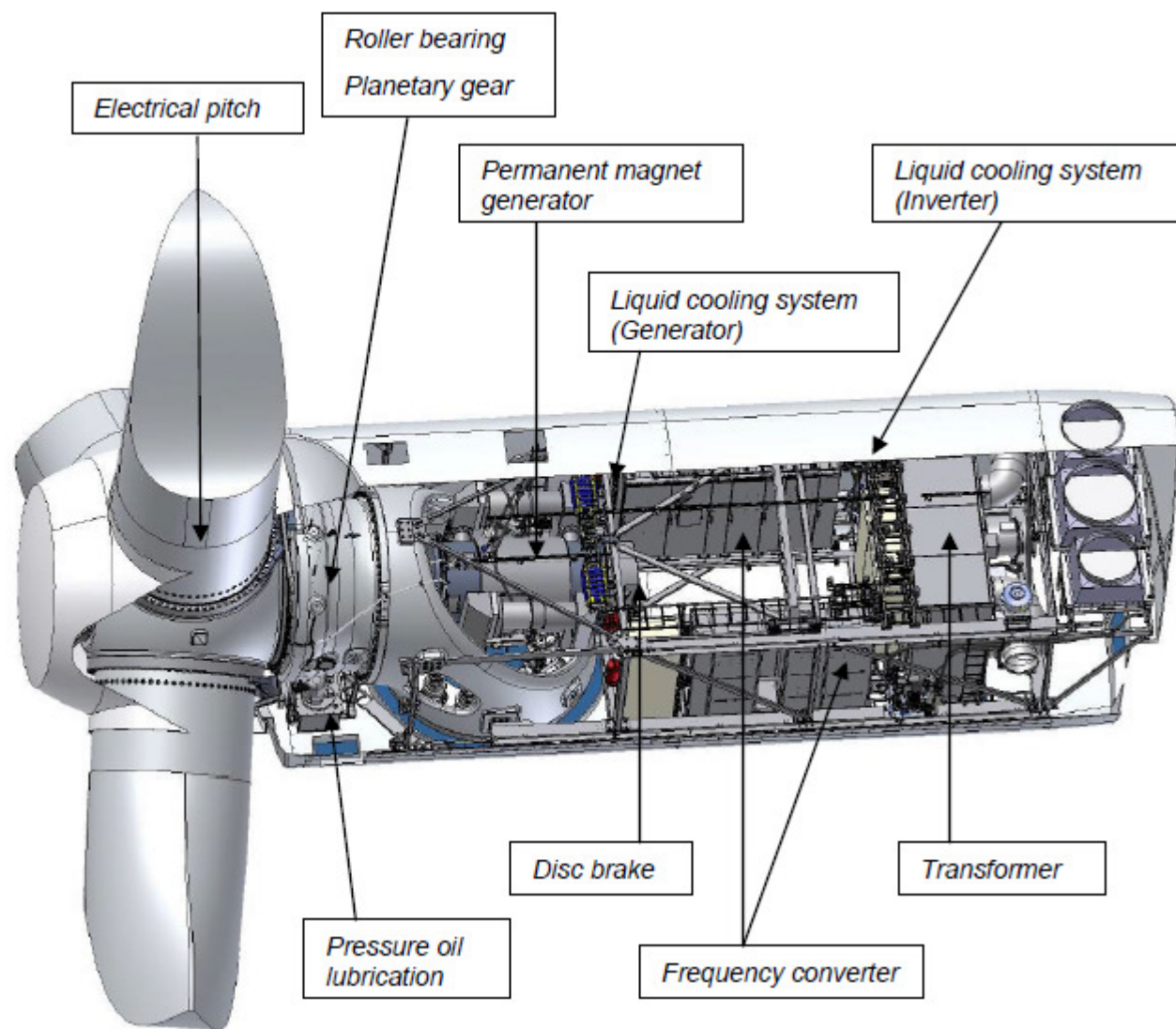








Gondel ja rootor





Vertikaalteljeline generaator

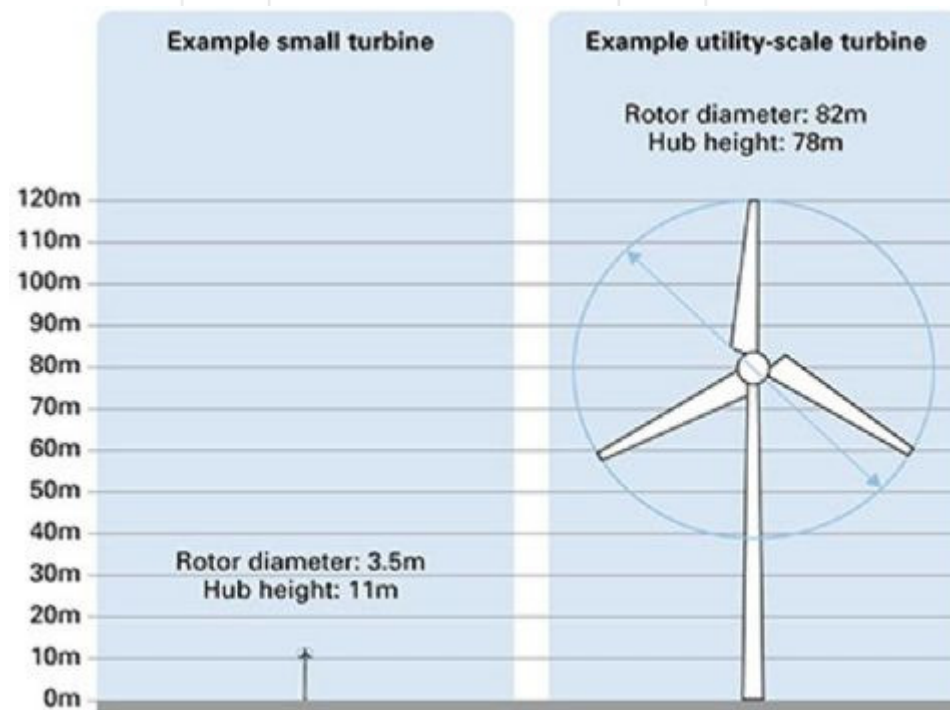


Tasuvus

Enercon E-82 E2 / 2,3 MW					
Rotor diameter	m		82	Bank Loan involvement	70%
Hub height	m		85	Shareholders involvement	30%
Rated Power	MW		2,3	Bank Loan involvement	€ 4 186 000,00
Number of WEC-s	pcs		2	Shareholders involvement	€ 1 794 000,00
Total Power	MW		4,6	Bank payment per mensem	€ -40 420,33
Price per WEC	€	2 948 500,00		Bank payment per annum	€ -485 043,93
Price	€	5 897 000,00		Shareholders per annum	€ -317 509,59
Price per W	€	100	1,28		
Price With Building	€	101	1,30	Project life	yr 20
Project Cost	€	5 980 000,00		Constant expenditure first 10 yrs	€/ann -952 637,52
With VAT	€	5 980 000,00			
				Yearly production	MWh 12507
Bank Loan	yr	10		Net cost per MWh first 10 yrs	€ -76,17
Back Payment starts	yr	1		Net cost per MWh yrs 11 - 20	€ -34,95
Bank interests rate		3%		Average net cost	€ -55,56
Shareholders interests rate		12%			
O&M first 10 yrs		1,5%		Yearly production	MWh 8157
O&M per annum first 10 yrs	€	89 700,00	€	Net cost per MWh first 10 yrs	€ -116,79
O&M yrs 11 - 20		2,0%		Net cost per MWh yrs 11 - 20	€ -53,59
O&M per annum yrs 11 - 20	€	119 600,00	€	Average net cost	€ -85,19
Maintenance cost	€/MWh	-12,00	€	-2,510 %	From initial cost
Net Normal sc.	€	-150 084,00	€		
Net Decreased sc	€	-97 884,00	€		



