Cost of energy system security the Romanian case

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EU Green Deal

Comunism ended because it did not internalized the cost of capital; Capitalism may end because it does not internalize the cost of environment

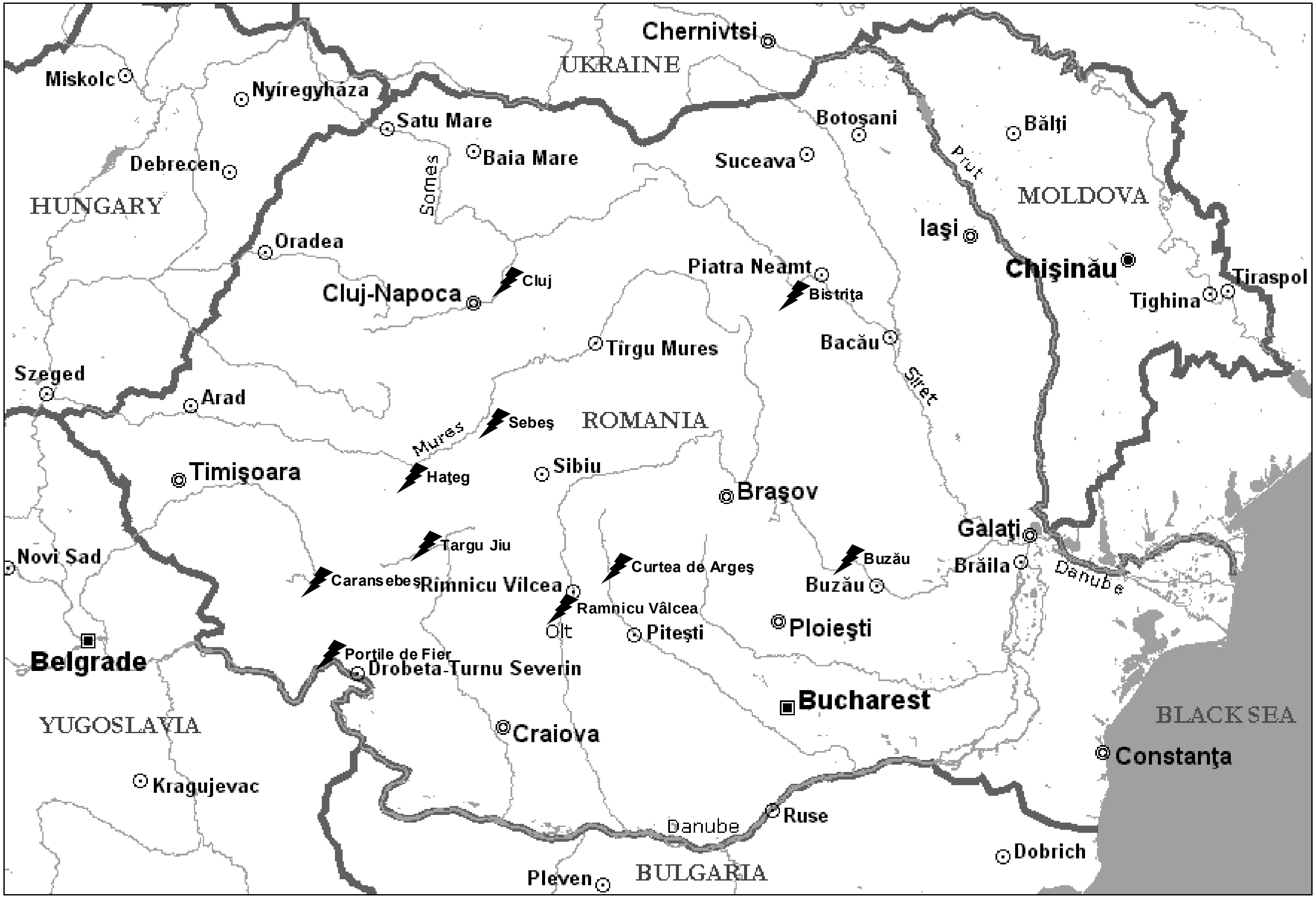
The Green Deal aims at diminishing the costs to the environment by making the EU economy emission neutral at the horizon of 2050.

Action lines:

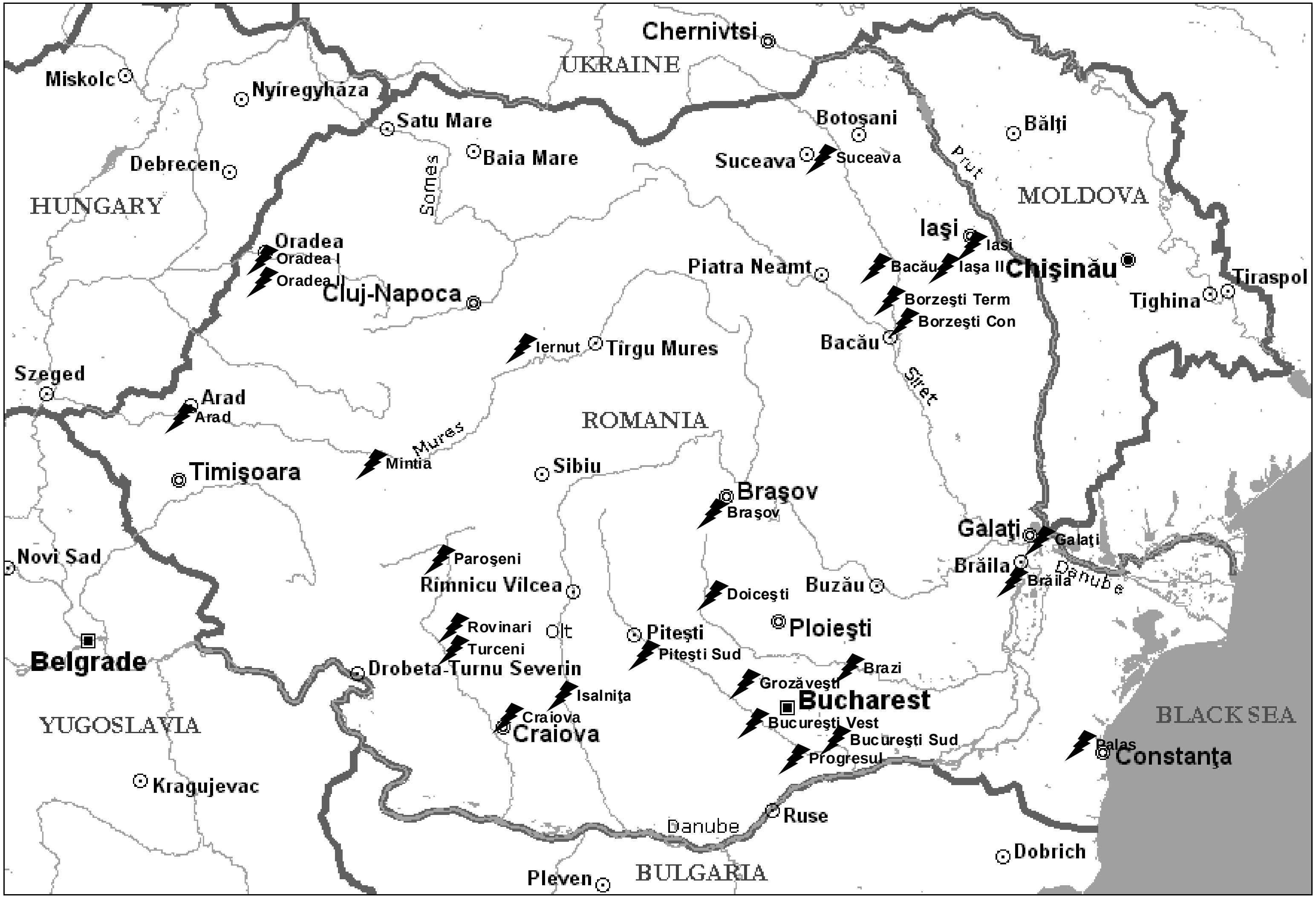
- Energy
- Transport
- Buildings
- Innovation

