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RENEWABLE POWER GENERATION IN POLAND

POWER GENERATION IN 2011

POLISH POWER GENERATION 2011

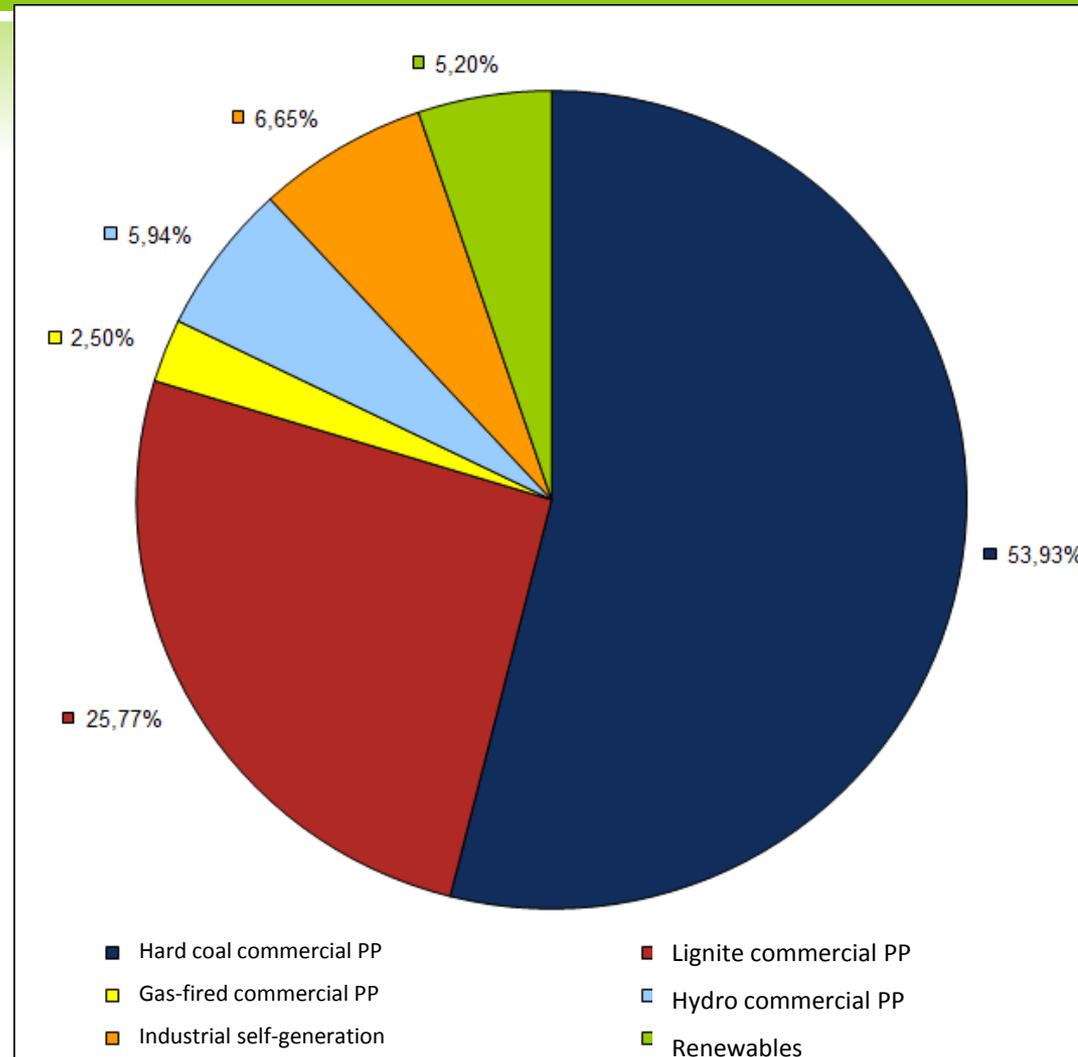
“Systemic” power stations

- Power plants which may be centrally dispatched from the National Power Dispatching Centre (TSO)
- 24 power plants, totally 25,370 MW, of them:
 - 5 hydroelectric plants
 - 1 CHP plant, hard coal
 - 18 condensing steam power plants, coal & lignite

Other (small-scale, industrial, CHPs)

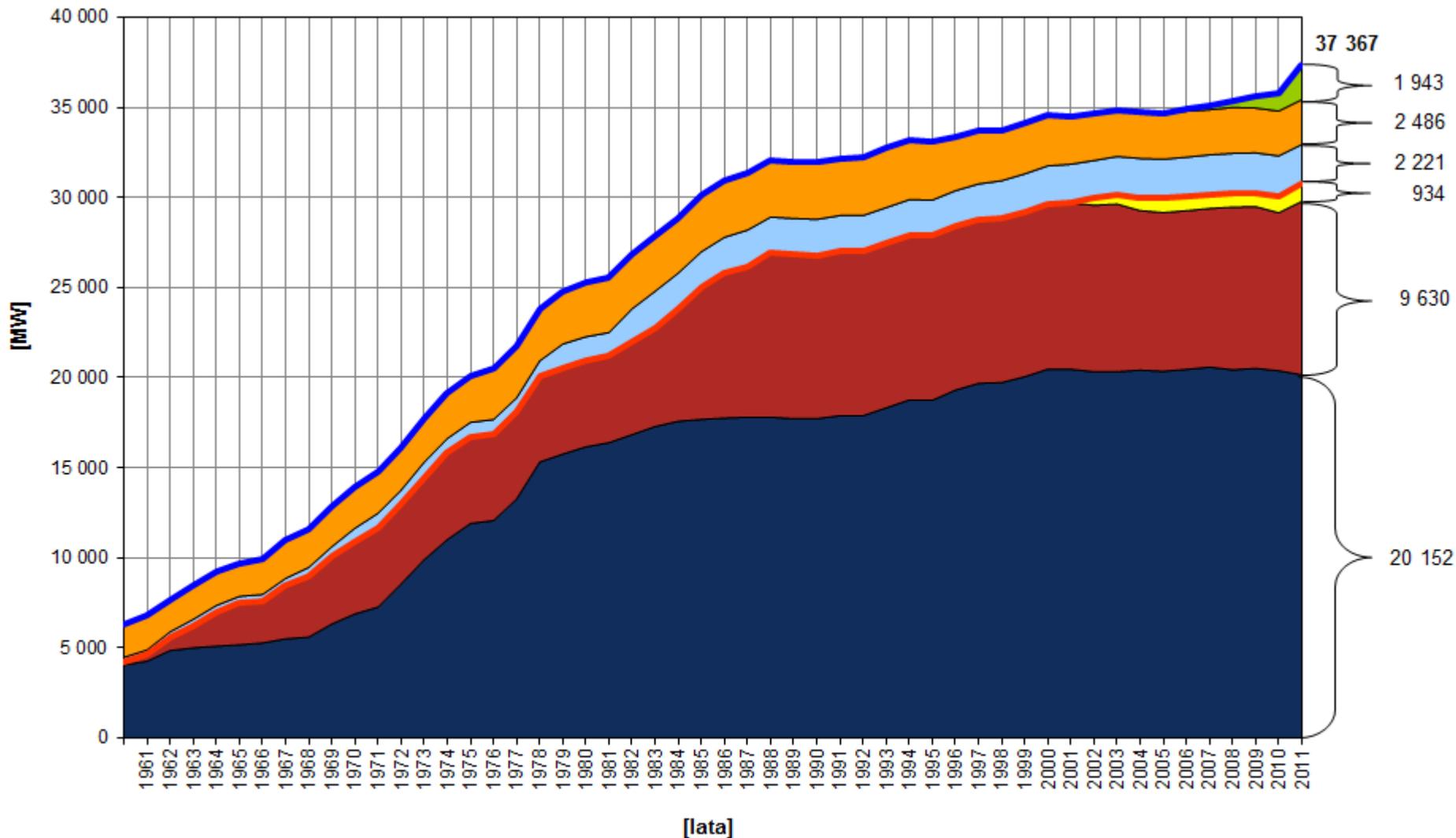
- 9200 MW, of them 1900 MW of wind power

INSTALLED CAPACITY 31 DECEMBER 2012



INSTALLED CAPACITY DEVELOPMENT

6



© 2010

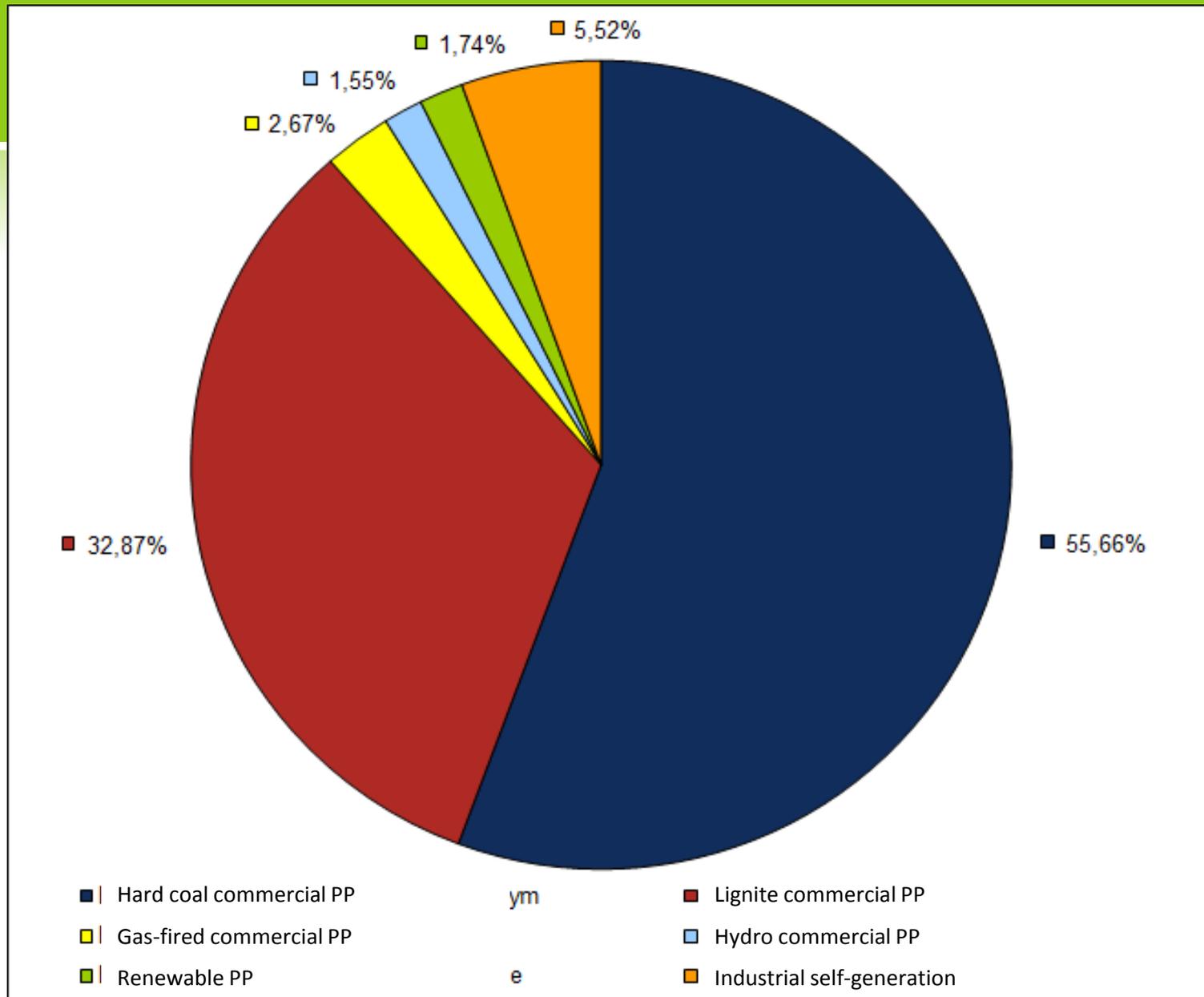
Hard coal commercial PP
Industrial self-gen

