Hydropower in Poland
- looking forward for a new stimulus

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HYDROPOWER EUROPE

Nordic Workshop
28-29 August 2019
Lulea University of Technology
Lulea-Sweden

- macroeconomic data of the country
- current status of the power sector
- hydropower potential and its use
- development trends
- challenges and opportunities
- projects under development

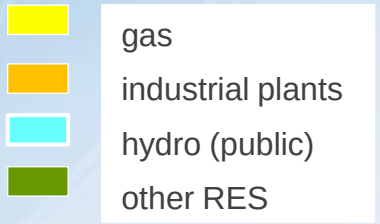
Wloclawek HPP, 162 MW
Vistula river, commissioning 1970
the latest large classic hydropower plant in Poland

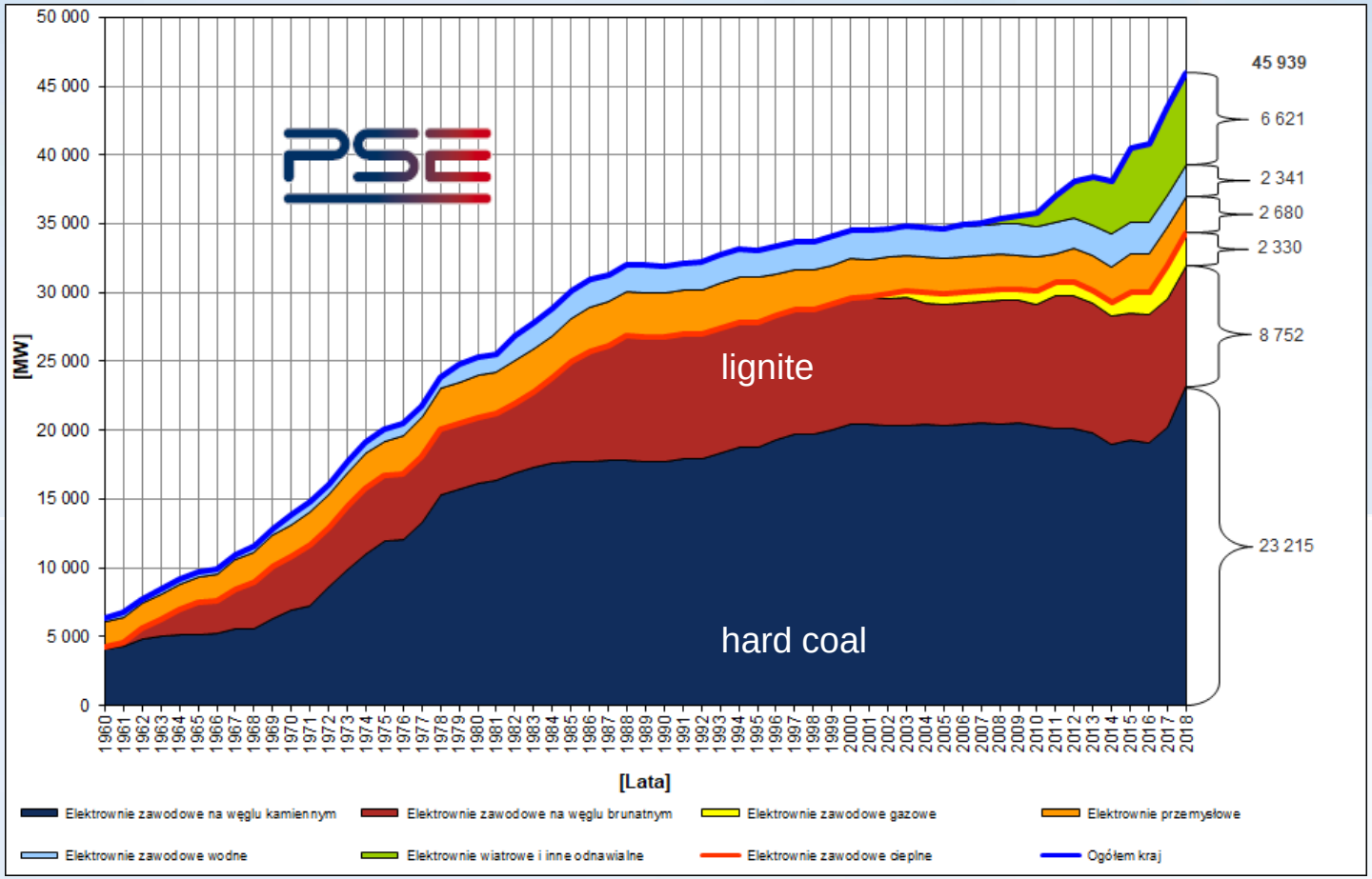
Macroeconomic data

Surface	312 500	km^2
Population	38,4	mln
GDP	466	mld EUR
Unemployment (2017)	7,0	%
Renewables share	10,9	%

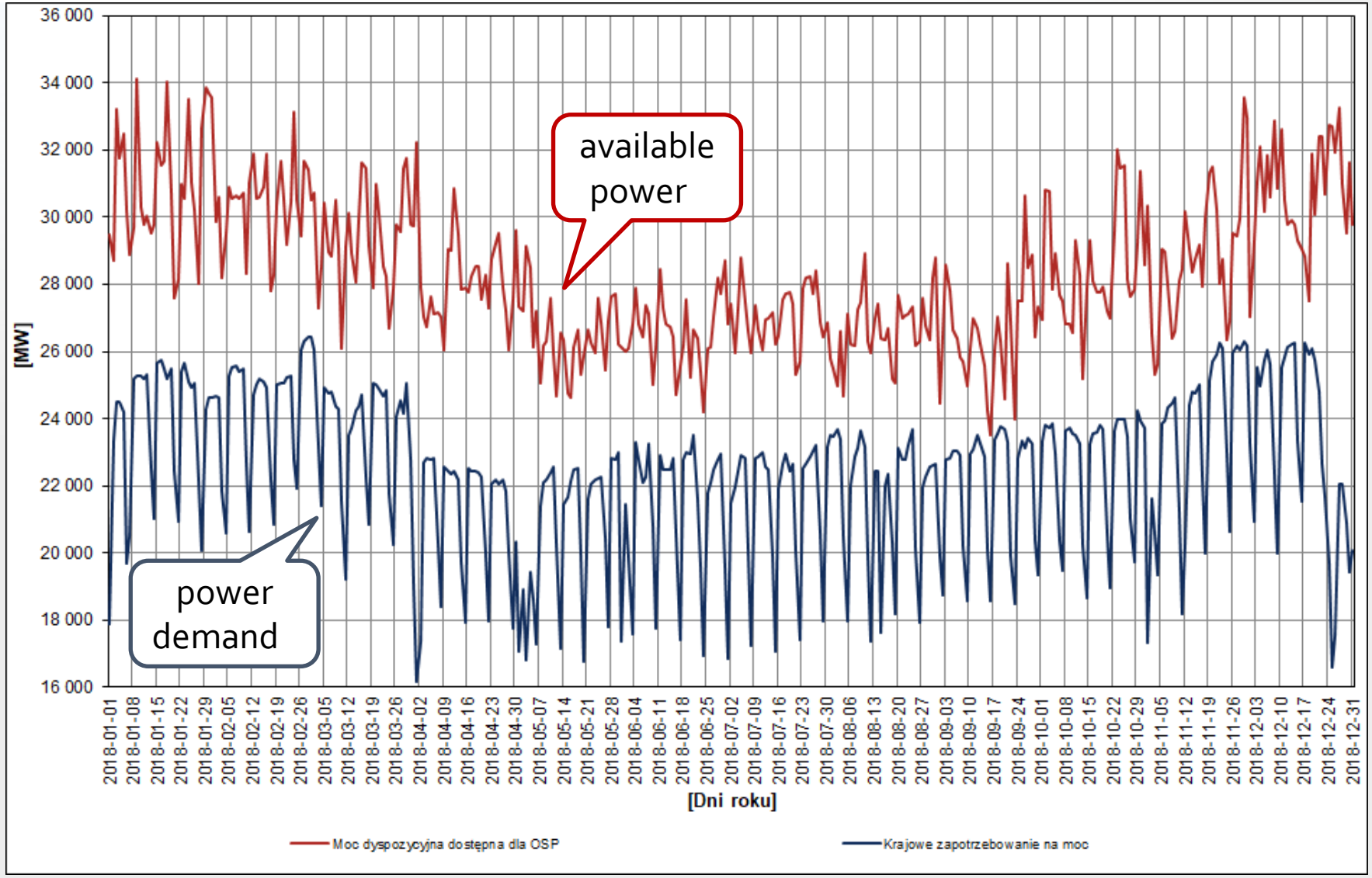
Electrical power sector (2018)

installed power	45 939	MW
generation	165 214	GWh
consumption	170 932	GWh
renewables generation (2017)	24 122	GWh
renewables share (2017)	14,5	%