Energy

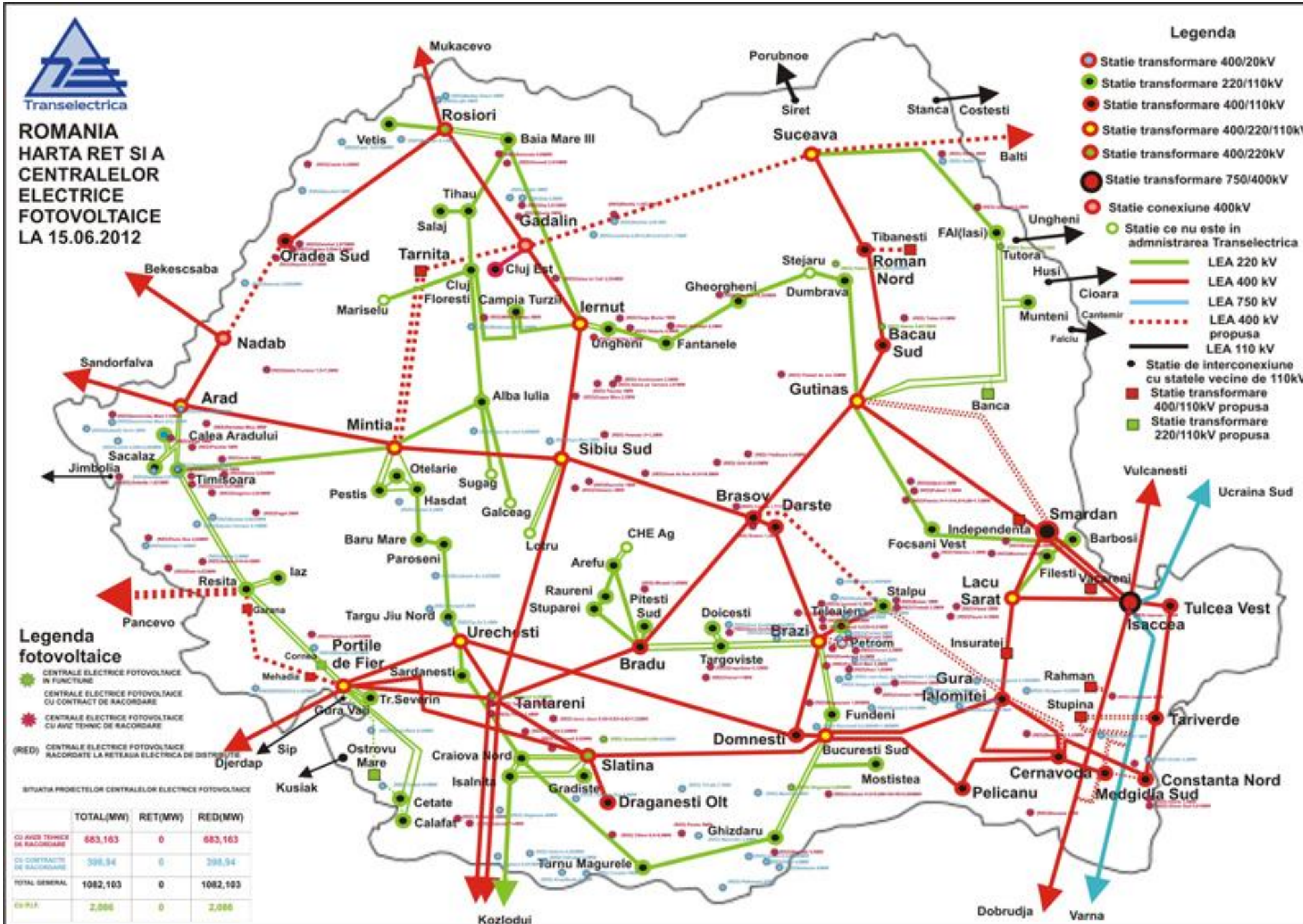
Case ROMANIA



Map 1: Hidroelectrica hydro power plants

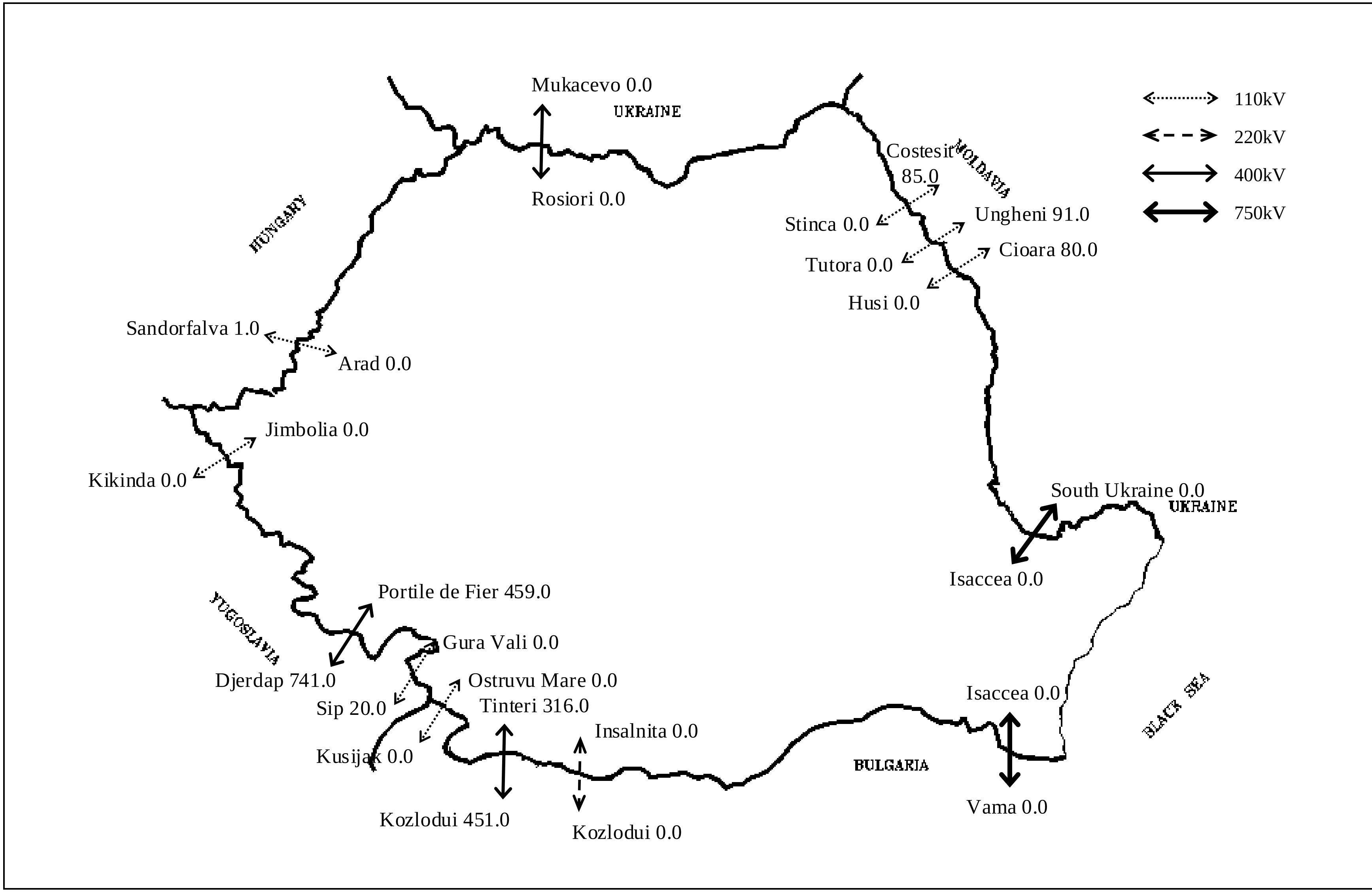


Map 2: Termoelectrica thermal power plants



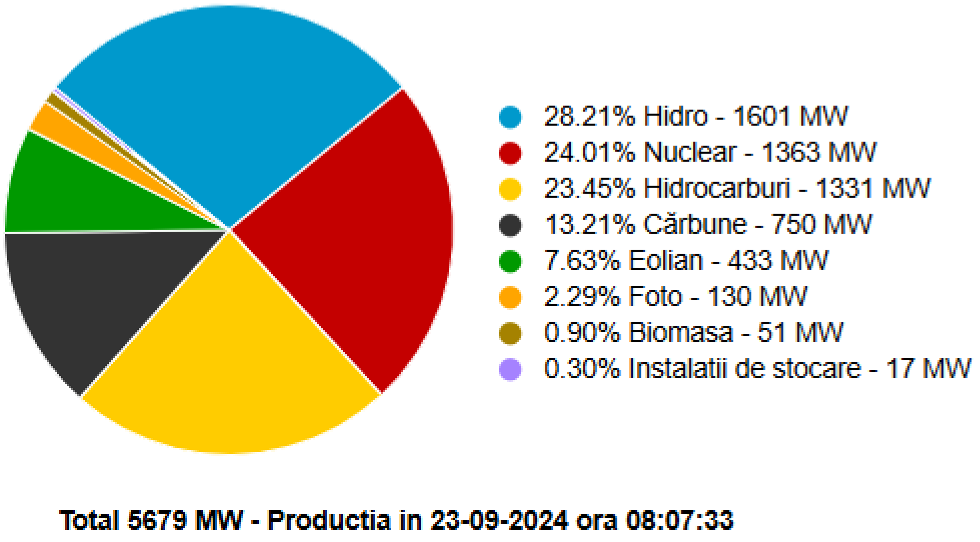
SITUATIA PROIECTELOR CENTRALELOR ELECTRICE FOTOVOLTAICE

	TOTAL(MW)	RET(MW)	RED(MW)
CU AVIZ TEHNICE DE RACORDARE	683,163	0	683,163
CU CONTRACTE DE RACORDARE	398,94	0	398,94
TOTAL GENERAL	1082,103	0	1082,103
CU P.I.F.	2,086	0	2,086



Map 5: Electricity exchanges across interconnections, 2000 (GWh)