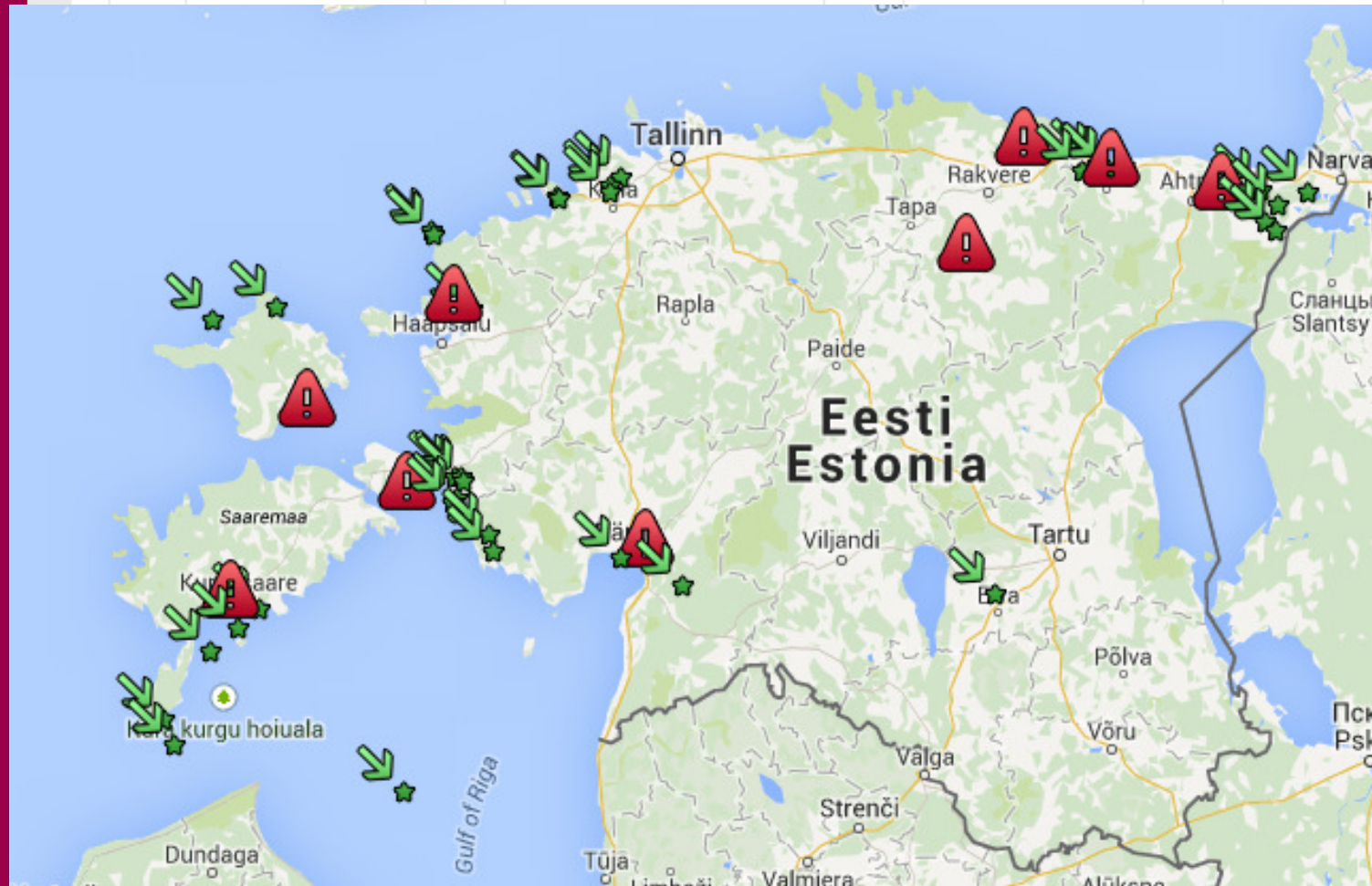
Tasuvus suur *versus* väike





Tuuleenergia eelised