Lignite commercial PP
Renewables

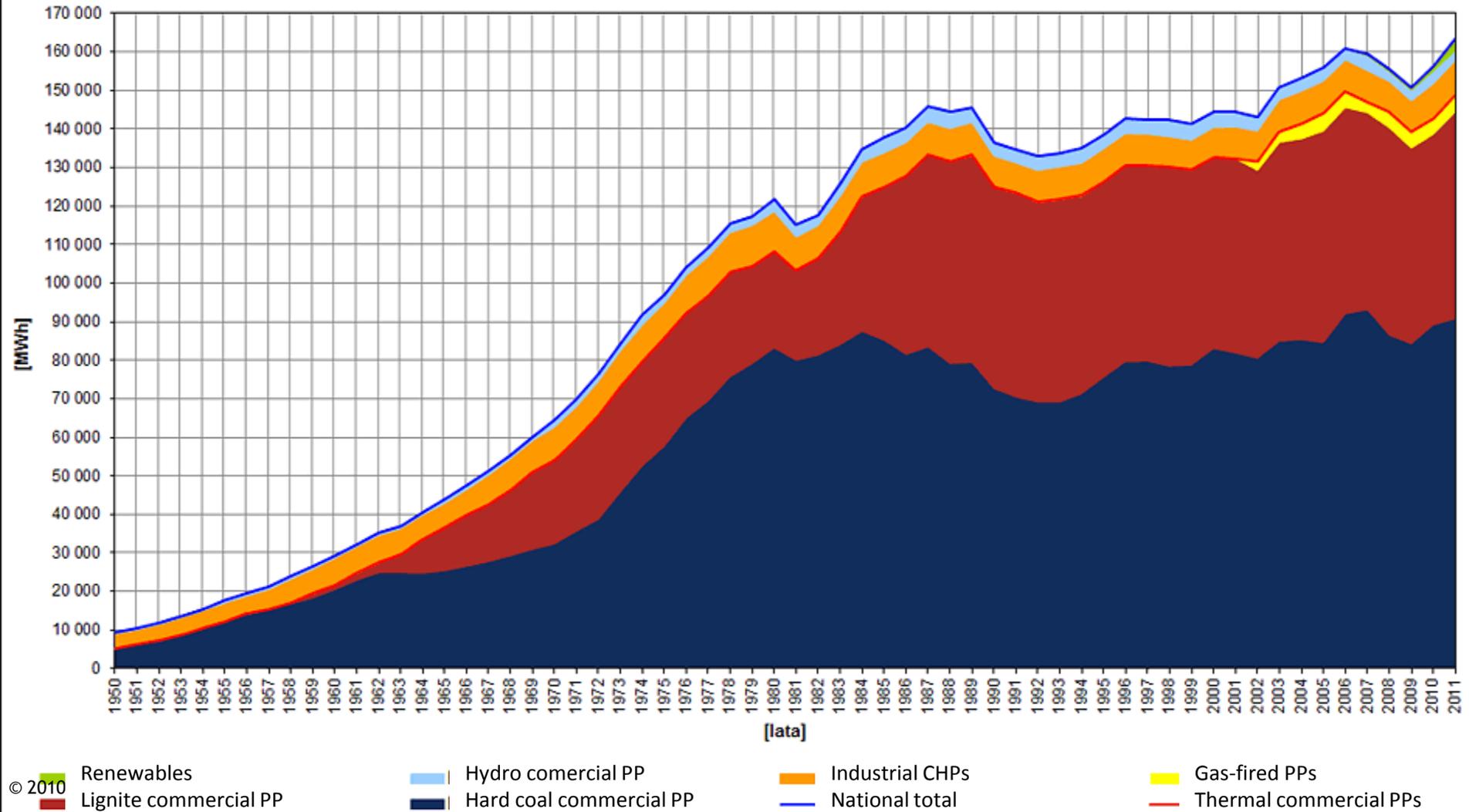
Gas-fired PP
National total

Hydro
Thermal commercial PPs

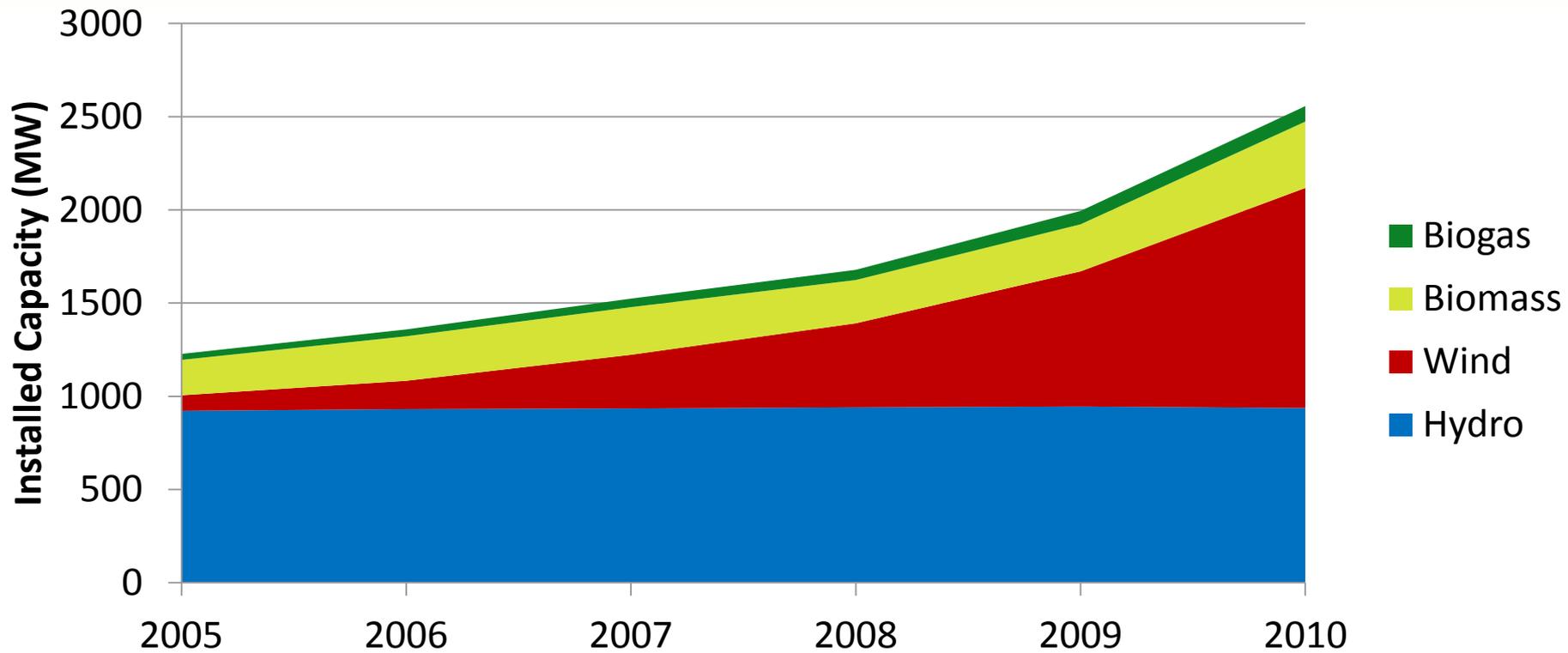
ELECTRICITY GENERATION 2011



ELECTRICITY GENERATION 1950-2009



RENEWABLES

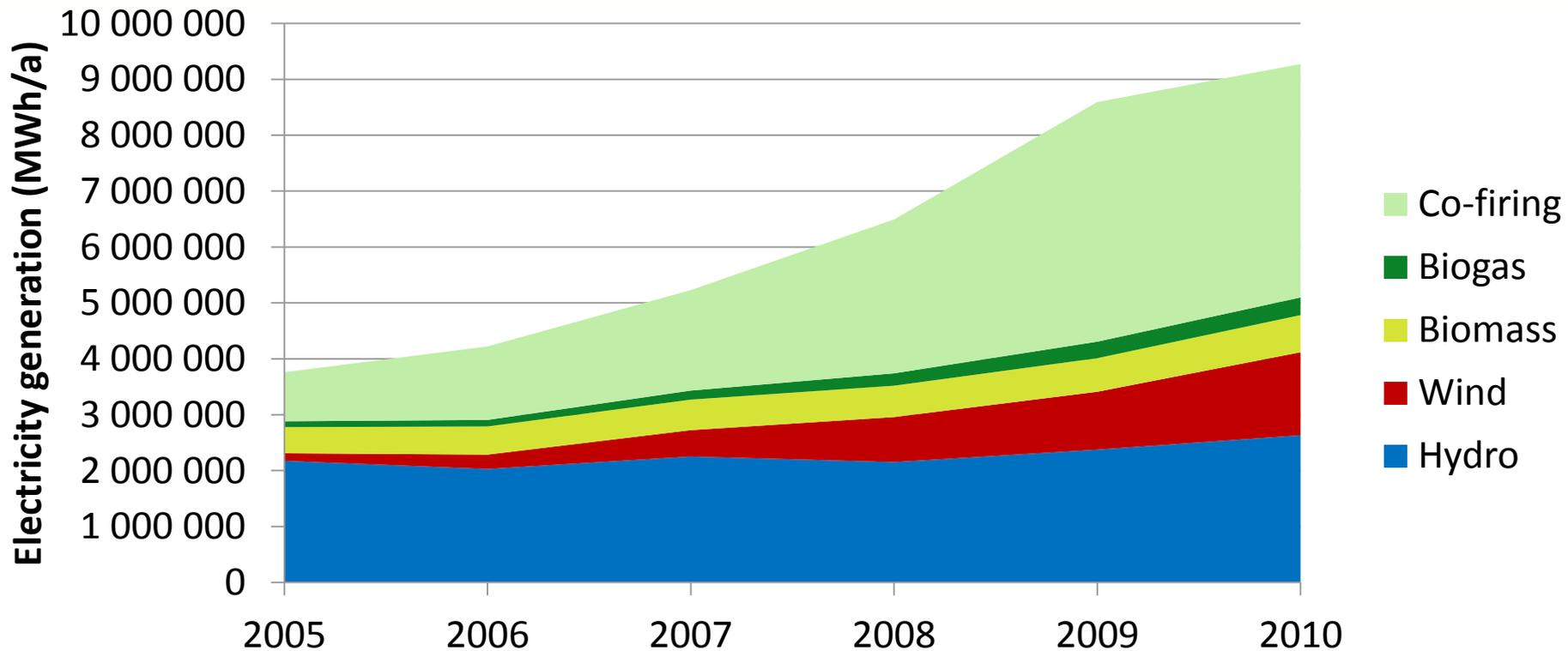


RENEWABLE POWER IN POLAND

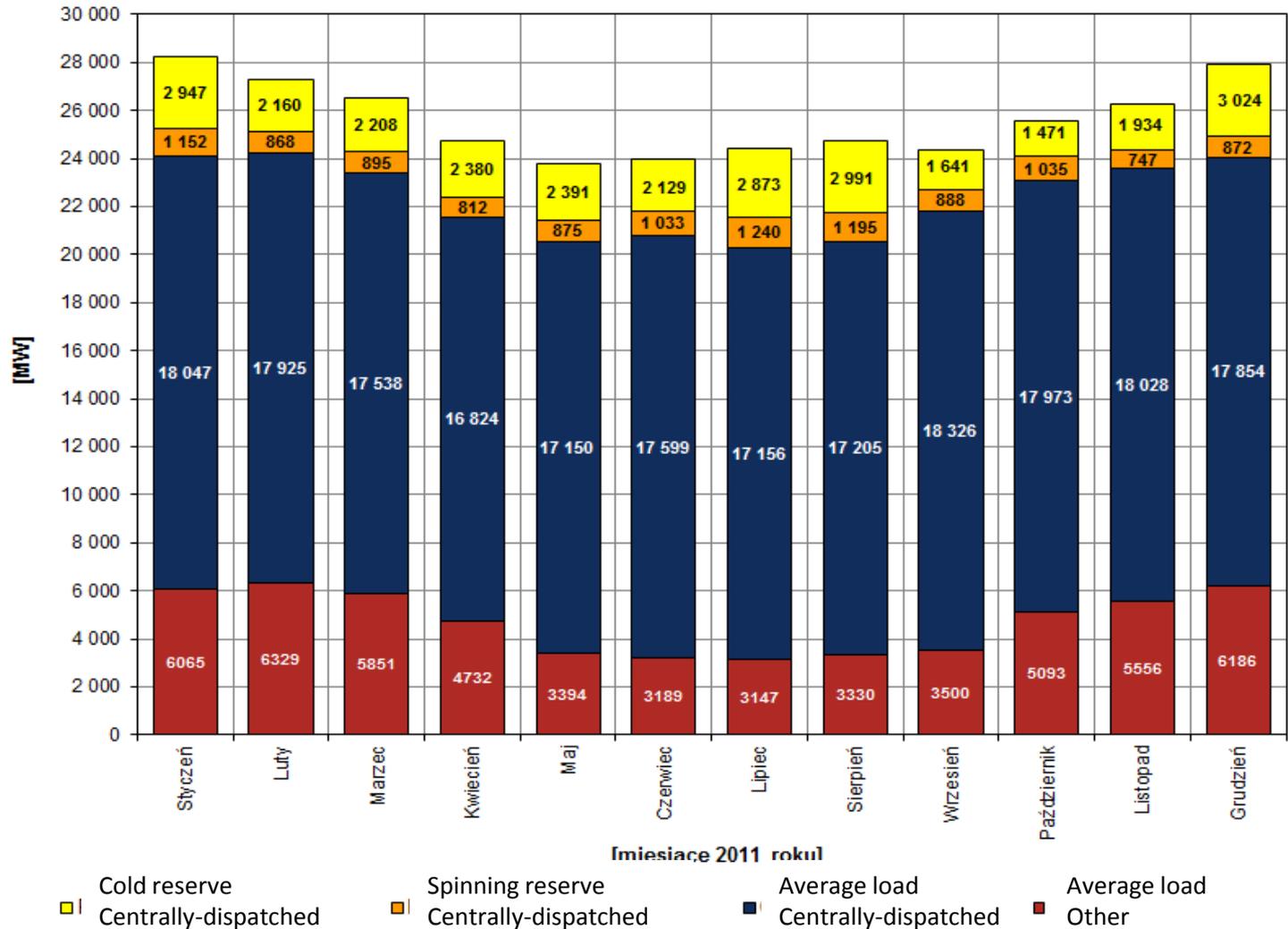
31 DECEMBER 2012

Type of plant	Number of plants	Installed capacity (MW)
Biogas	171	103.487
Biomass	19	409.679
PV	6	1.124
Wind	526	1616.361
Hydro	746	951.389
TOTAL	1468	3082,040
<i>Biomass co-firing</i>	45	N/A
<i>Biogas co-firing</i>	2	N/A