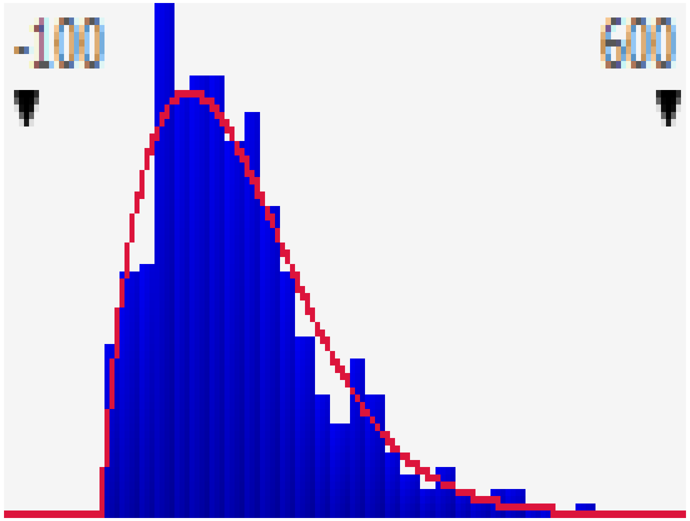
Romania power system production



Elements of security

According to the Security strategy of the energy systems launched by the EU Commission in 2014 it is necessary to have a diversified portfolio of electrical energy generation technologies that ensures the coverage of situations when various types of risks manifest themselves. The same applies for gas interconnectors and for the climate change risks impact on critical infrastructures.

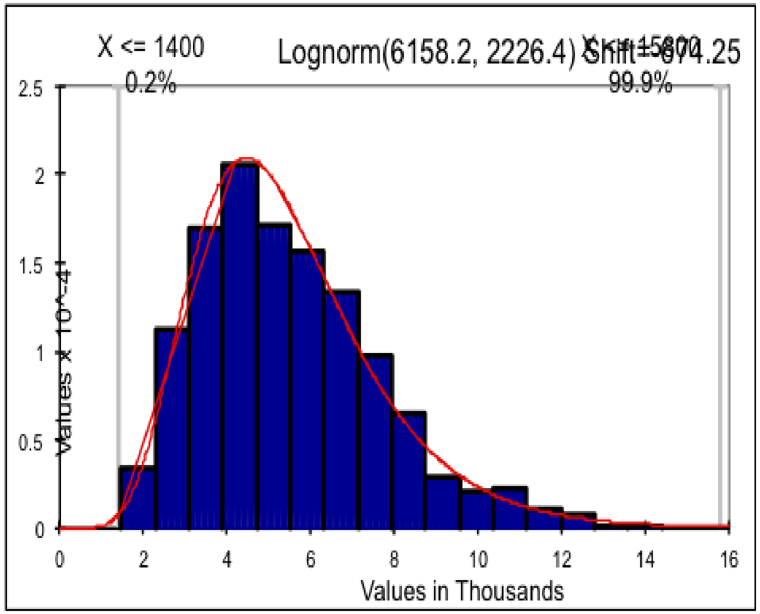
The standard deviation of each volatile source is giving the size of the needed reserve of power for the system. The probability distribution are based on real data over sizeable time intervals. For instance for the Danube flow the data period is 1845-2006.
For the climate change risks the data period is 1961-2011.
For Italy the gas grid risk map is based on earthquake and land slide and mechanical risk, while for Romania it is based on the climate change risks and mechanical risk.



Precipitations

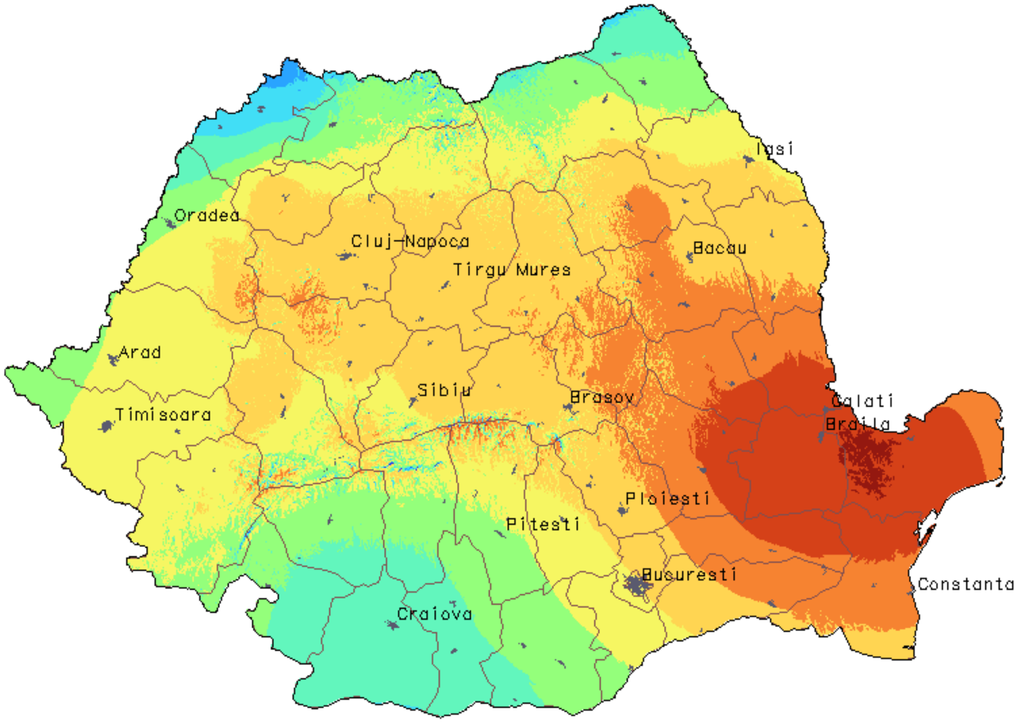
SD/Mean rain	0.6552731 1	hidro lake	
		TWh	16
		TWh lake	4.8
		h/year	8760
		exposure TWh	3.1453109 28
		power MW	359.05375 89