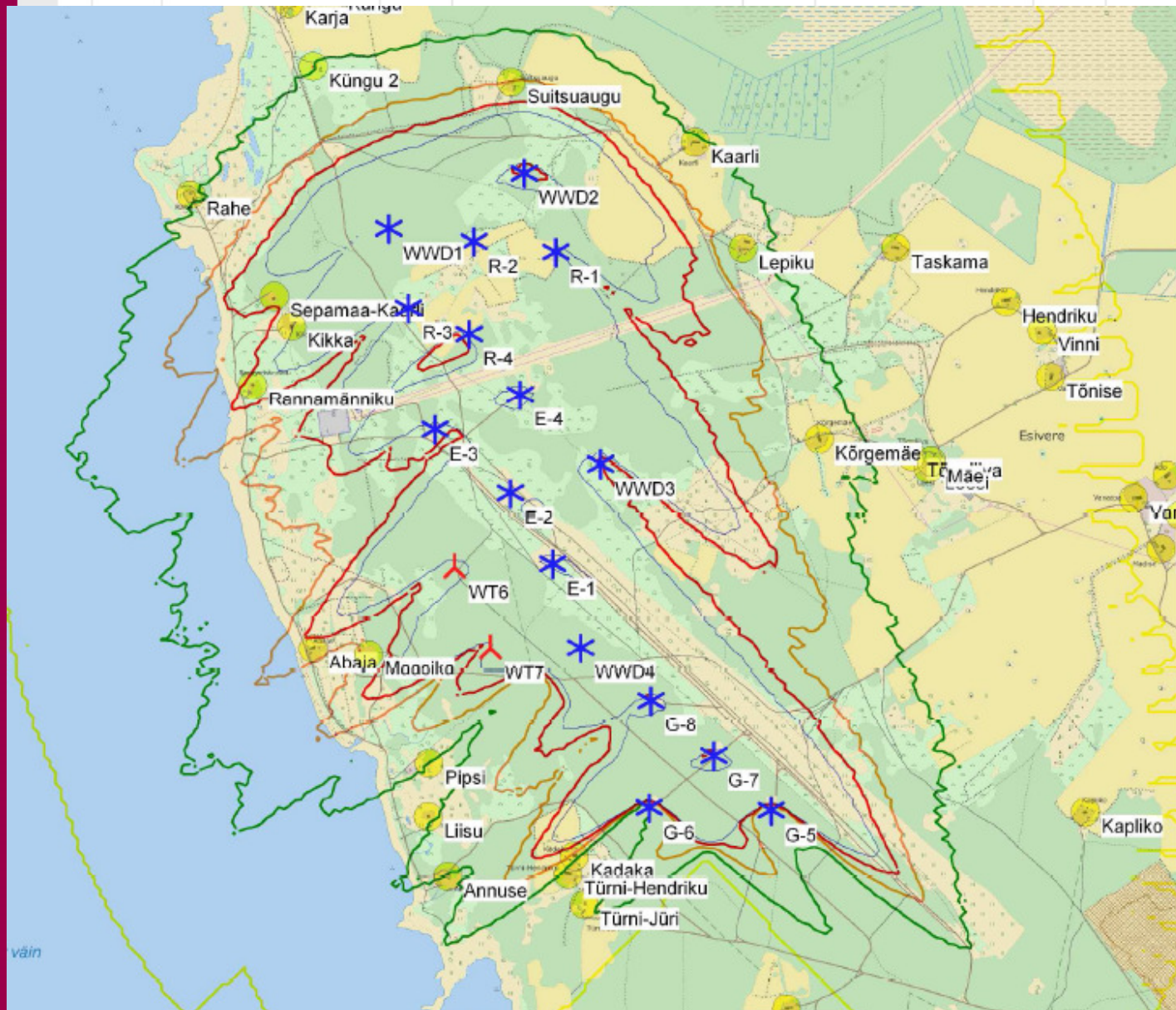




Müüdid ja tegelikkus