Out of the PSE power balance for the year 2018



Out of the annual PSE power balance for May 2019

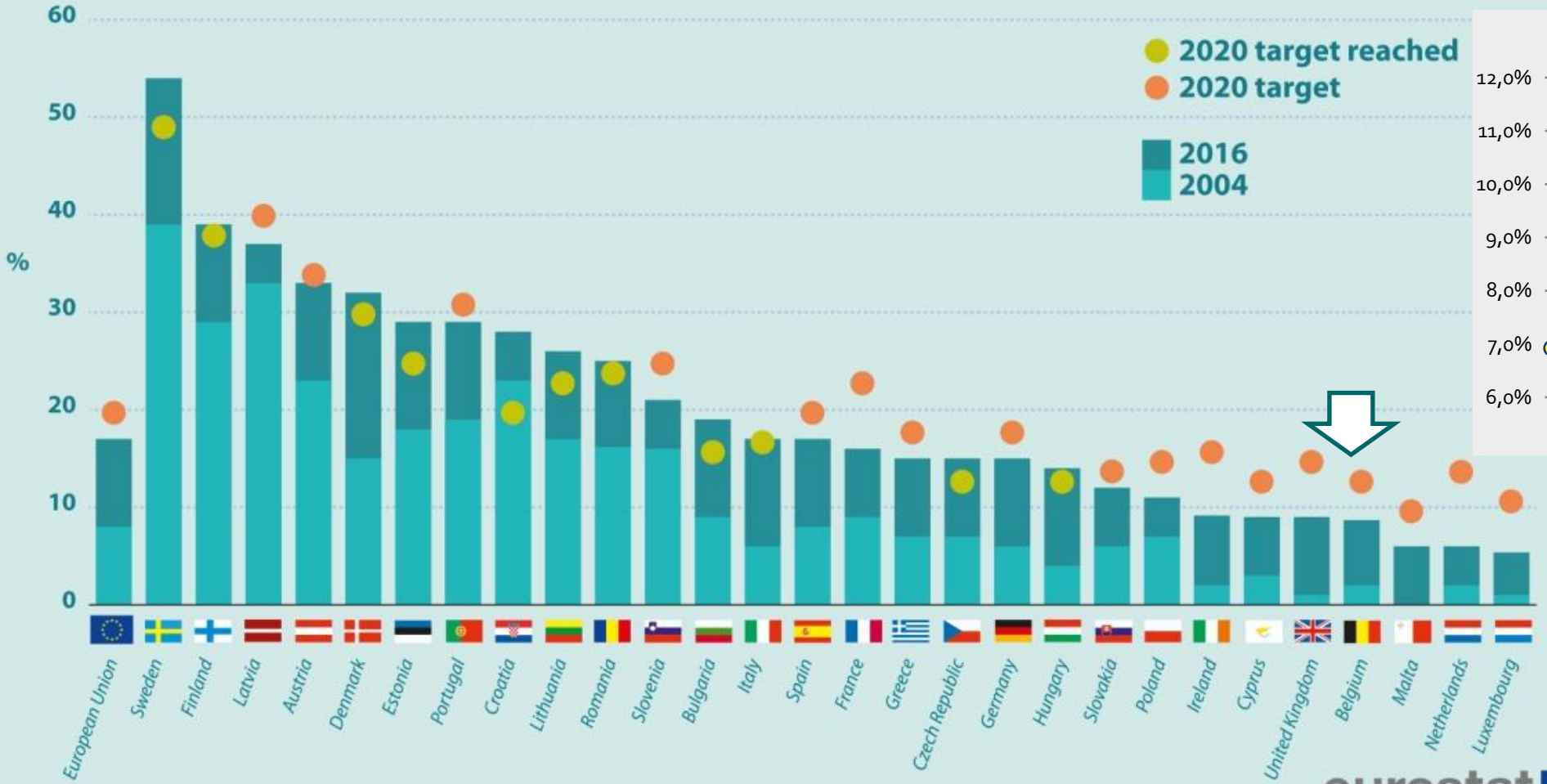
Attainable capacity of Polish power plants, MW	45 802
Attainable capacity of CD Units, MW	29 285
Attainable capacity of CD Thermal Units, MW	27 579
Attainable capacity of CD Hydraulic Units, MW	1 706
Attainable capacity of Wind Units, MW	5 917
CD Units capacity as available for the TSO, MW	22 640
Capacity of Polish power plants as available for the TSO, MW	**26 742**
Power demand of Poland, MW	**22 750**
Power surplus available for the TSO, MW	3 992
Power surplus required by the TSO, MW	4 095
Difference between the power surplus available and required by the TSO, MW	**-103**

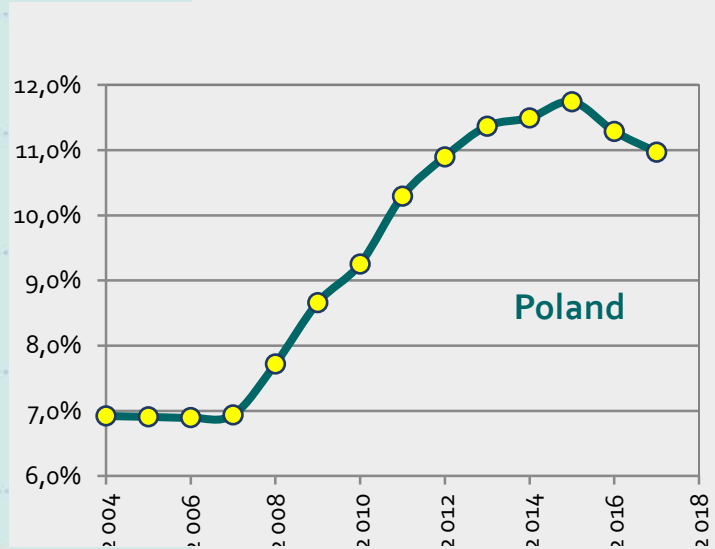
CDU – Centrally Dispatched Unit

TSO – Transmission System Operator

Share of energy from renewable sources in the EU Member States

(in % of gross final energy consumption)