Danube

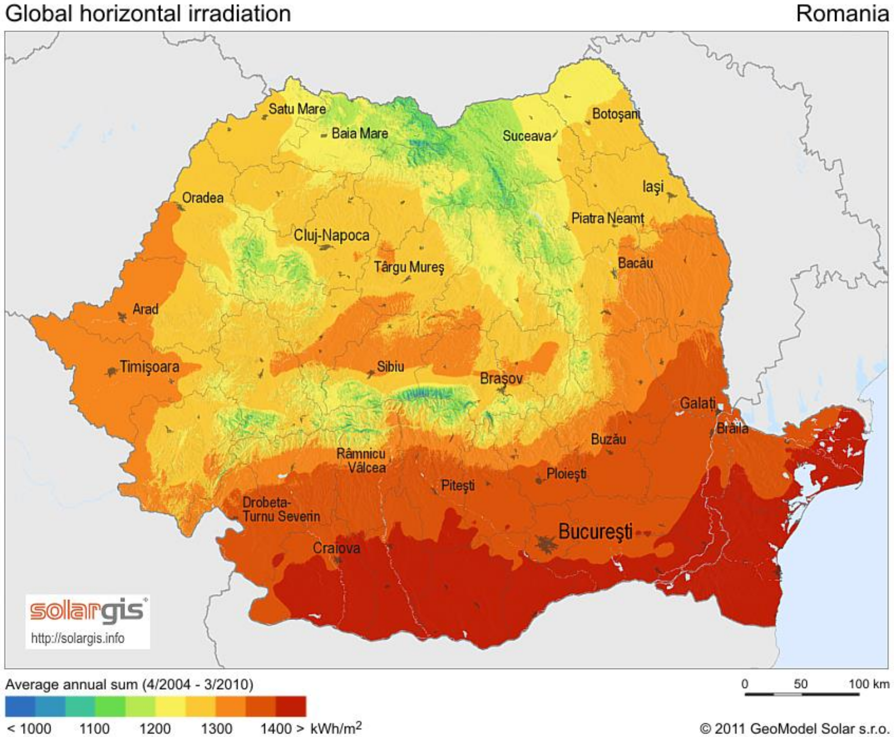


SD/Mean Danube	0.36153 4215			
		Needed security hydro run river		
		TWh	16	
		TWh run river	11.2	
		h/year	8760	
		exposur e TWh	4.04918 3203	
		power MW	462.235 5254	

Wind



SD/Mean wind	0.5	wind	
		TWh	3
		TWh wind	3
		h/year	8760
		exposure TWh	1.5
		power MW	171.23287 67



Photovoltaic

SD/Mean PV	0.6	PV	
		TWh	1
		TWh PV	1
		h/year	8760
		exposure TWh	0.6
		power MW	68.49315068

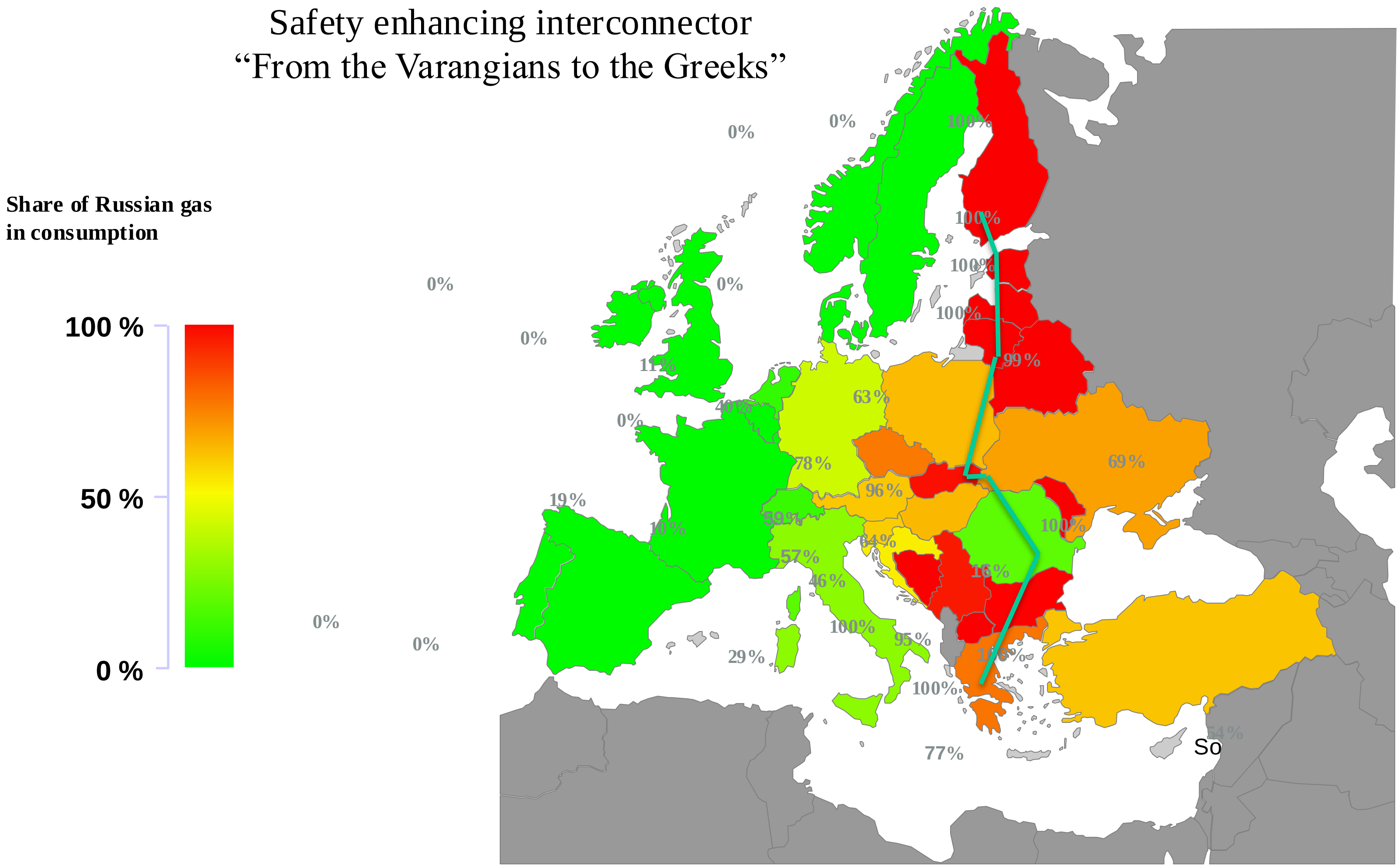
In the table below a simulation of a typical financing scheme is presented for a coal power plant of 669 MW having a total of 3000 US$/kW and a lifetime of 50 years (the monetary units in the table are given in US$ but they can be replaced with Euro without changing the values).