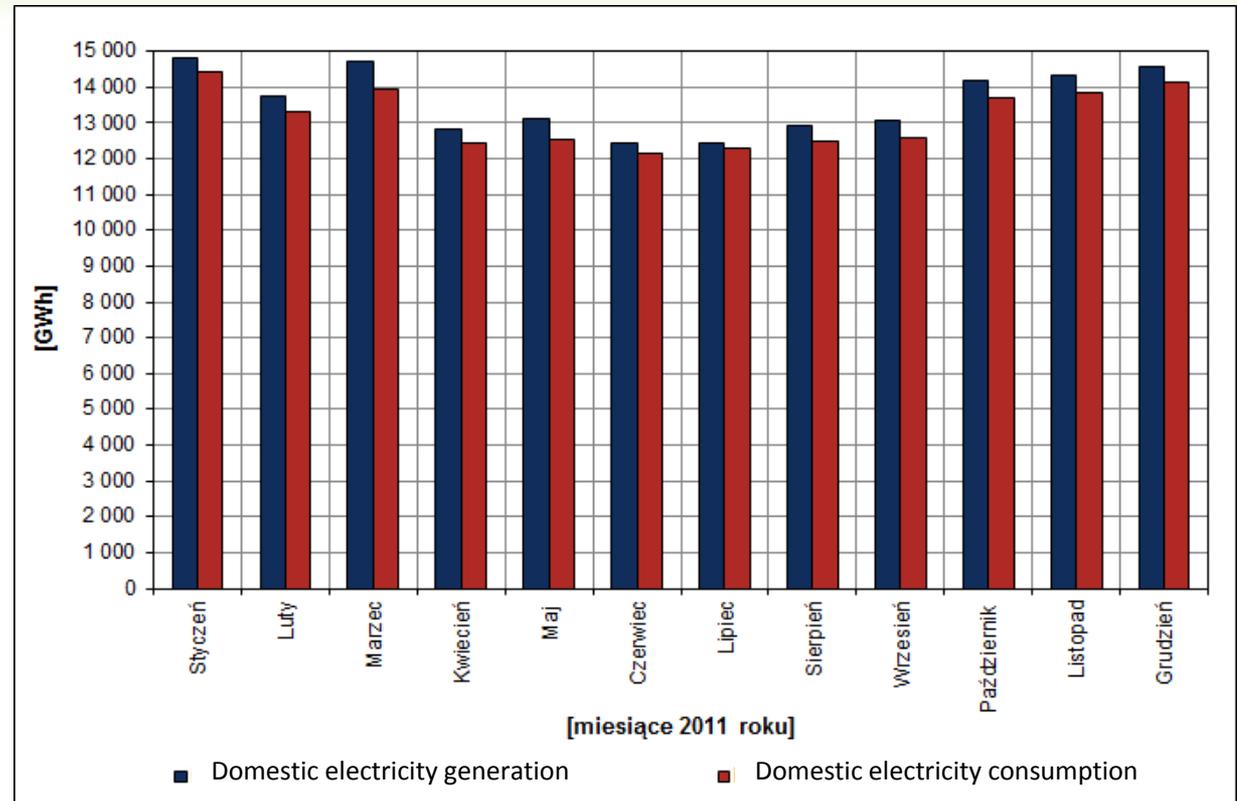
RENEWABLES



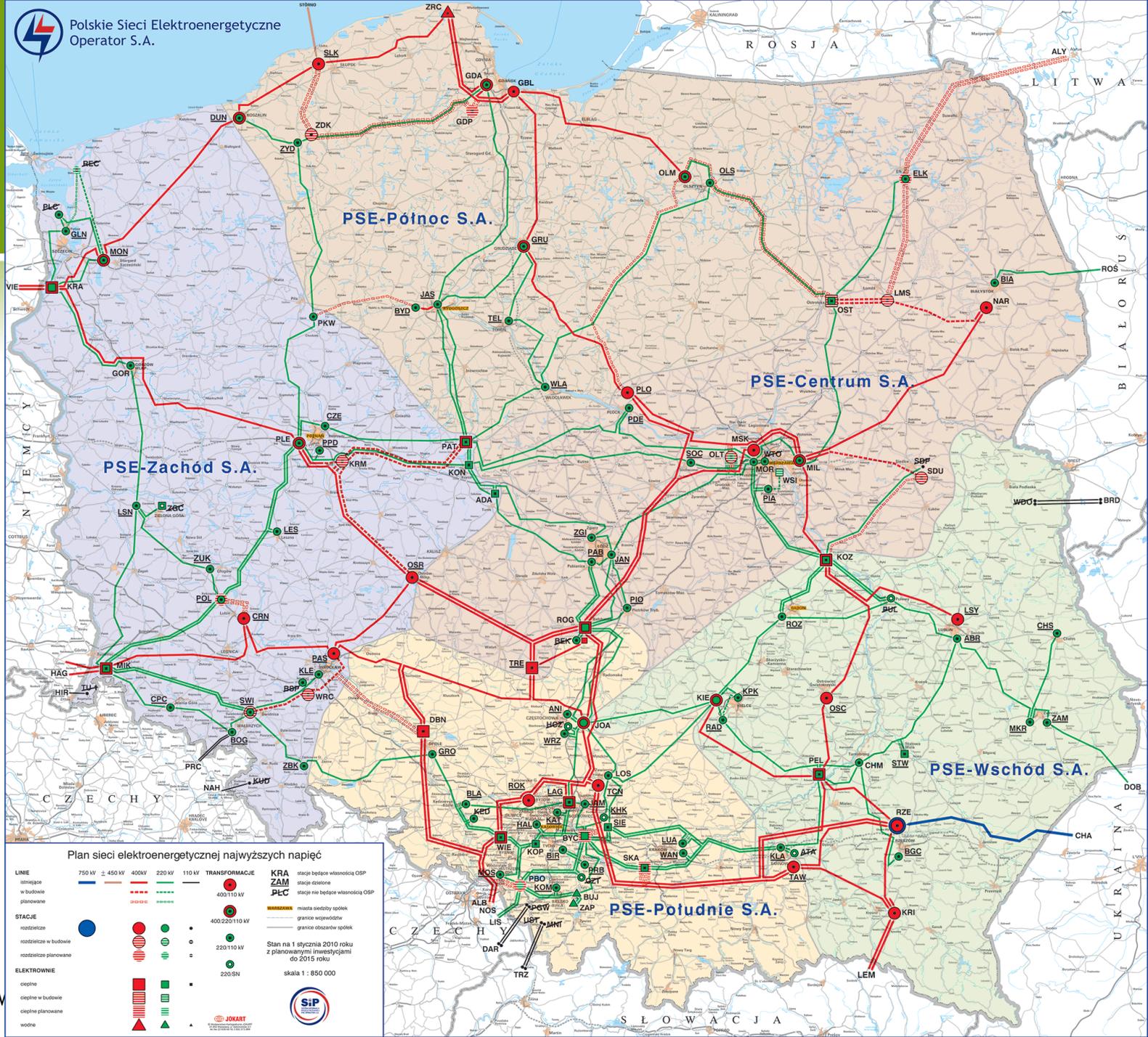
AVAILABLE POWER AND RESERVES



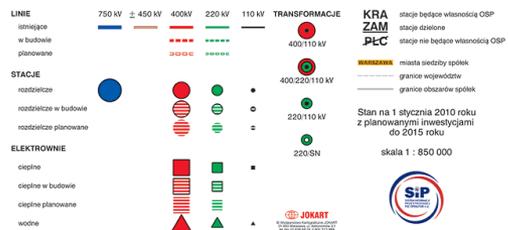
GENERATION VS CONSUMPTION



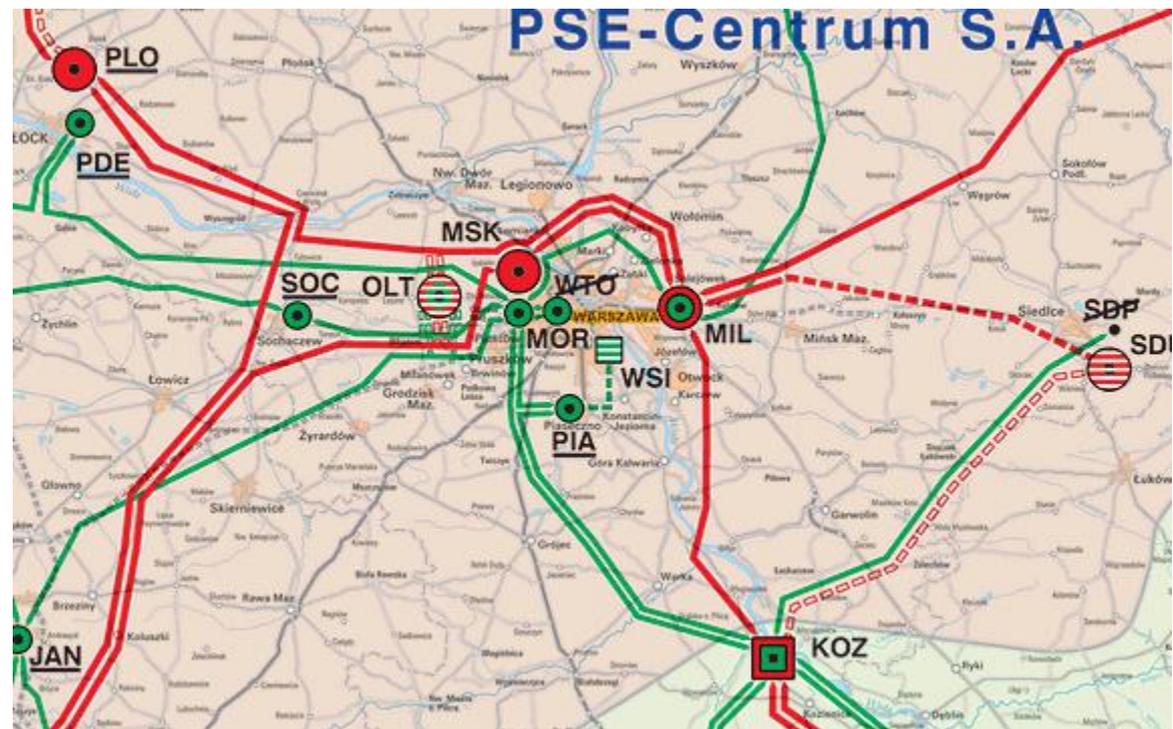
750 kV
400 kV
220 kV



Plan sieci elektroenergetycznej najwyższych napięć



POLISH TRANSMISSION SYSTEM



POLISH CROSS-BORDER CONNECTIONS

Germany

- Krajnik-Vierraden, 2 × 220 kV, 930 MVA (planned upgrade to 400 kV)
- Miłkowska-Hagenwerder/Kisdorf, 2 × 400 kV, 2 × 1385 MVA
- Turów-Hirschwelde, 110 kV

Czech Republic

- Boguszów-Porici, 110 kV
- Kudowa-Nachod, 110 kV
- Wielopole-Albrechtice/Nošovice, 2 × 400 kV, 2 × 1385 MVA
- Bujaków/Kopanina-Liskovec, 2 × 220 kV, 394+362 MVA

Slovakia

- Krosno/Iskrzynia – Lemšany, 400 kV, 2 × 1385 MVA

Ukraine

- Rzeszów-Khmelnitskaya NPP, 750 kV, 1300 MVA
(shut down in 1993, to be recommissioned with DC link)
- Zamość-Dobrotwór, 220 kV, 362 MVA (synchronized with Polish grid – radial system)

Belarus

- Wolka Dobrzyńska-Brest, 110 kV (private line connected to Polish distribution grid)