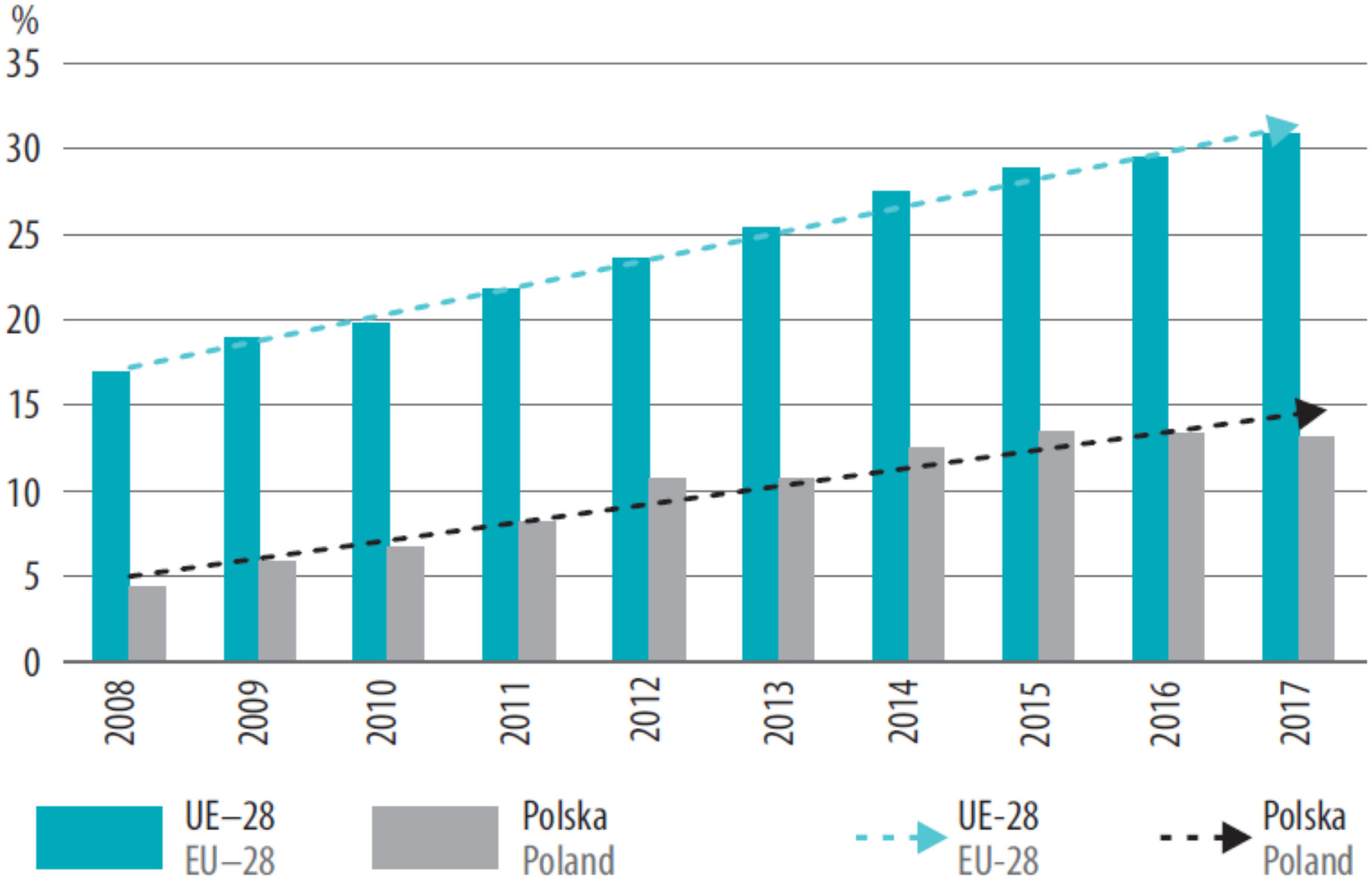


GUS

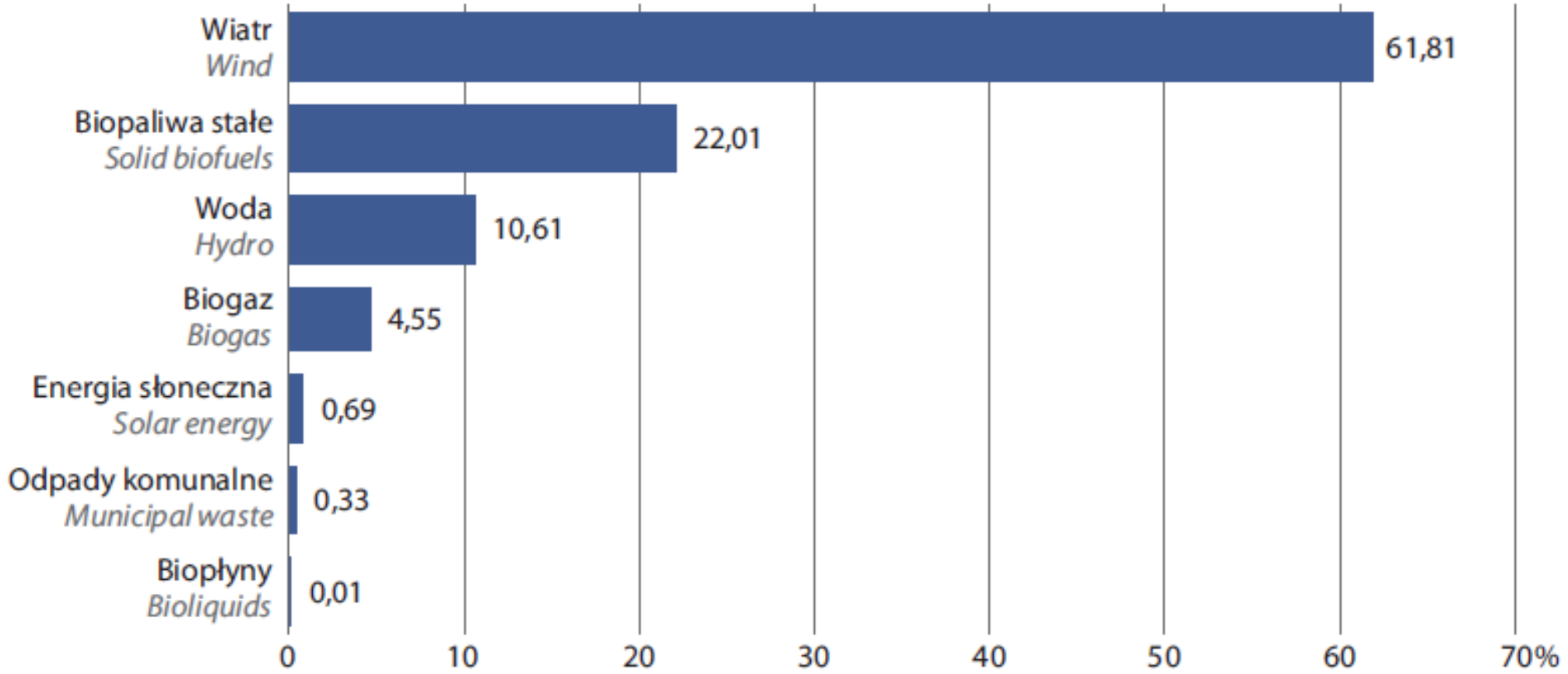
Main Statistical Office

Udział energii OZE w końcowym zużyciu energii brutto w elektroenergetyce w latach 2008-2017

Share of renewable energy in final gross energy consumption of electricity in 2008-2017



Wykres 39. Udział nośników energii odnawialnej w produkcji energii elektrycznej w 2017 r.
Chart 39. Share of renewable energy carriers in electricity production in 2017



GUS Main Statistical Office

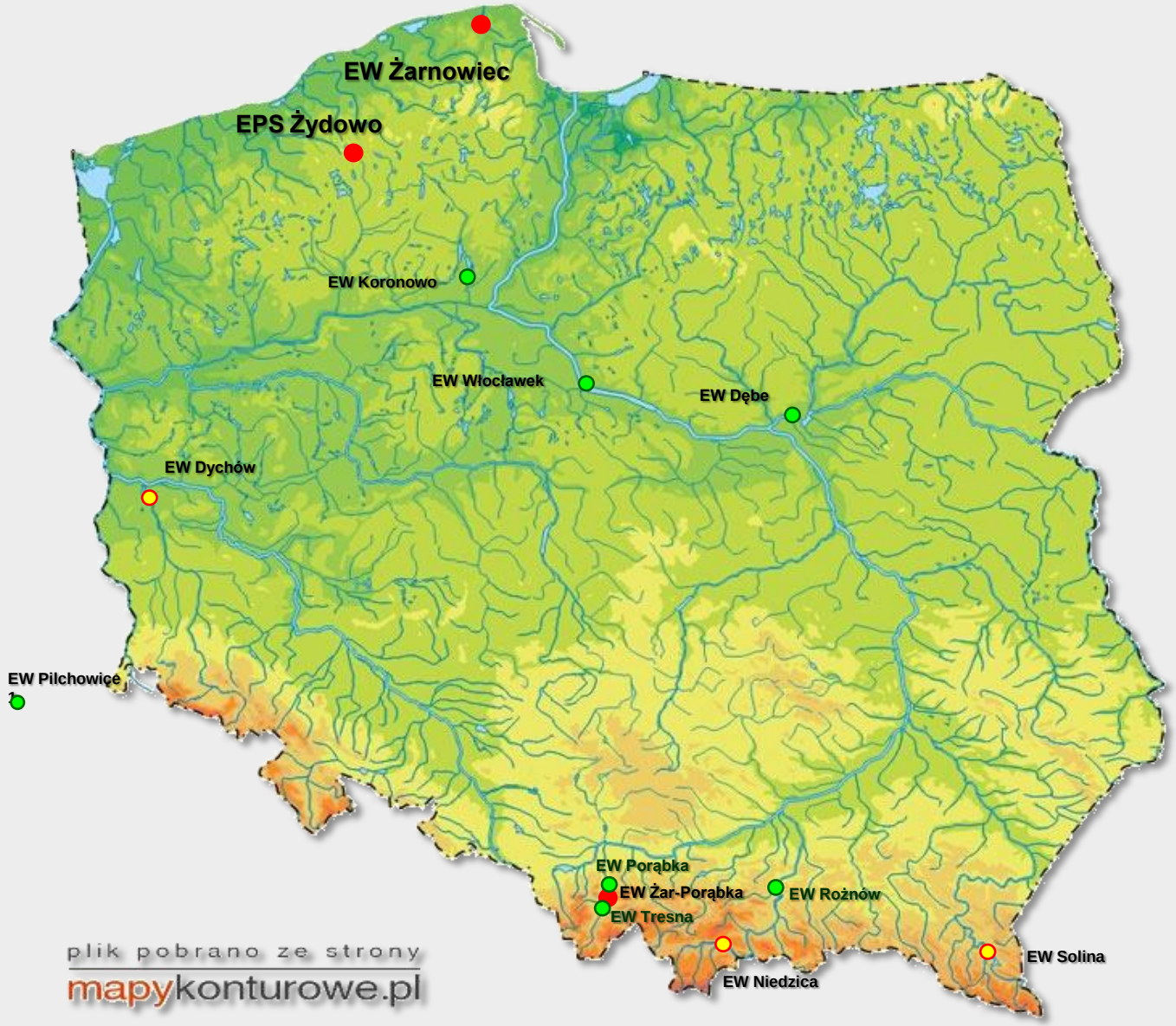
Warszawa Warsaw 2018

Energia ze źródeł odnawialnych w 2017 r.

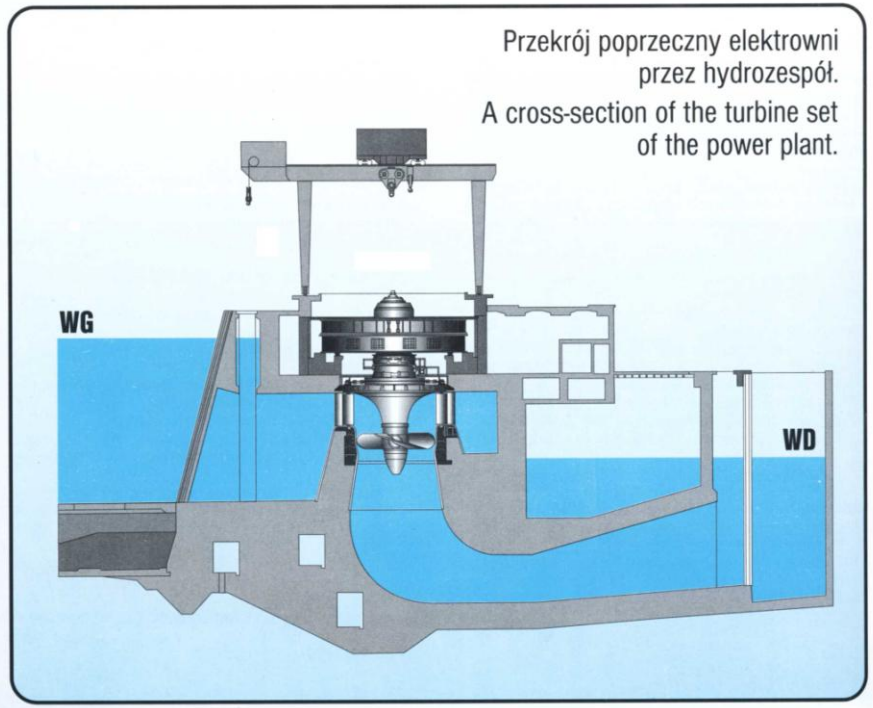
Energy from renewable sources in 2017

Current status: Large hydro in Poland

Power plant	Capacity, MW
Włocławek	160,2
Rożnów	50
Koronowo	26
Tresna	21
Debe	20
Pilchowice I	13,4
Porąbka	11
Solina	200
Dychów	91,5
Niedzica	91,5
mixed pumping total	383
renewable total	685
Porąbka-Żar	500
Żarnowiec	716
Żydowo	167
pumped storage total	1383
large hydro total	2068