	A	B	C	D	E	F	G	H	I	J	
1	financing	FI equity	loc. equity	Comm.loan	Exp.loan	LT loan	Bonds	TO: $/KW	$mm i10	$mm i15	$/K\
2								FI equity	0.00	0.00	
3	i	0.00	0.00	0.13	0.00	0.07	0.06	loc. equity	0.00	0.00	
4	N	8	8	5	15	15	10	Comm.loan	450.00	450.00	6
5	PMT	0.00	0.00	269.47	0.00	162.76	72.03	Exp.loan	0.00	0.00	
6	capital $/kWh	0.0720	0.8	utilization	$/kW	PMT SUM	504.26	LT loan	850.00	850.00	12
7	fixed op $/kWh	0.0131	40.97	$/KW	$/kW	project life	259.13	Bonds	300.00	300.00	4
8	var oper $/kWh	0.0011				difference:	94.60%	Total	1600.00	1600.00	23
9	fuel $/kWh	0.0017	0.47	$/MWh t	$/kWh inv. project life:		0.0370	cost adjustment ratio>		1.00	
10	TOTAL $/kWh	**0.0879**	3.64	MWh t/MWh				$mm cap	1600.00		
11	LIFE $/kWh>>	**0.0529**	0.0350	B10-B11				-idc	0.00		
12	WDR	life	PV cap	PV fix op	PV var op	PV fuel	PV kWh	-pr.conting	0.00		
13	0.08452	50	3012.72	1068.30	89.63	139.85	81477.64	-wk.cap	0.00		
14	AFUDC = allowance for funds used during construction							other adj	0.00		
15	YTC = years to commissioning				i = interest or return rate			net capital	1600.00		
16	WDR = weighted discount rate				N = years to maturity			MW	669.6		
17	ERROR	verifies i8 and i29			PMT = annual capital charge			$/kW	2389.49		
18	Capital charge unit components:										
19		FI equity	loc. equity	Comm.loan	Exp.loan	LT loan	Bonds	TOTAL			
20	$/kWh>>>	0.0000	0.0000	0.0385	0.0000	0.0232	0.0103	0.0720			
21											
22	AFUDC calc.	FI equity	loc. equity	Comm.loan	Exp.loan	LT loan	Bonds	YTC	cashflow %		
23		0.00	0.00	92.81	0.00	79.51	25.39	5	0.15	All cost data $/k\	
24		0.00	0.00	71.15	0.00	62.92	20.15	4	0.15		
25		0.00	0.00	51.91	0.00	47.34	15.20	3	0.15		
26		0.00	0.00	34.82	0.00	32.73	10.54	2	0.15		
27		0.00	0.00	26.19	0.00	25.35	8.18	1	0.20		
28		0.00	0.00	8.22	0.00	8.18	2.65	0	0.20		
29	afudc/kW	0.00	0.00	285.09	0.00	256.03	82.11	623.23	1.00	1.00	
30	$/kW <afudc	0.00	0.00	672.04	0.00	1269.41	448.03	2389.49			
31	$/kW w. afudc	0.00	0.00	957.13	0.00	1525.44	530.14	**3012.72**			
32											
33	For WDR:	"i" weighted by PMT shares;		N =	1						
34		FI equity	sp. equity	Comm.loan	Exp.loan	LT loan	Bonds	TOTAL			
35	PMT	0.00	0.00	1077.73	0.00	1625.36	561.95	3265.04			