- Białystok-Ros, 220 kV, 362 MVA
(shut down in 2004, planned for reconstruction with DC link to Narew)

Sweden

- Słupsk-Starno, 450 kV DC, 600 MW

POLISH ENERGY POLICY 2030

KEY TARGETS

Improving energy efficiency

- Zero-energy economical growth
- Improved power generation efficiency (today ca 35%)
- Cutting down losses in transmission and distribution
- Increased energy consumption efficiency

Improving security of supplies

- New sources of natural gas and crude oil

Development of renewables

- 15% of renewables in 2020

Introduction of nuclear power

- 1 nuclear power unit expected in 2020
- Over 10% share of nuclear power generation in total generation in 2030

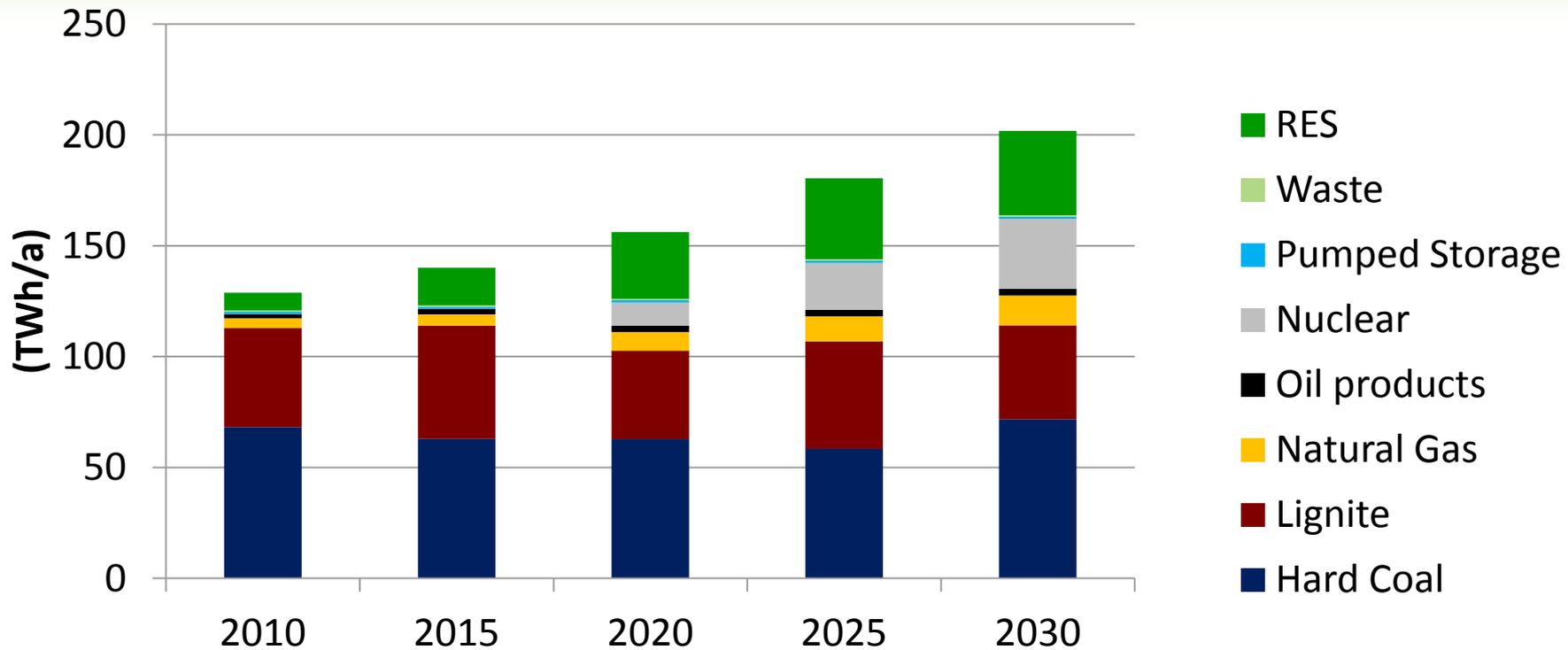
Development of competitive energy markets

- Electricity, heat, fuels

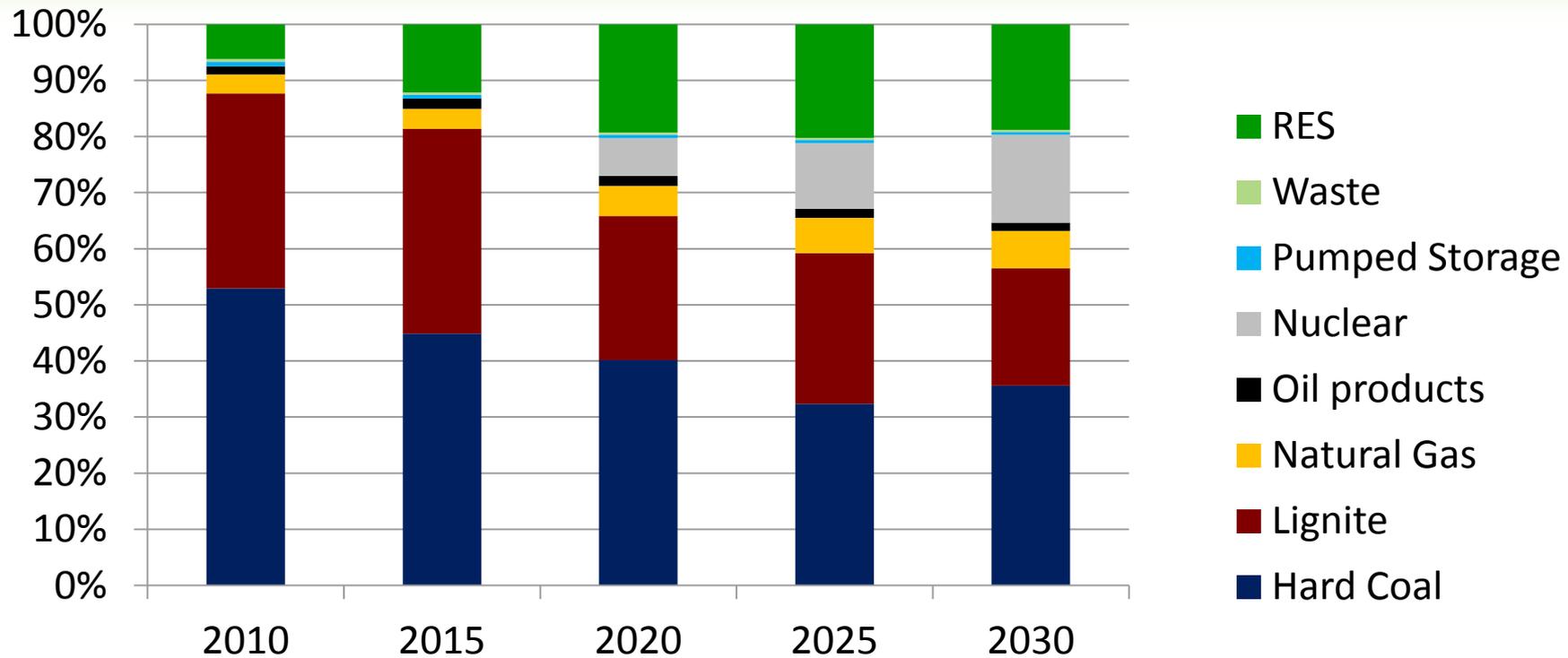
Limitation of environmental footprint

- Poland is supposed to implement full-auction ETS by 2020, until then some share (diminishing year-by-year) of emission allowances will be assigned free-of-charge.
- Cutting down PM, SO_x, NO_x emissions