Energa



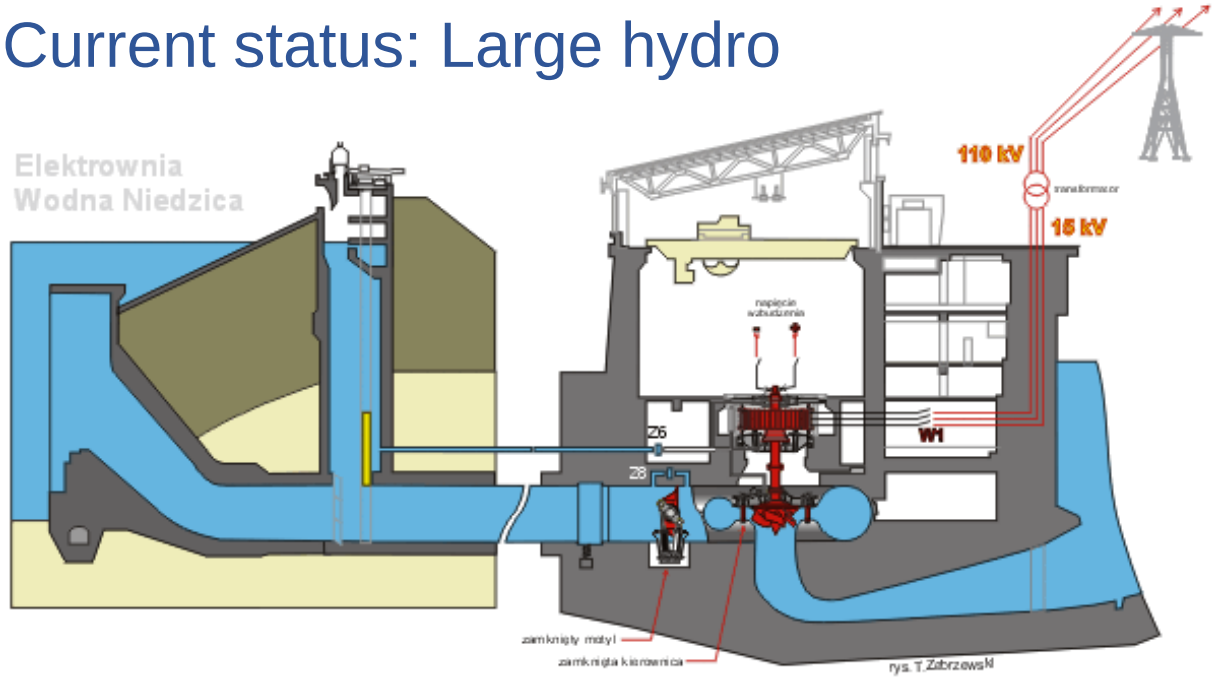
EW Włocławek, 162 MW

Żarnowiec

Pumped Storage Power Plant
(1983)

H = 106 ÷ 126 m
P = 4 x 179 MW (turbine mode)
4 x 200 MW (pump mode)

Current status: Large hydro

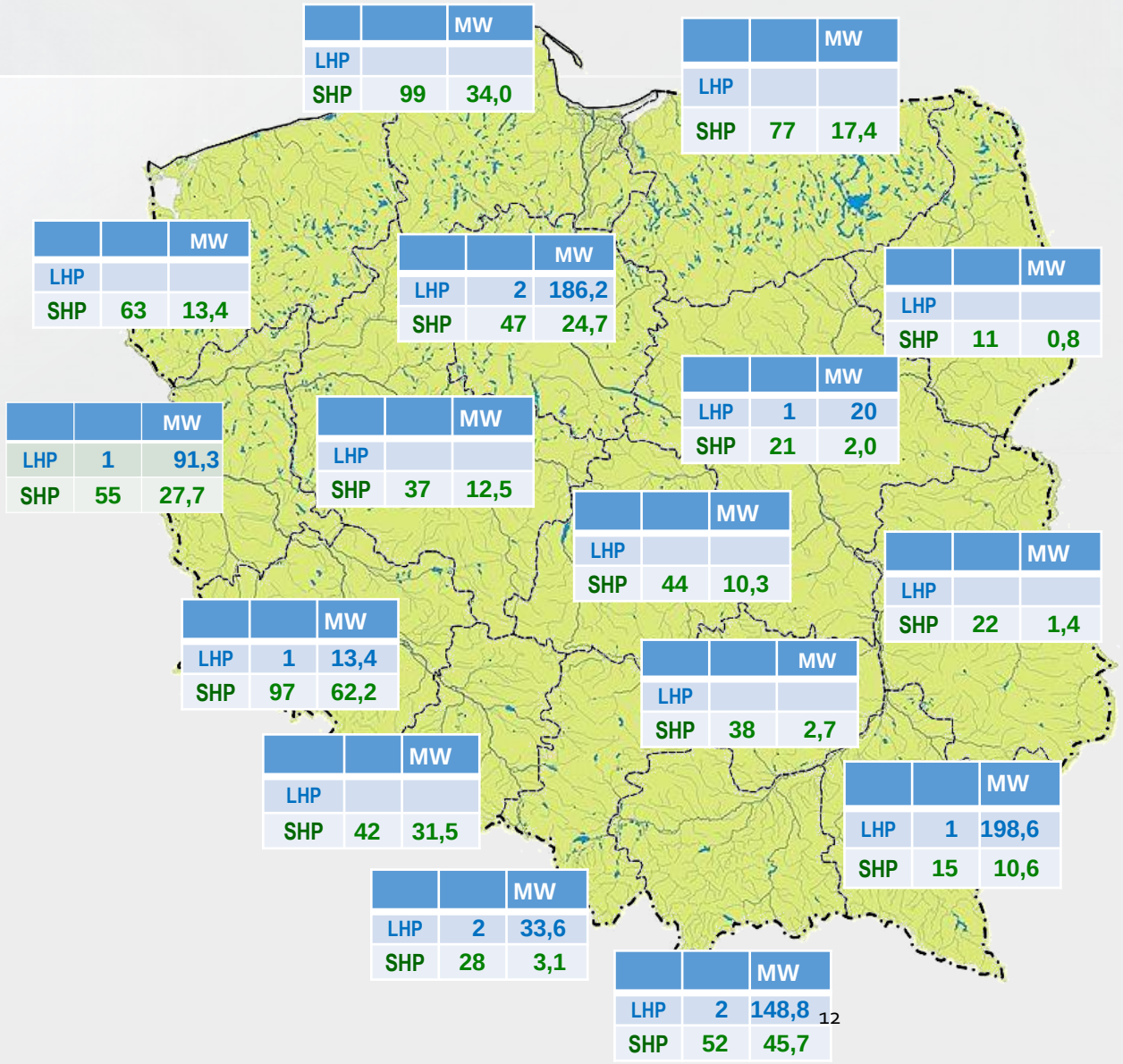


Current status: Renewable hydro in Poland

Urząd Regulacji Energetyki

State of 31.12.2016

Category	No of plants	Capacity
P ≤ 0,3 MW	583	44,6
0,3 MW < P ≤ 1 MW	97	58,7
1 MW < P ≤ 5 MW	66	158,6
5 MW < P ≤ 10 MW	6	48,3
small hydro total	**737**	**302,1**
classic large hydro	7	309,2
pumped storage with natural inflow	3	382,7
renewable hydro total	**747**	**994,0**
2018	**752**	**981,0**