The 3 seas initiative and gas network security

North South interconnector

Dependency on Russian gas imports

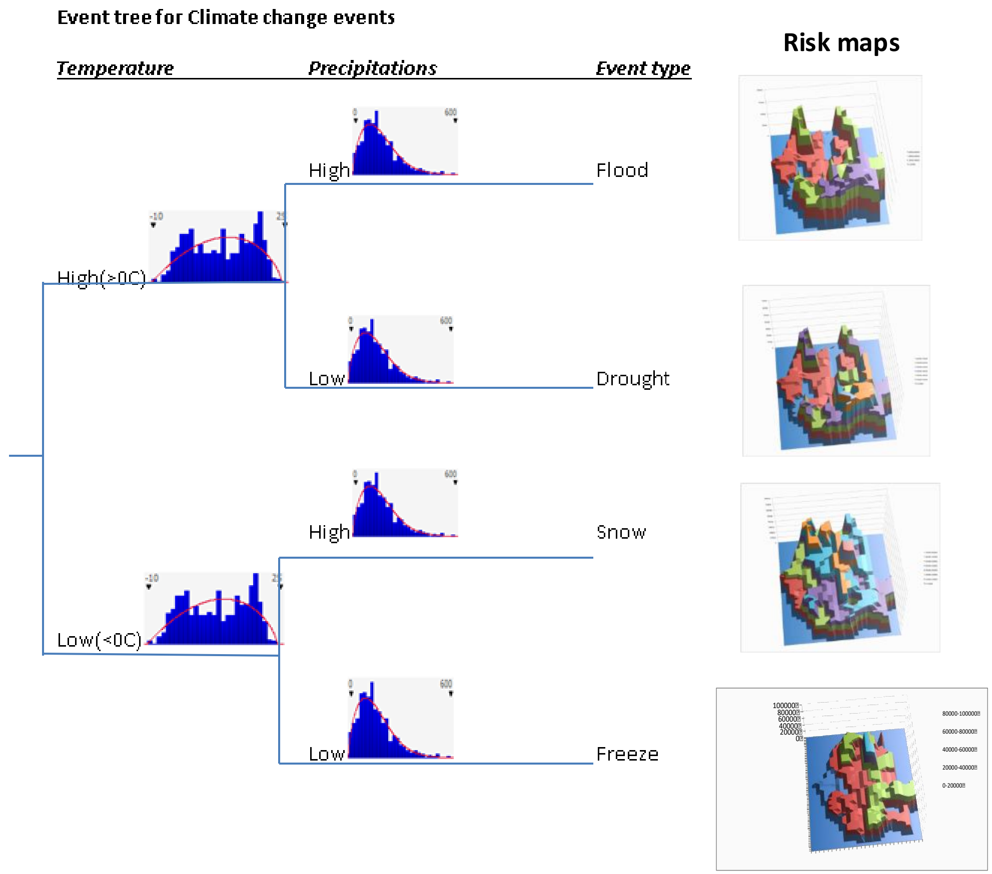


Source : CEDIGAZ- Estimate of international gas trade by pipeline in 2009

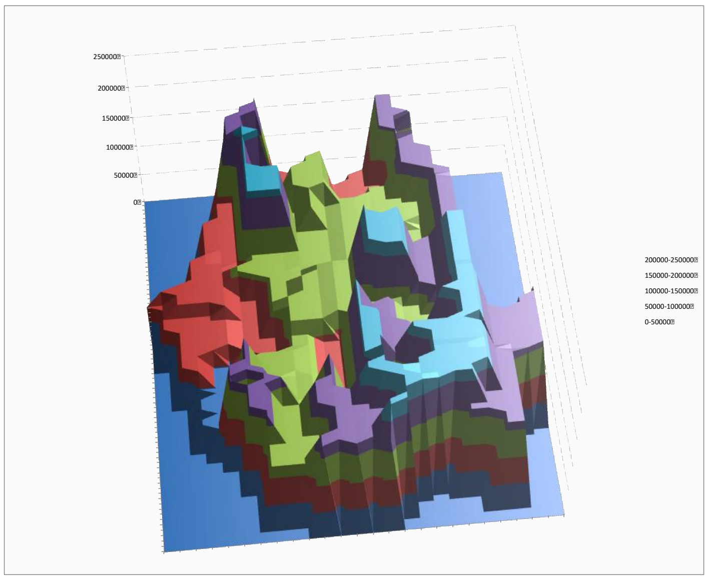
Climate change risk

Big data analysis needed

Potential Insurance policy


Event tree for Climate change events
Risk maps
Temperature
Precipitations
Event type
High(>0C)
Low(<0C)
High
Low
High
Low
Flood
Drought
Snow
Freeze

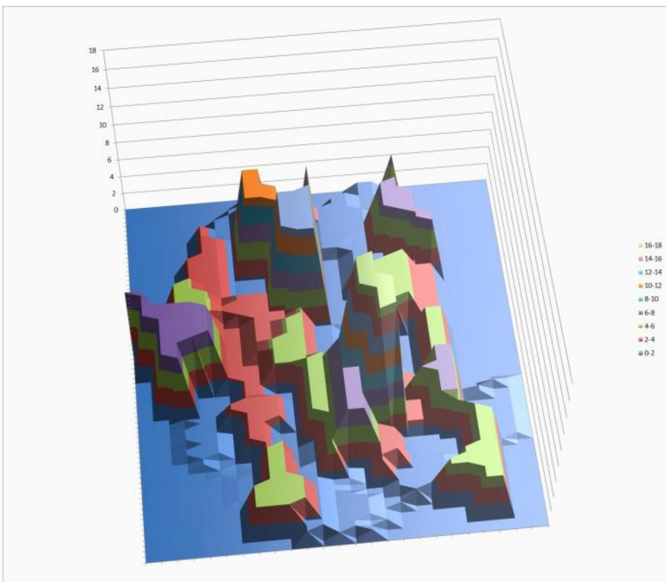
Total CC events risk map [thousands US$]



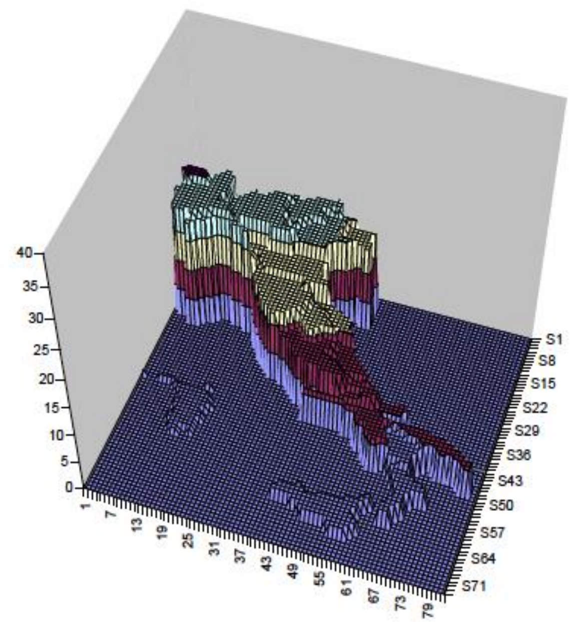
distribution of risk premium per capita

County	Premium Risk /cap US$	County	Premium Risk /cap US$
Bucuresti	0	Harghita	19.68
Alba	17.05	Hunedoara	8.44
Arad	11.81	Ialomita	43.59
Arges	8.28	Iasi	12.27
Bacau	8.33	Ilfov	6.68
Bihor	8.43	Maramures	8.31
Bistrita Nasaud	27.29	Mehedinti	32.56
Botosani	20.53	Mures	11.32
Braila	35.06	Neamt	11.59
Brasov	12.96	Olt	21.09
Buzau	16.20	Prahova	11.77
Calarasi	40.17	Salaj	51.13
Caras Severin	8.74	Satu Mare	31.13
Cluj	8.77	Sibiu	17.69
Constanta	13.86	Suceava	5.13
Covasna	59.81	Teleorman	23.70
Dambovita	22.91	Timis	6.71
Dolj	9.90	Tulcea	36.61
Galati	20.83	Valcea	15.41
Giurgiu	46.07	Vaslui	22.73
Gorj	16.76	Vrancea	25.50

Romania gas grid CC and mechanical risk [probable deaths/1000 cap]



Natural gas risk in Italy [probable deaths / million inhabitants]



Forecasting and planning

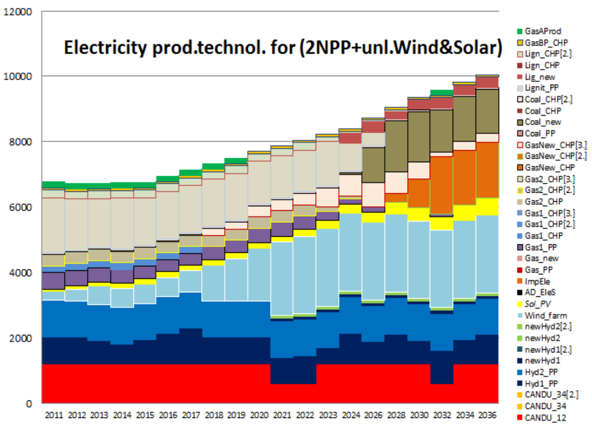
Models for the energy system penetration of new technologies