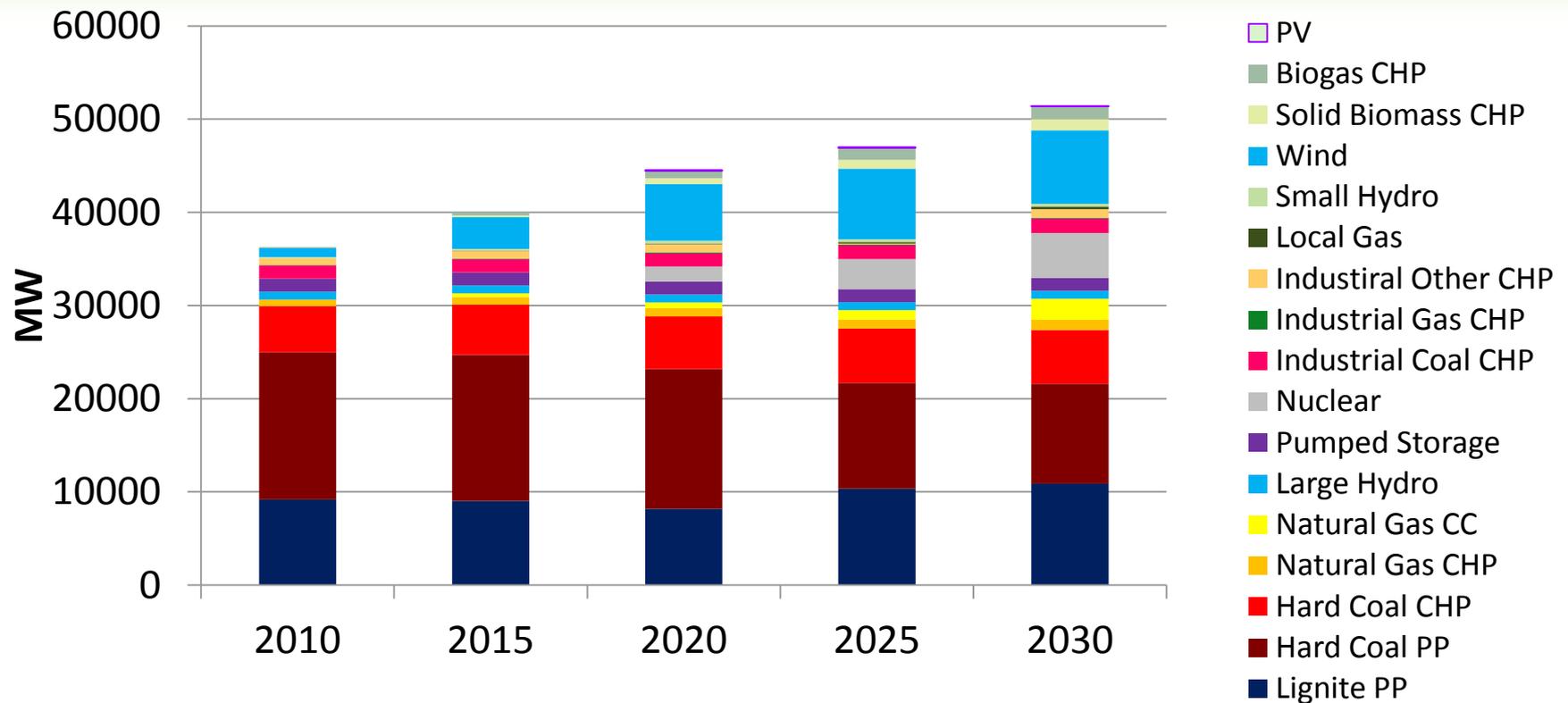
NET ELECTRICITY GENERATION BY 2030



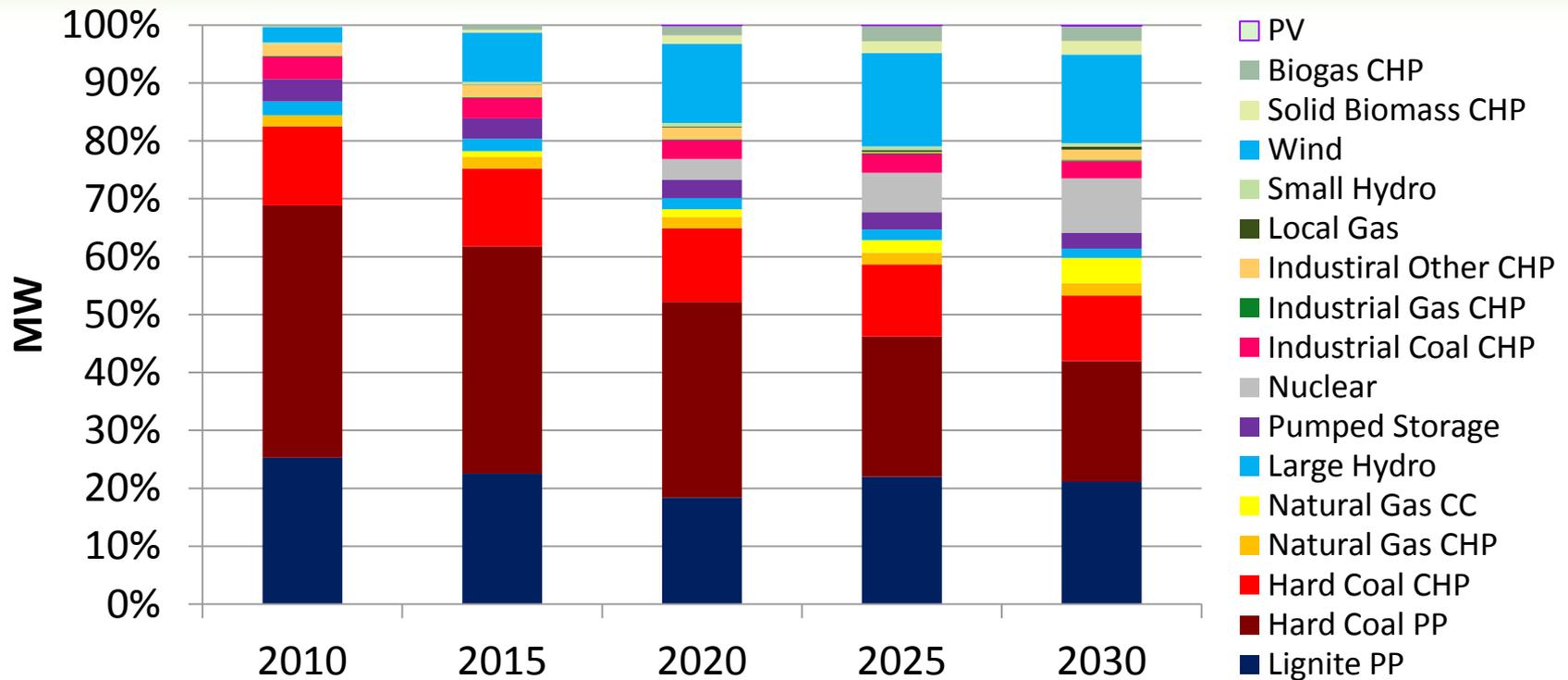
NET ELECTRICITY GENERATION BY 2030



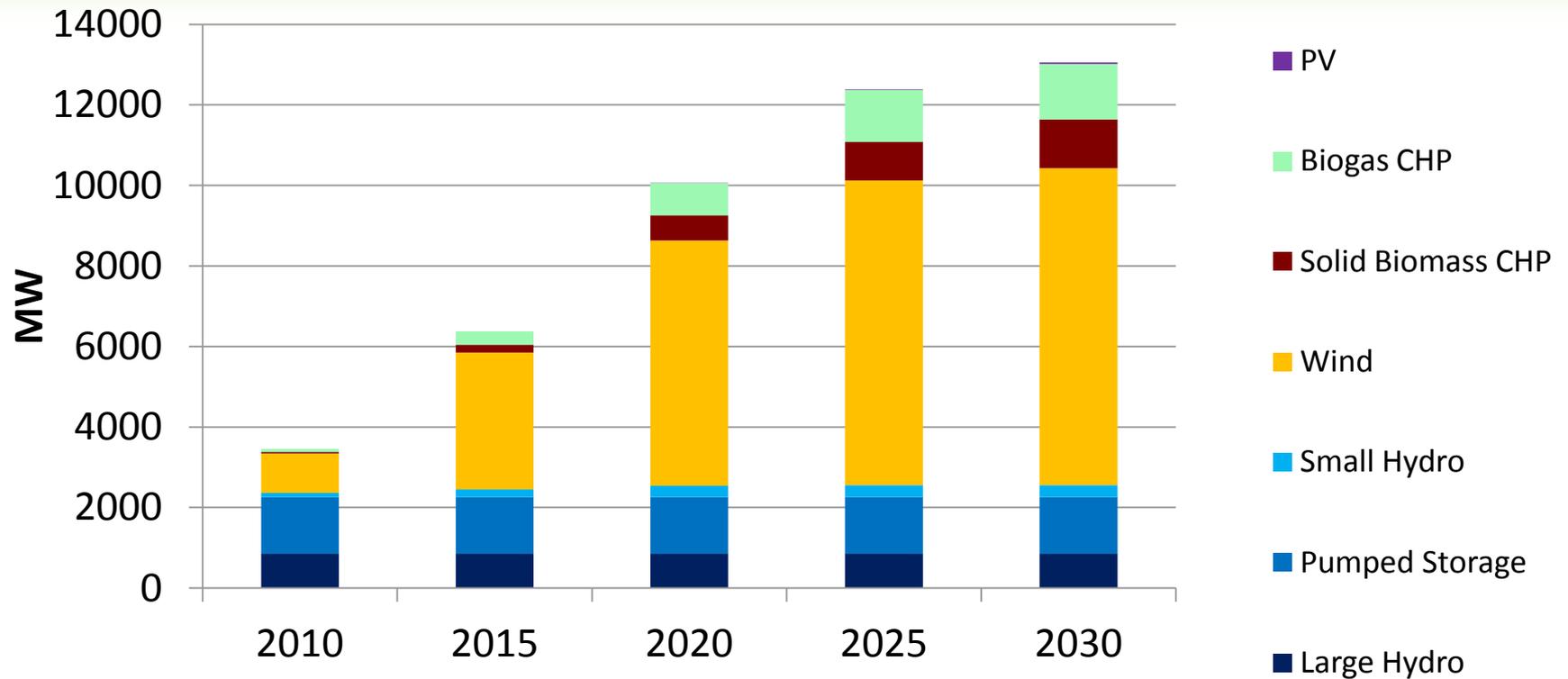
INSTALLED CAPACITY



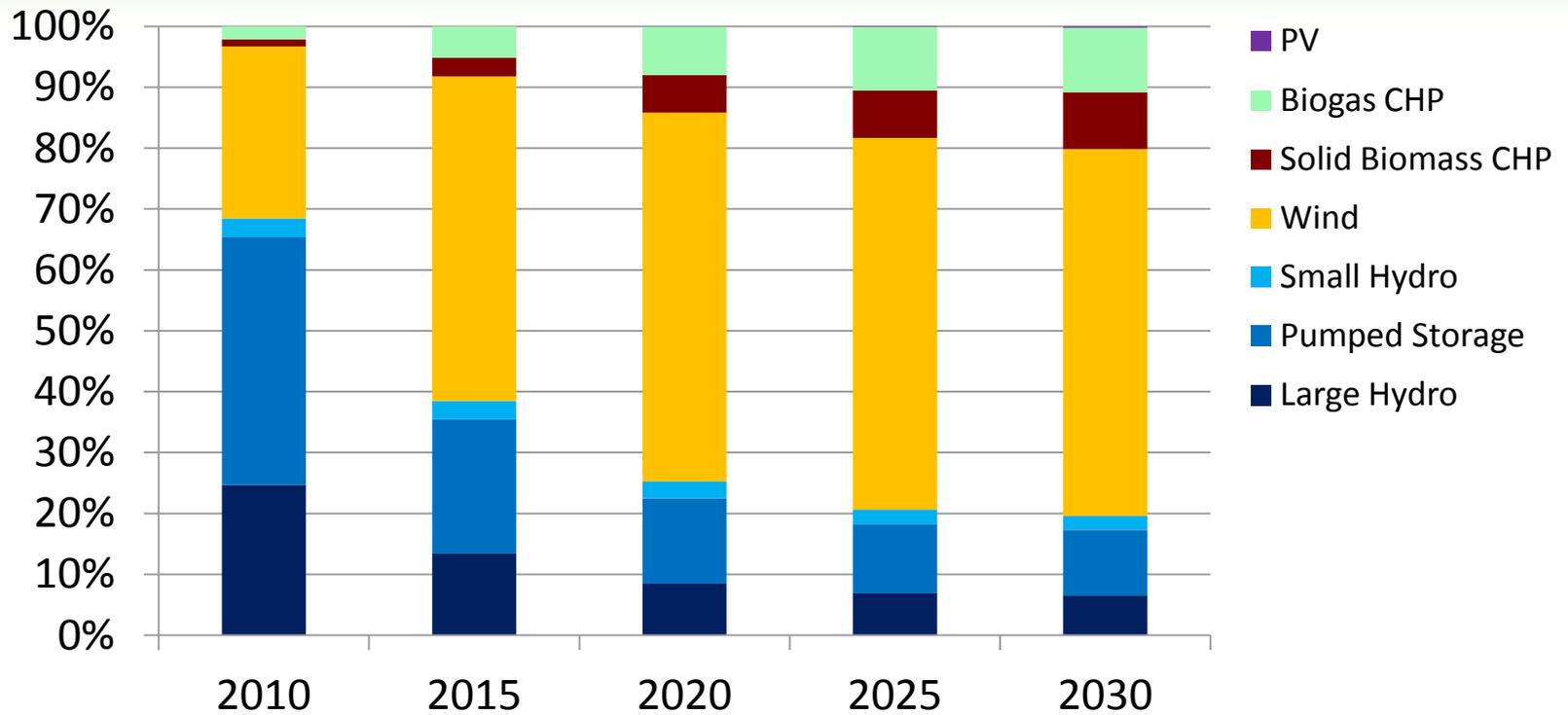
INSTALLED CAPACITY



INSTALLED RENEWABLE CAPACITY



INSTALLED RENEWABLE CAPACITY



RES DEVELOPMENT

Hydroelectricity

- No new large plants (what about Włocławek?)
- No new pumped storage (what about Młoty?)
- Limited development of small hydro (100→300 MW)

Wind

- Primary renewable technology for Poland
- Increase from 1000→7800 MW

Biogas/biomass

- Limited development

Photovoltaics

- Only pilot projects, 32 MW in 2030

INCENTIVES

Green certificates

- Renewable power generation

Yellow certificates

- High-efficiency CHP below 1 MWeI or gas-fired
- Annual average efficiency 75% for S.C. or 80% for CC
- Primary Energy Savings > 10%

Red certificates

- High-efficiency CHP over 1 MWeI and fired with non-gaseous fuel
- Annual average efficiency 75% for S.C. or 80% for CC
- Primary Energy Savings > 10%

Purple certificates

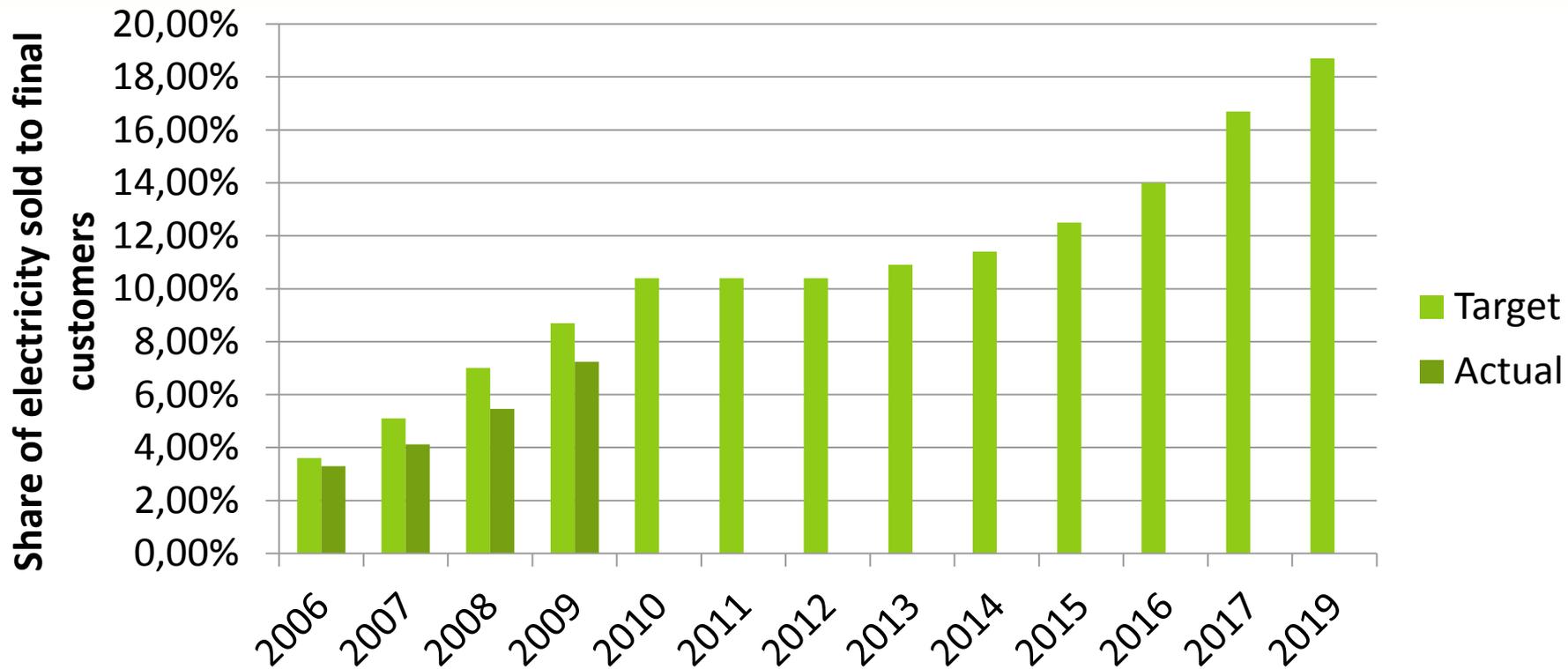
- Power generation using coal mine ventilation methane

INCENTIVES SYSTEM

- ⊙ The appropriate kind of certificate is issued by The Energy Regulatory Office (the ERO) to the PRODUCER of the electricity for each MWh of electricity generated in a “coloured” source.
- ⊙ Each ELECTRICITY DISTRIBUTOR is required to present to the ERO appropriate number of each kind of certificates at the end of the year (he has to prove, that no less than certain percentage of electricity it delivered was produced in green, yellow and red sources). For each lacking certificate the company has to pay a **penalty fee**.