Państwowe Gospodarstwo Wodne Wody Polskie

Current status:
New small hydro installations at existing weirs

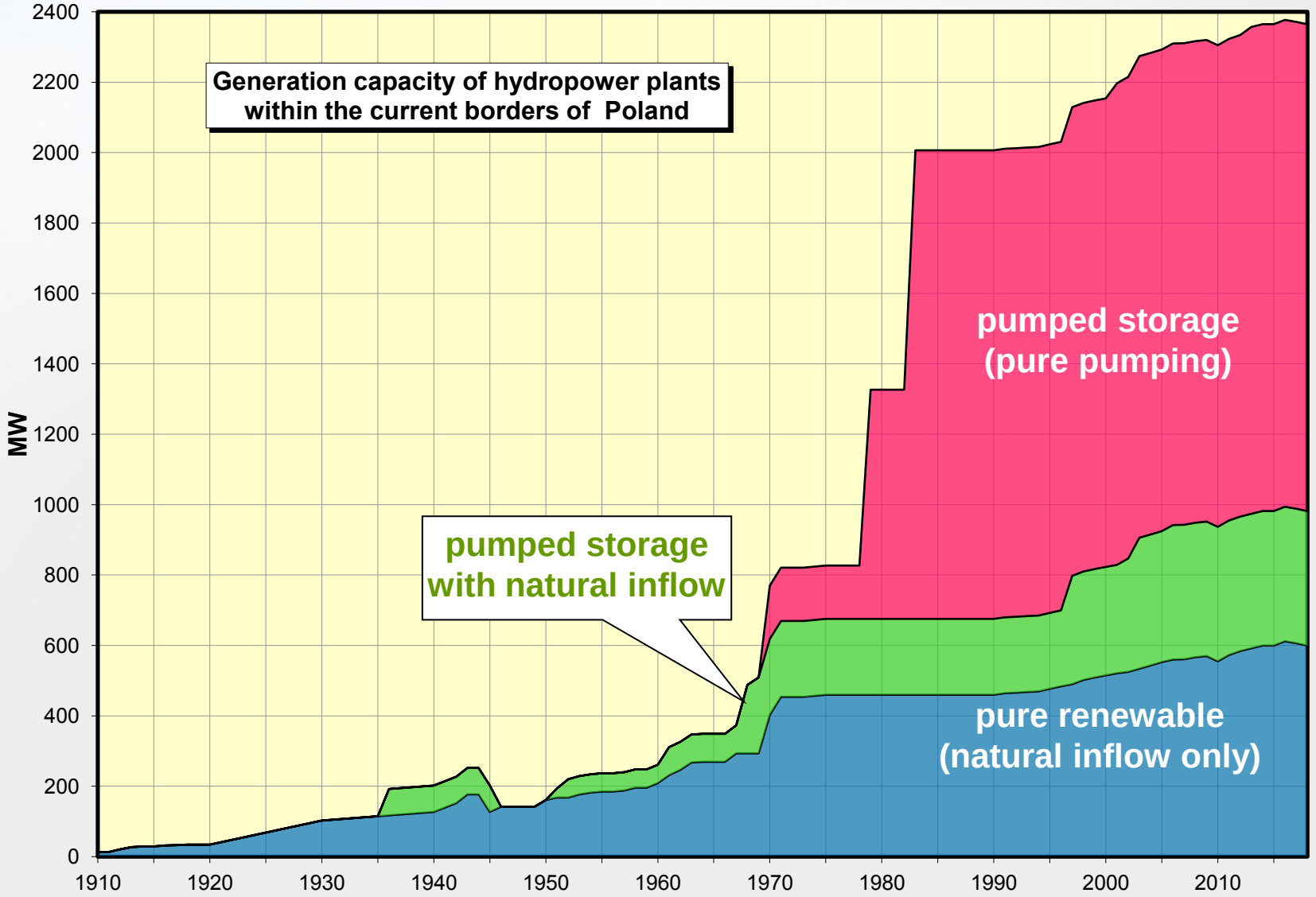
Kozielno low head SHP at Nysa Klodzka river, P = 1,85 MW

Current status: New small hydro installations at existing weirs

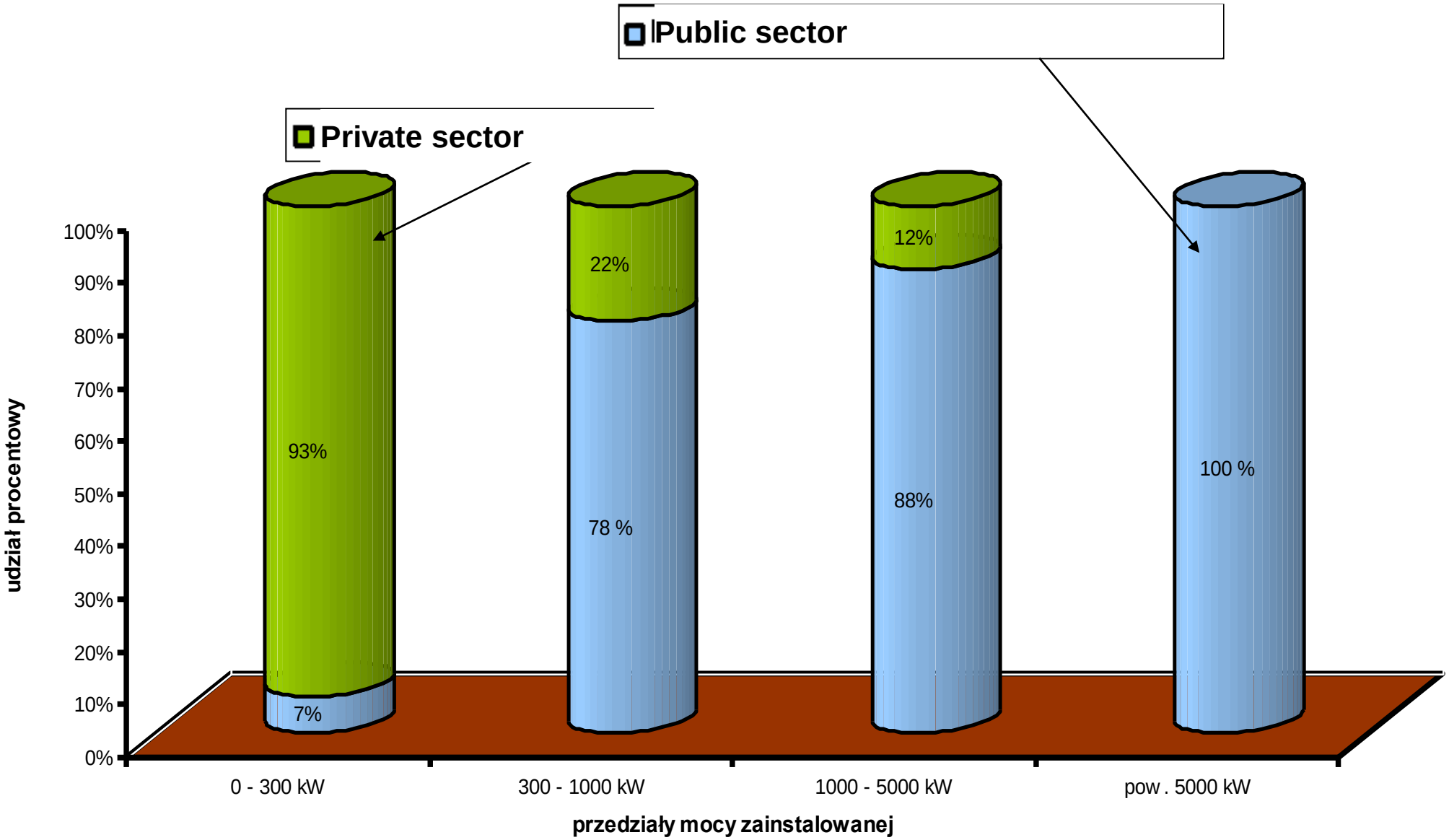
Zawada low head SHP at Upper Oder

P = 1500 kW, Q_{max} = 43 m³/s

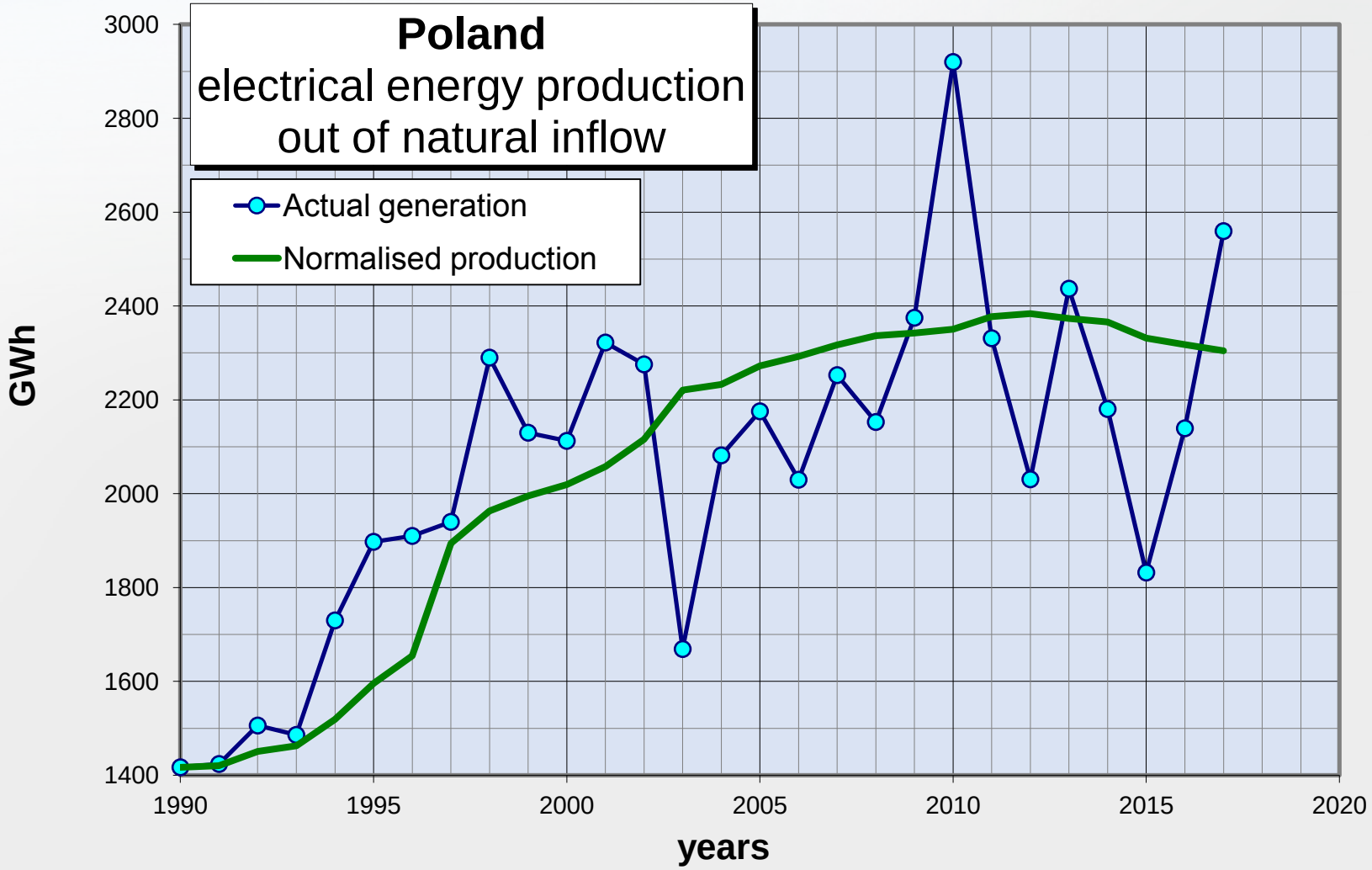
Looking backwards – over 120 years of history (since 1896)