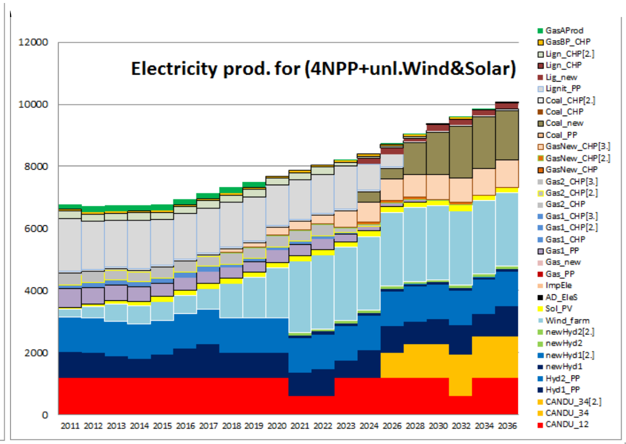
Optimize for emissions reduction

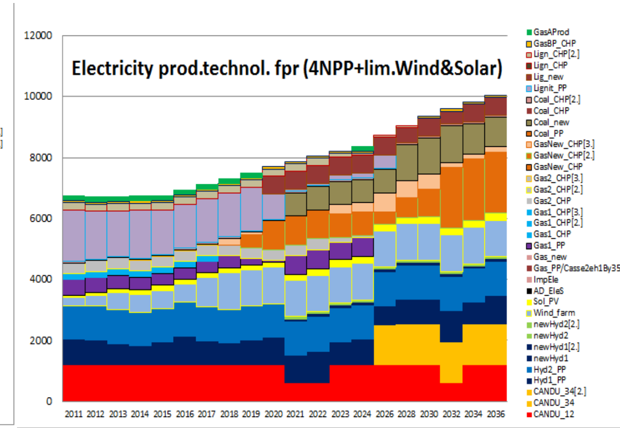
ACTING FOR THE NEAR FUTURE

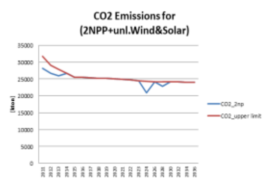
MESSAGE results for 3 Scenarios for Nuclear/Renewable ratio in the NEMix until 2035

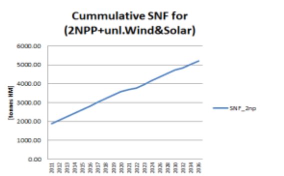
Goal: Select the optimal Nuclear/Renewable ratio in the NEMix until

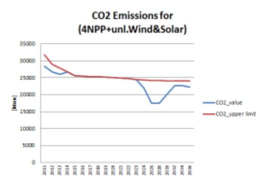


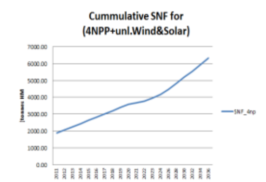


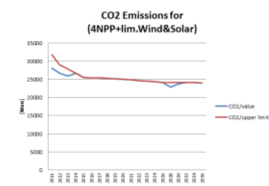


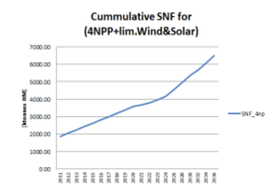


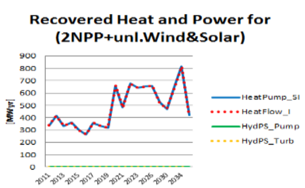


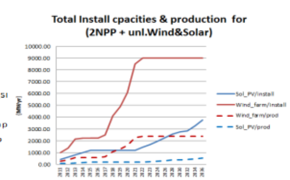


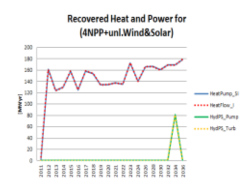


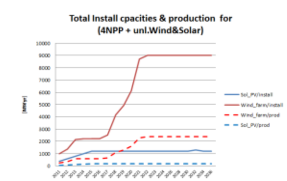


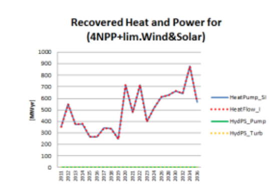


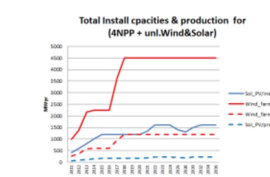












Nuclear fuel cycle

Large power emission free technology

New small modular reactors

Will fusion be in time ?

Conclusions

the results of evaluating the mitigation and adaptation measures to the risks in the energy system (considering only hydraulicity, wind and photovoltaic) lead to the need of coal capacities of at least 1000 MW

Security to gas supply may be enhanced with North South interconnectors that link the three seas in the East of the EU.

Climate change risk becomes important and an insurance policy should be considered fast.

The energy sector may not be regarded from only a commercial view point, its strategic importance as well as the social one make necessary taking into consideration noncommercial costs that must be internalized in the financing scheme to reach optimal decisions.

Transport

The largest local emitter

Home work:

Consider the energy consumed as fuel for transport in EU

Change transport to electric till 2050

Generate the same amount of energy to charge the batteries of the electric vehicles

How much new installed power will be needed each year and what will be the cost of investment ?

Potential subject for a study on green deal in transport.

Electrical busses used
in the centre of Rome

Buildings

40% of the energy consumption goes to buildings in the EU

Raising buildings efficiency involves various technologies e.g. thermal insulation, windows energy conversion materials, internal lighting, etc.

This leads to zero energy (passive) buildings as a component of smart cities concept, that could also store energy in cement batteries

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Thermal and visible image

Distributed generation for off grid buildings

Innovation

New technologies are needed, with short time to market, in order to achieve neutrality. Financing innovation is a must.

Suggestion: raise the budget deficit from 3% to 4% if the extra 1% is spent on innovation and implementation of new technologies toward neutrality.

Generate a coherent system of international cooperation to do research and latter to disseminate the results.

Involve corporate research and bring value added to the generated patents

Circular Economy

Change economic structure and dynamic from linear to circular

Devise innovative financial schemes for clean technological investments

Change waste liabilities into resource assets through new technologies to minimize and eventually eliminate carbon footprint.

THANK YOU

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