- ⊙ The certificates can be freely traded on the market and do not have to “follow” the electricity.



“CERTIFIED” ENERGY



HYDROELECTRICITY IN POLAND

HYDROELECTRICITY IN POLAND

Flow-type plants

- > 50 MW: 1 plant, Włocławek, 160.2 MW
- 10-50 MW: 5 plants, 129.6 MW
- 5-10 MW: 6 plants, 48.2 MW
- 1-5 MW: 60 plants, 136.4 MW
- 0.3-1 MW: 85 plants, 51.3 MW
- < 0.3 MW: 586 plants, 43.0 MW

Pumped storage / Flow

- Dychów, 91.3 MW
- Niedzica, 92.75 MW
- Solina, 198.6 MW

Pumped storage

- Żarnowiec, 716 MW
- Porąbka-Żar, 500 MW
- Żydowo, 156 MW

ELEKTROWNIA WODNA ŻARNOWIEC

Upper reservoir – Czymanowo

- Area 122 ha
- Capacity 13 million m³

Lower reservoir – Żarnowiec Lake

Power plant

- 4 reversible turbine-pump Francis units
- Pumping power 4 × 200 MW
- Power generation capacity 4 × 179 MW
- Dispatched remotely from KDM in Warsaw
- Commissioned in 1983, planned to cooperate with NPP

ELEKTROWNIA WODNA ŻARNOWIEC



ELEKTROWNIA WODNA WE WŁOCŁAWKU

Dam on Vistula River

- Head 8.8 m

Reservoir – Włocławek Lake

- Length 58 km, average width 1.2 km
- Capacity 408 million m³

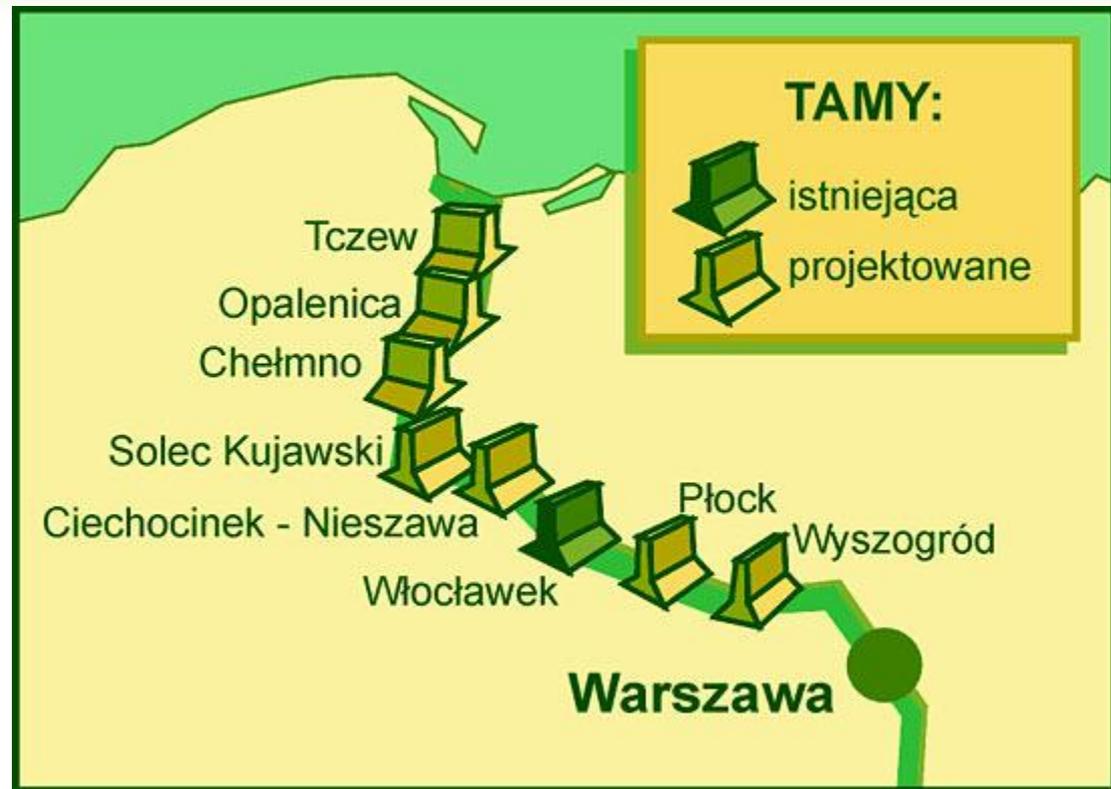
Power plant

- 6 Kaplan Turbines, 160.2 MW
- Nominal flow 2190 m³/s, head 8.80 m
- Average generation 739 GWh/a
- Commissioned in 1970

ELEKTROWNIA WODNA WE WŁOCŁAWKU



LOWER VISTULA CASCADE AS ORIGINALLY PLANNED



PROBLEMS WITH WŁOCLAWEK DAM

Problem

- Dam designed as a part of a cascade
- Actual head higher than designed value
- Excessive forces – poor technical condition
- Action required!