Share of public and private sector in the total number of hydropower plants in Poland



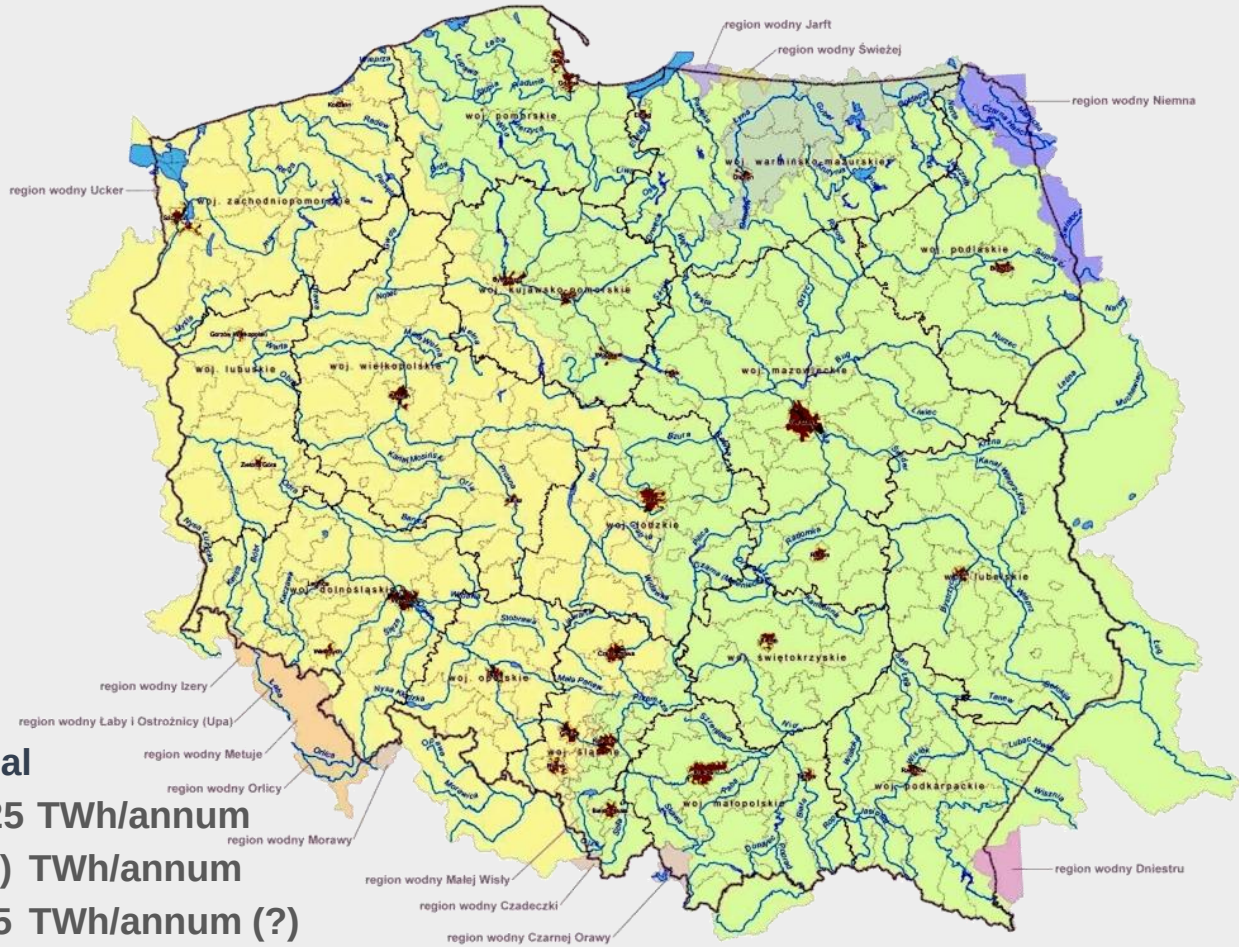
Current trends in hydropower electricity generation



POLAND

– a lowland country with modest hydropower potential

No.	Water system	Potential, GWh
1	**Vistula + catchment basin**	**9 270**
2	**Vistula**	**6 177**
3	**Left bank tributaries**	**513**
4	Pilica	170
5	Brda	119
6	others	224
7	**Right bank tributaries**	**2 580**
8	Dunajec	814
9	Wisłoka	126
10	San	714
11	Bug	309
12	Narew	179
13	others	438
14	**Oder + catchment basin**	**2 400**
15	**Oder**	**1 273**
16	**Left bank tributaries**	**619**
17	Nysa Kłodzka	134
18	Bóbr	320
19	others	165
20	**Right bank tributaries**	**507**
21	Warta	351
22	others	156
23	**others (mainly small rivers in Pomerania)**	**280**
Total (items 1+14+23)		**11 950**



hydropower potential

gross/theoretical 25 TWh/annum

technical 12 (13,7) TWh/annum

economic 8,5 TWh/annum (?)

small hydro

technical 5,1 TWh/annum

economic 2,5 TWh/annum

Hydropower potential and its use in Poland and EU

No.	Member State	Technical potential	Installed capacity (RES)	Normalised production (RES)	Utilisation of the technical potential	Specific investment costs	
						<10 MW	≥ 10 MW
		GWh/year	MW	GWh	%	k€/kW	k€/kW
1	Austria	73 000	8 380	38 746	53,1	4,5	no data
2	Belgium	400	119	370	92,5	2,5 ÷ 12	no data
3	Bulgaria[1]	4520	3 019	3693	92,5	1,4 ÷1,5	no data
4	Czech Rep.	4 880	1 531	2 253	46,2	6,8	3
5	Estonia	163	6,8	22	13,5	1,9	no data
6	Finland	16 916	3 049	14 000	82,8	3,5	no data
7	France	120 000	25 423	*61 650*	51,4	2,3 ÷ 4,5	2,0 ÷ 3,0
8	Germany	36 000	3 905	*19 503*	54,2	7,5	no data
9	Grecja	no data	3 200	5 239	b.d.	1,5	2
10	Ireland	847	241	788	93	3,0 ÷ 12	no data
11	Italy	160 000	17 721	*44 092*	27,6	4,5	b.d.
12	Latvia	5 360	1 553	2 963	55,3	2,6	no data
13	Lihuania	2 090	130	422	20,2	2,5	no data
14	**Poland**	**12 000**	**945**	**2 353**	**19,6**	**6,5**	**>10**
15	Portugal	19 440	5 039	11 380	58,5	2,5	no data
16	Romania	34 509	6 403	17 193	49,8	2,5÷ 3,5	4,0 ÷ 5,0
17	Slovakia	7 560	1 802	4 424	58,5	6,35	6,36
18	Slovenia	8 800	1 219	*5 241*	59,6	7	6
19	Spain	68 500	no data	*28 230*	41,2	1,5	no data
20	Sweden	130 000	16 934	68 071	52,4	3,1 ÷3,5	1,3
21	UK	27 203	1 542	4 965	18,1	3,0 ÷12	1,8

Data source:
HYDI, 2011

STREAM MAP

[1] Economic potential shown instead of the technical one.