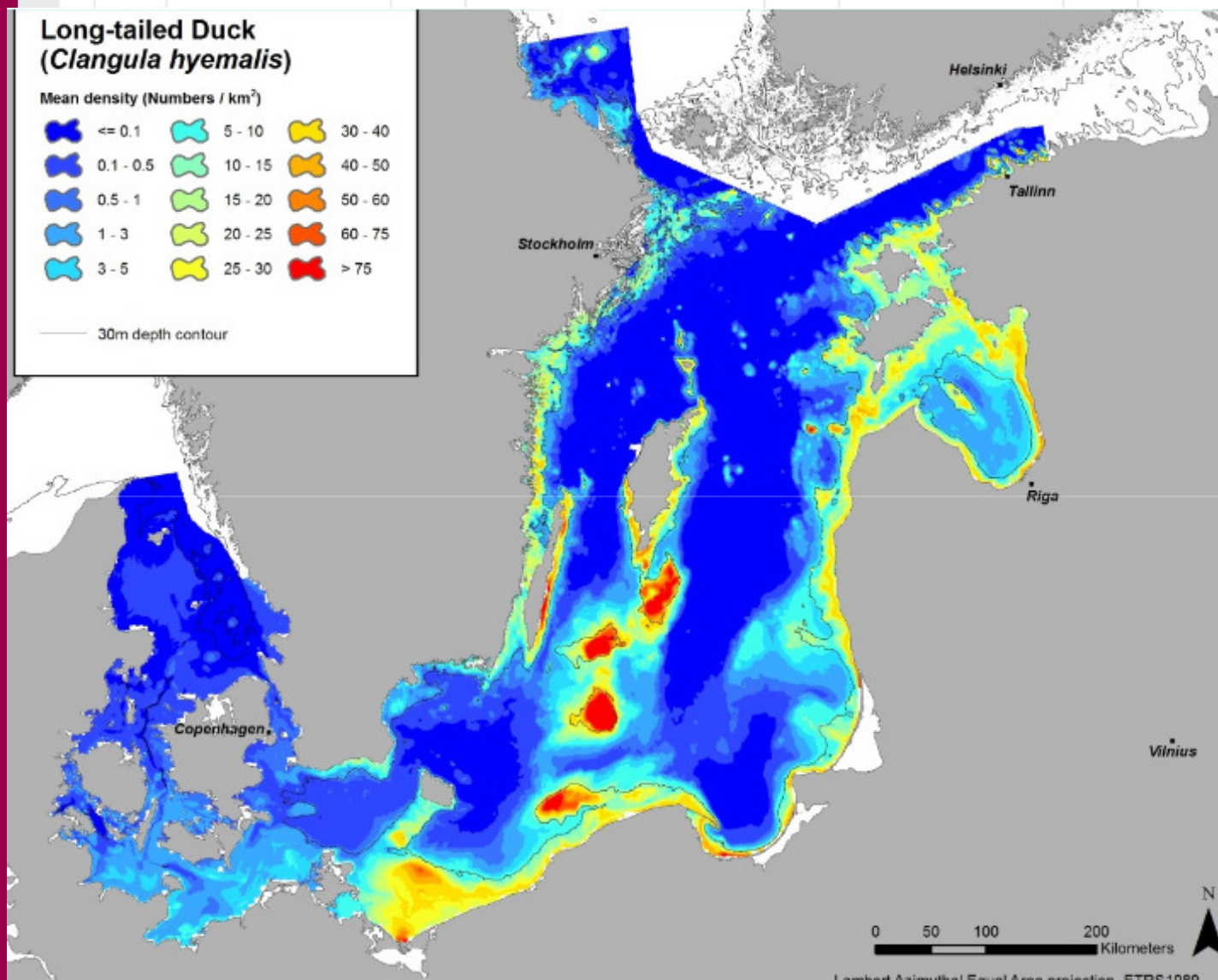








Linnud





Tuulepargi ehitamine ei koorma keskkonda





Tänan!