Solution

- Demolish the dam
- Complete the cascade as planned in 1970s
- Construct one supporting dam downstream from Włocławek

ZEW SOLINA MYCZKOWCE

Two dams on San river

- Solina Dam – gravity dam, upstream
Length, 664.8 m, height 81.8 m
- Myczkowce Dam – earth dam, downstream
Length 386.0 m, height 17.5 m
Flow stabilization

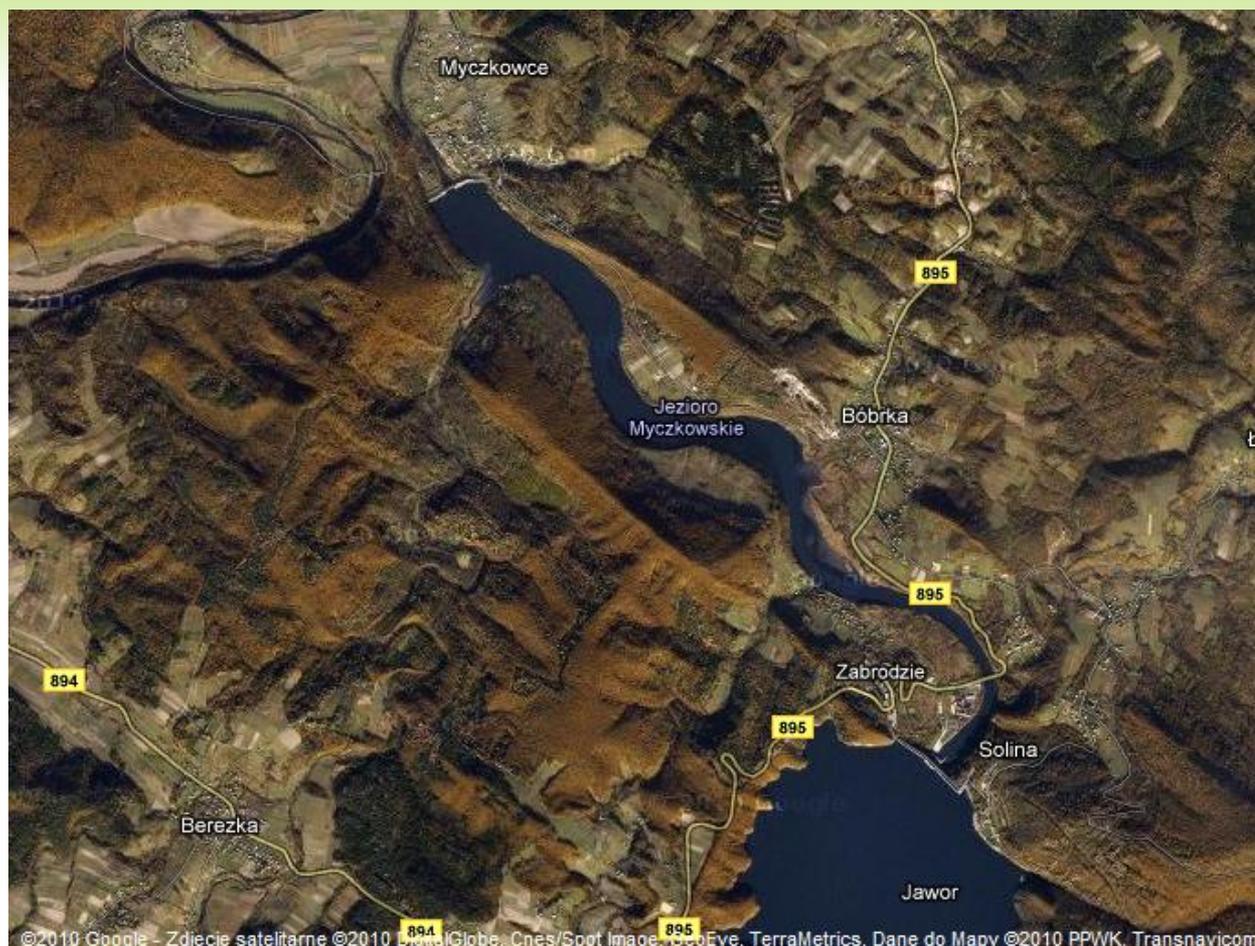
Two reservoirs

- Solińskie Lake
- Myczkowskie Lake

Two power stations

- EW Solina – 198.6 MW, 4 × Francis turbines
May operate as pumped storage (2 turbines reversible)
- EW Myczkowce - 8.3 MW, 2 × Kaplan turbine –
– flow of the river plant

ZEW SOLINA MYCZKOWCE



SOLINA DAM



Pumped storage plant

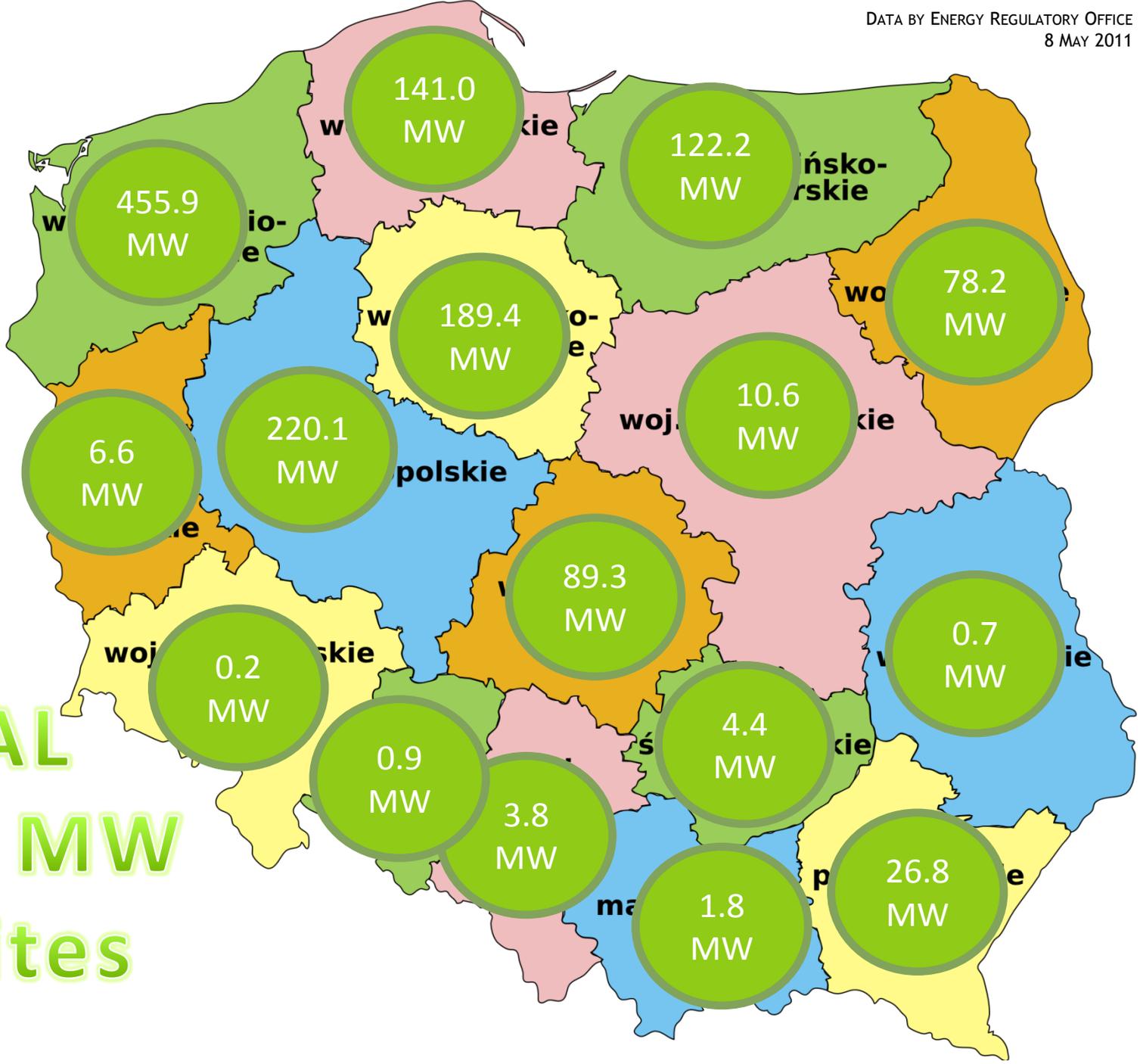
- 3 × 250 MW
- Located in village Młoty, near Bystrzyca Kłodzka
- Head 80 m, channels 345 m long

Project history

- Project started in late 1960s
- Underground channels drilled in 1980s
- Project abandoned in 1990
- Owned by Kogeneracja S.A. (EDF)
- Completion investigated – estimated cost PLN 2 bn.
- Building permit valid until 2015