Economic constraints & support system

before 2004

- feed-in-tariffs for small hydro (< 5 MW)
- wide use of ancillary services and energy storage (especially before mid 1990-ies)

2004-2015

- green certificate system for all renewables
- low use of energy storage due to environmental and economic reasons

currently

- green certificate system coming gradually to the end (till 2020)
- auction system for new and rehabilitated hydro up to 20 MW (15 years of guaranteed electricity price)
- feed-in-tariffs and premiums for small hydro below 1 MW (mini SHPs)
- low use of energy storage

Threats for existing power plants

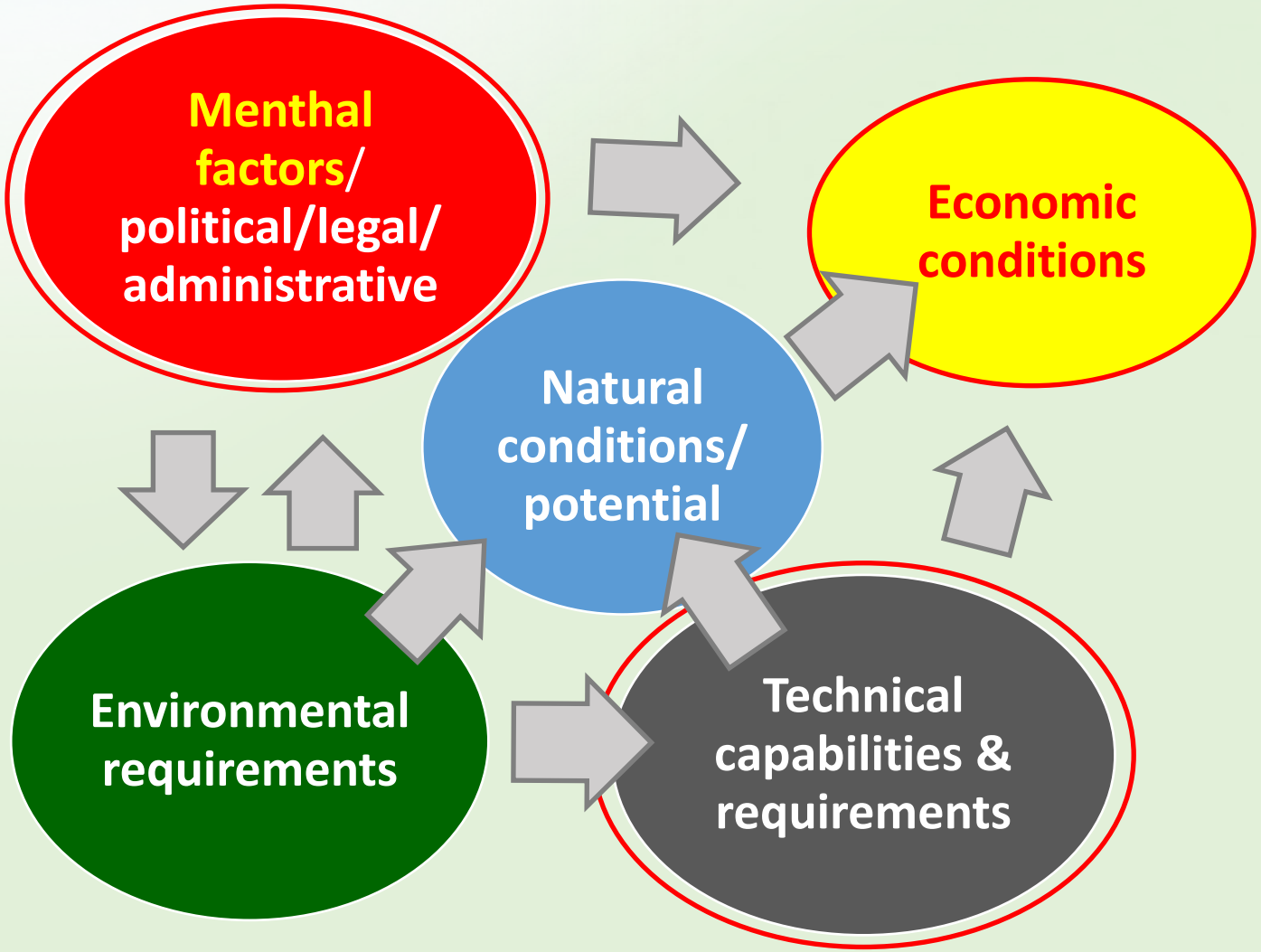
- **instability** of legal and economic conditions - lack of consequent, hydropower oriented policy
- **high risk** for a producer in the current auction system
- rehabilitation **projects undertaken just to receive a 15 years support period**
- **no guarantee of long-year profitability** for non rehabilited installations or after 15 years of support
- **heavy** fiscal **burdens** and those related to maintanence of used multipurpose dams owned by water management authorities
- too high **electricity transmission prices** to justify energy storage in pumped storage installations on the buy-and-sell basis
- too **low price difference** to justify energy storage
- heavy **environmental requirements** and strong position of green lobby

The installed capacity of Polish hydropower plants has been falling down in 2017 and 2018 according to the national regulator data.

Expectations of public hydropower operators according to a recent TEW inquiry

- Payment for **water retention service** (rather unlikely)
- Verifying and re-ordering **the system of managing the hydropower related decisions** (Wody Polskie state enterprise is currently both a party and a decision maker in the administrative procedure)
- Waiving the water retention service providers of **the water use fee**
- Including restoration of **water retention capacity in existing reservoirs** in the currently prepared water retention development plan for the period of 2021-2030

Development barriers in categories



Hydropower development barriers - menthal factors

- **Insufficient understanding of the need** to develop renewable energy sources
  - action taken only under the EU pressure
- **Underestimating hydropower potential of the country**
- **Prioritising local ecological goals over global ones** (mitigation of climate change effects, flood and drought protection, preserving fossil fuels for future generations, water and energy safety etc.) **by the green NGOs and some political powers**
- **Lack of understanding for the role of hydropower** in the electrical power grid penetrated by intermittent electricity sources
  - attempts to use electrochemical storage as basic energy storage technique
- **Inconsequent water management policy**
  - multidecade disregard of the increasing water deficit and flood threat
  - the same for preserving/development of inland navigation routes

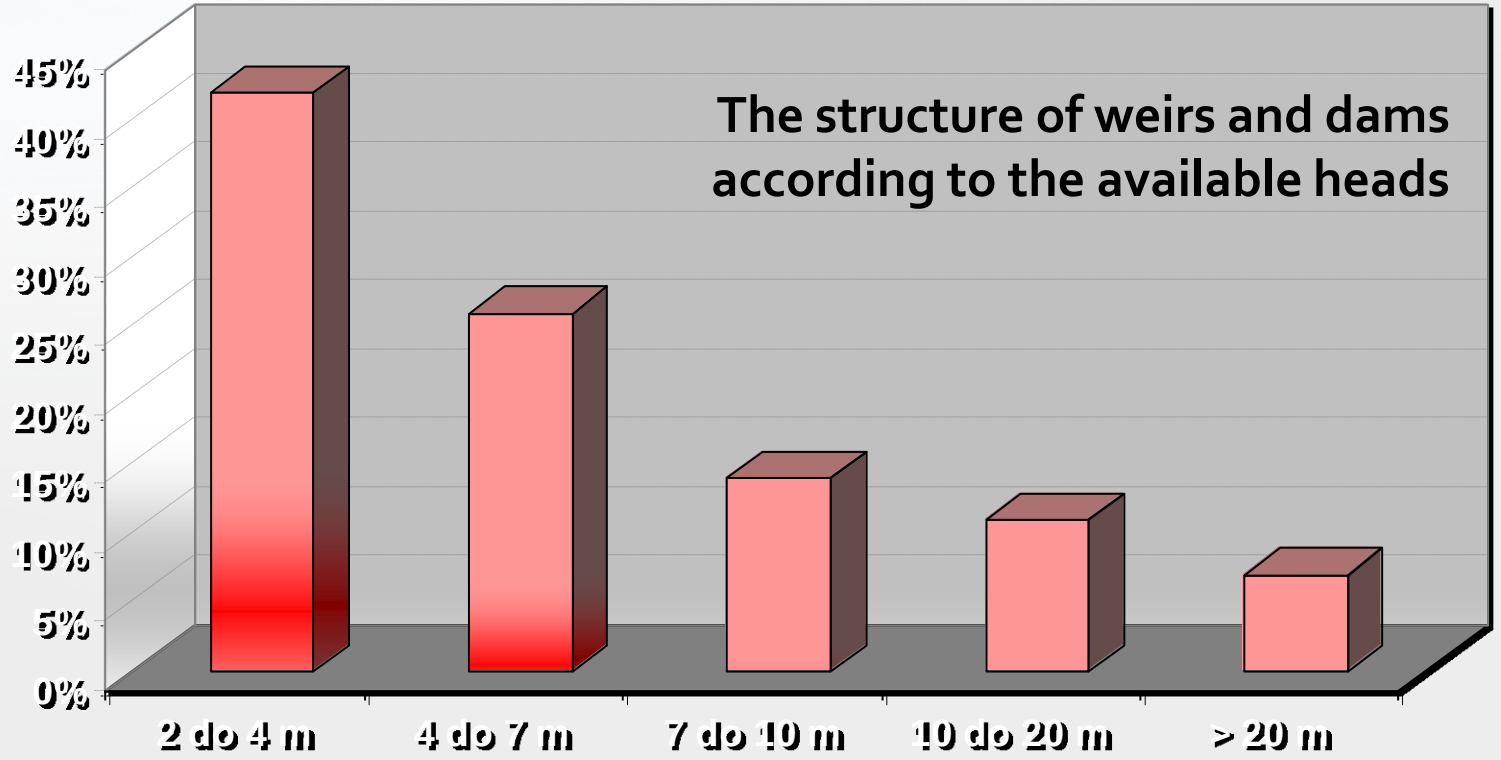
The national water management policy shows positive changes in recent years. It is only to be hoped that a national consensus on this issue is possible.