41

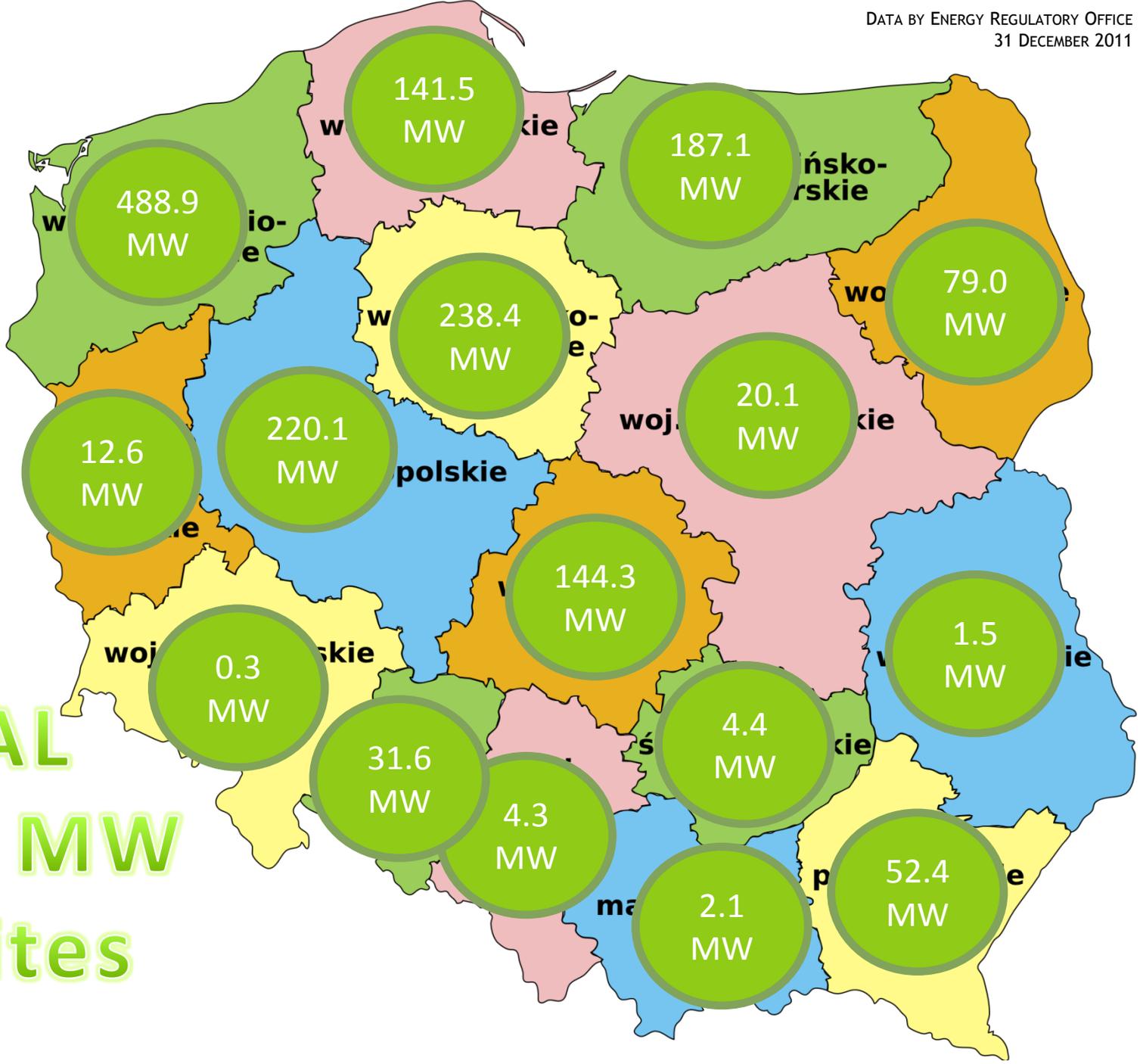
MAY
8
2011



TOTAL
1351.8 MW
453 Sites

42

DECEMBER
31
2011

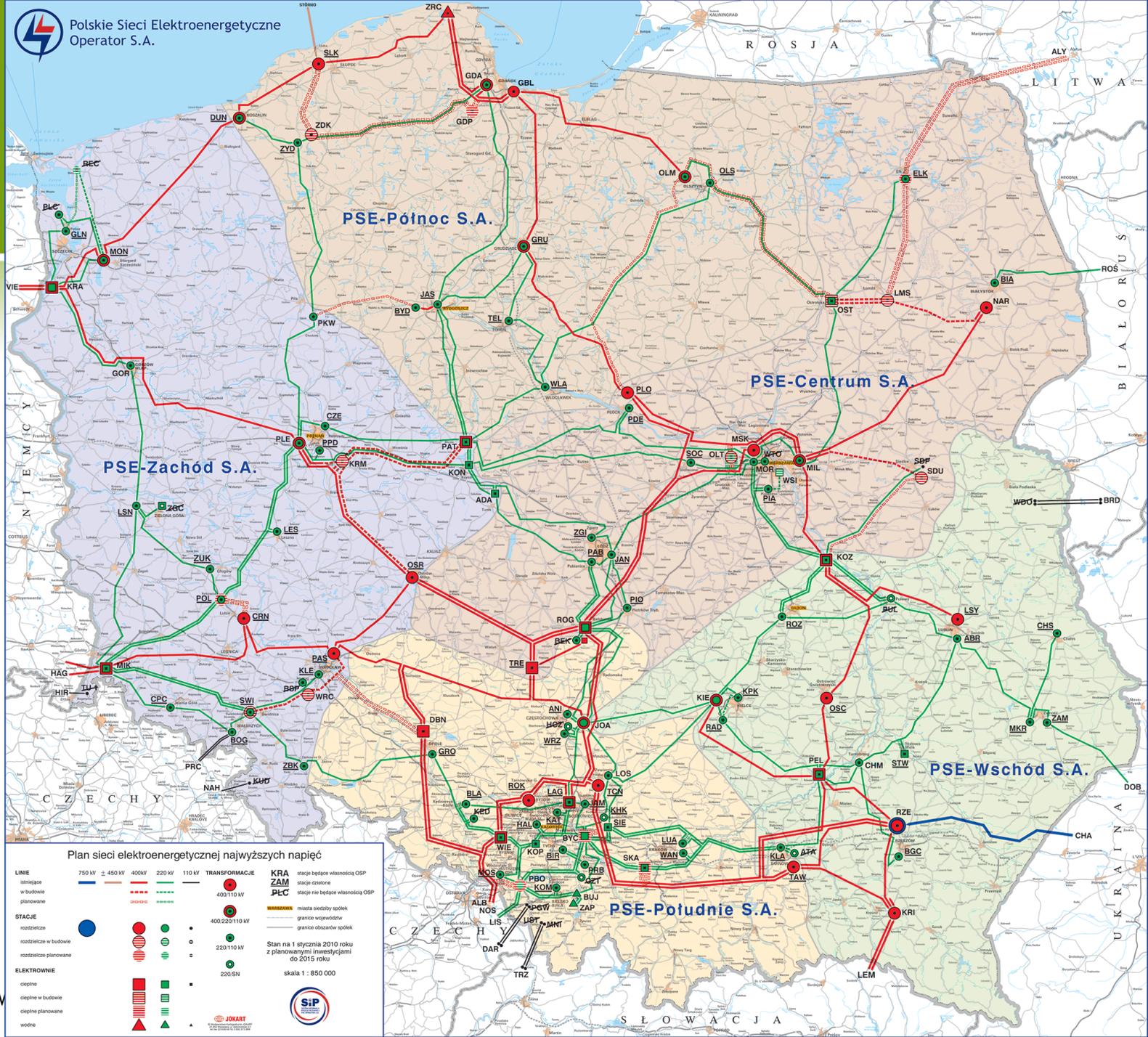


TOTAL
1616.4 MW
526 Sites

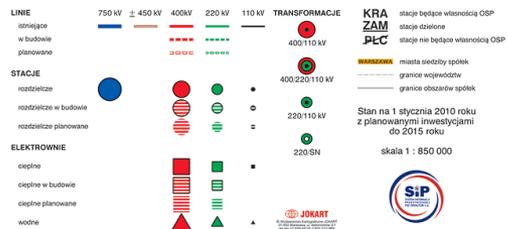
WIND POWER DEVELOPMENT

	Market potential by 2020 (EC BREC IEO)	Policy forecast by 2020	Market potential by 2030 (ARE S.A.)	Policy forecast by 2030
Wind power capacity (MW)	15,250	6089	17,450	7867
Annual generation (TWh/a)	33.5		40.0	
Average utilization time (h/a)	2200		2300	
Offshore projects capacity	550		1650	
Offshore generation (TWh/a)	1.7		5.0	
Offshore utilization time (h/a)	3000		3000	

750 kV
400 kV
220 kV



Plan sieci elektroenergetycznej najwyższych napięć

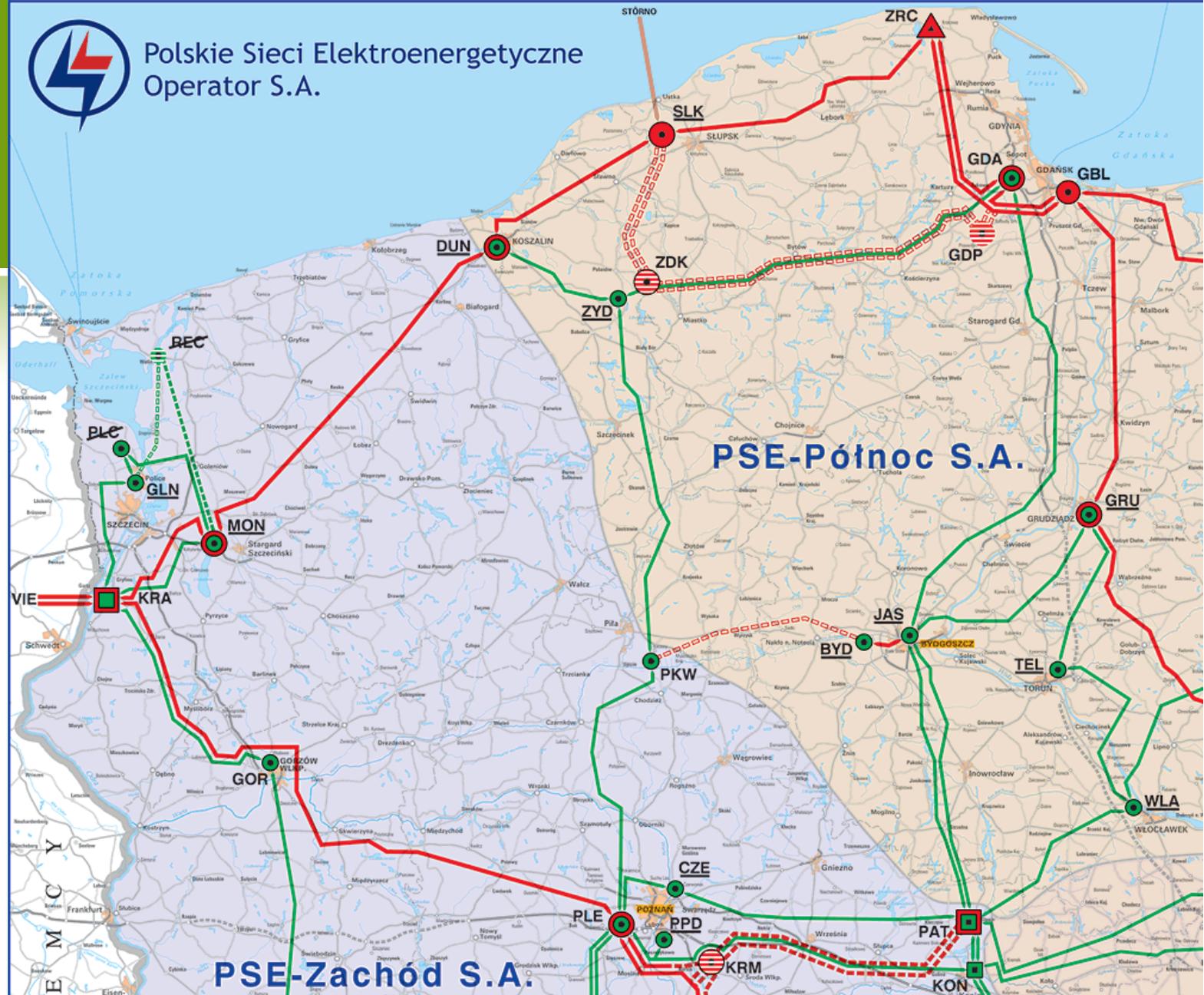




Polskie Sieci Elektroenergetyczne
Operator S.A.

45

750 kV
400 kV
220 kV



BIOGAS POWER IN POLAND

BIOMASS POWER GENERATION 2012

Type of plant	Number of plants	Installed capacity (MW)
Wastewater treatment	67	35.555
Agricultural	15	15.343
Landfill gas	87	53.659
Mixed biogas	2	0.930
TOTAL	171	103.487
<i>Biogas co-firing</i>	2	N/A