New opportunities

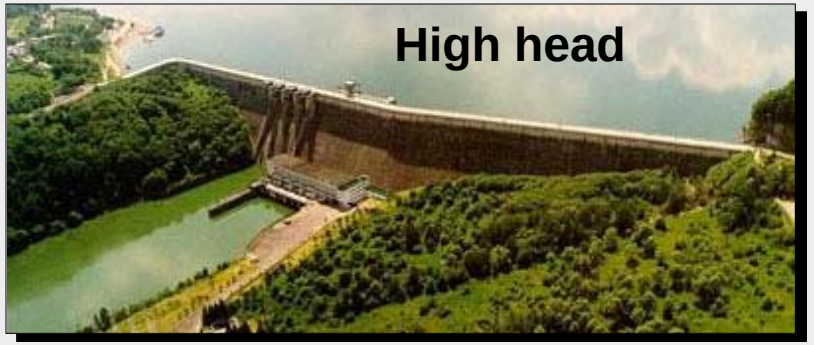
- **Multipurpose projects**, including:
  - utilising the existing water barrages for hydropower purposes;
  - new projects under recently announced water management programme, including development of inland navigation routes.
- **Ancillary grid services**, including:
  - energy storage;
  - compensation of grid parameter fluctuations introduced by intermittent electricity sources.

The current situation in water and Energy sector and consequent EU policy may force political elites to continue supporting this development direction.

Opportunities
– installations at existing low-head weirs



Low head



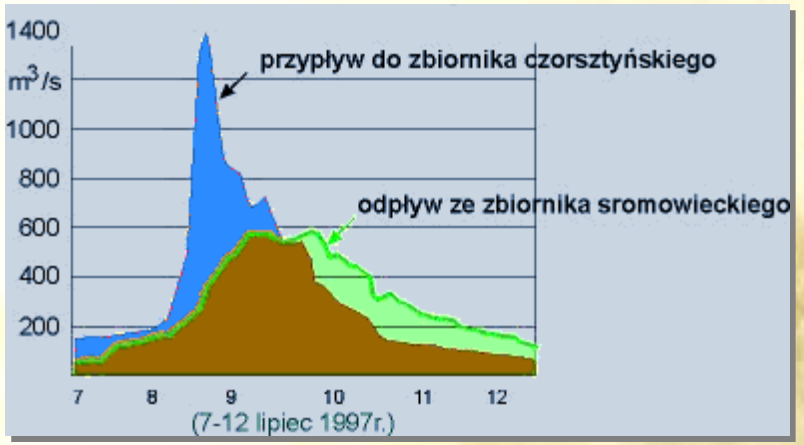
Opportunities
– installations at existing low-head weirs

Most new SHPs are erected at the existing weirs.

Low head weirs in administration of Water Management Authorities (RZGW) provide raw capacity of up to 3 MW.

Opportunities
- flood protection

EW Niedzica
- „Millennium water” in July 1997
Flattening of the flood wave
by the Niedzica Dam



Opportunities
inland navigation routes

ECE/TRANS/120/Rev.4

ECONOMIC COMMISSION FOR EUROPE
INLAND TRANSPORT COMMITTEE

EUROPEAN AGREEMENT ON MAIN INLAND WATERWAYS OF INTERNATIONAL IMPORTANCE (AGN)

DONE AT GENEVA ON 19 JANUARY 1996

ACCORD EUROPÉEN SUR LES GRANDES VOIES NAVIGABLES D'IMPORTANCE INTERNATIONALE (AGN)

EN DATE, À GENÈVE, DU 19 JANVIER 1996

ЕВРОПЕЙСКОЕ СОГЛАШЕНИЕ О ВАЖНЕЙШИХ ВНУТРЕННИХ ВОДНЫХ ПУТЯХ МЕЖДУНАРОДНОГО ЗНАЧЕНИЯ (СМВП)

СОВЕРШЕНО В ЖЕНЕВЕ 19 ЯНВАРЯ 1996 ГОДА

Poland joined the agreement in 2017.

UNITED NATIONS NATIONS UNIES
ОРГАНИЗАЦИЯ ОБЪЕДИНЕННЫХ НАЦИЙ

Opportunities

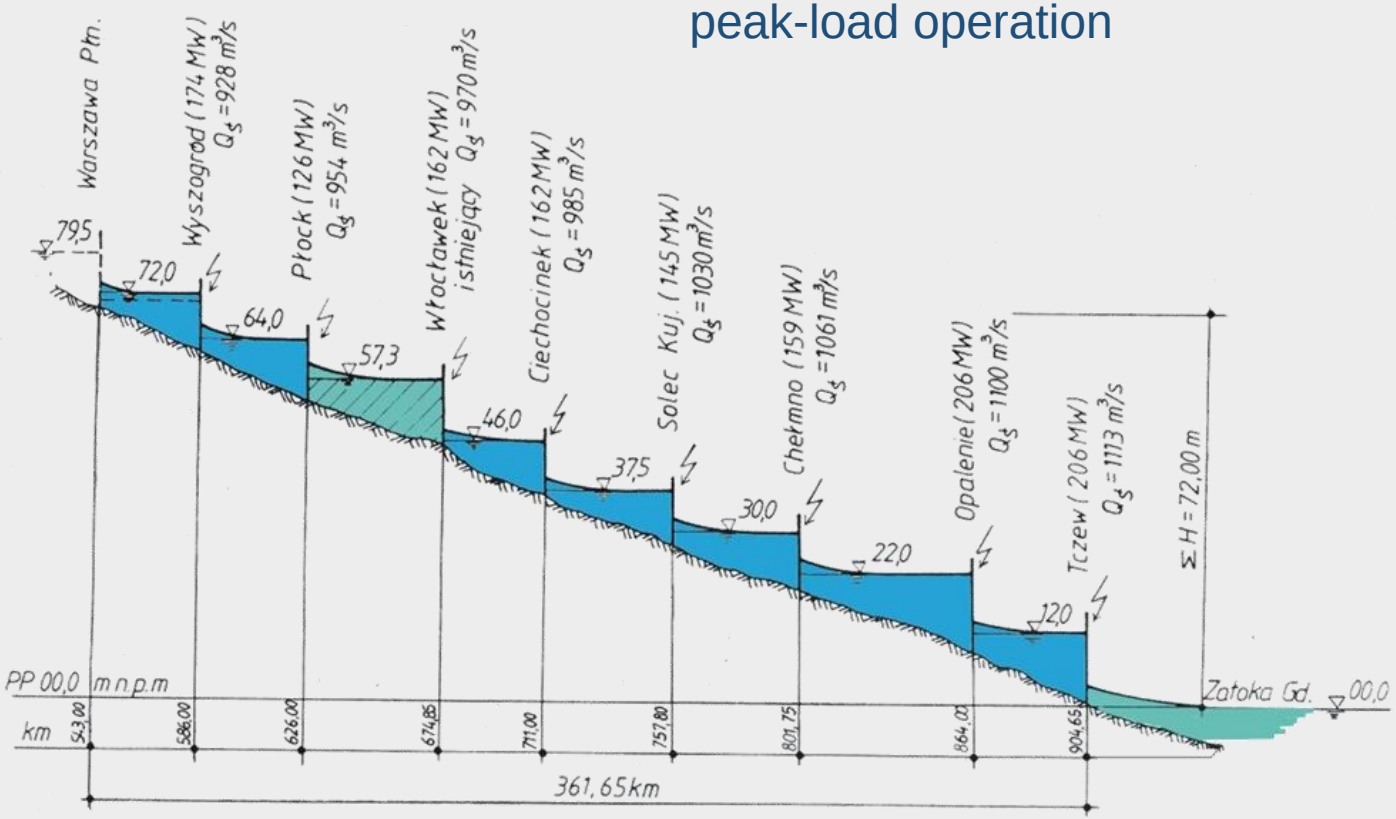
Large hydro projects

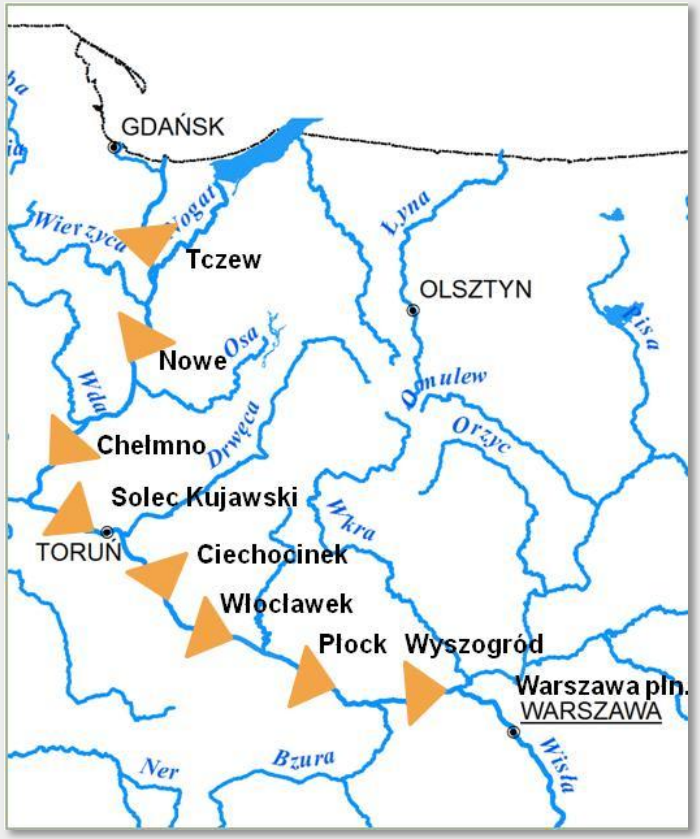
Lower Vistula Cascade (1980)

installed power: 1340 MW

annual production: 4300 GWh

peak-load operation





Recently (2016)

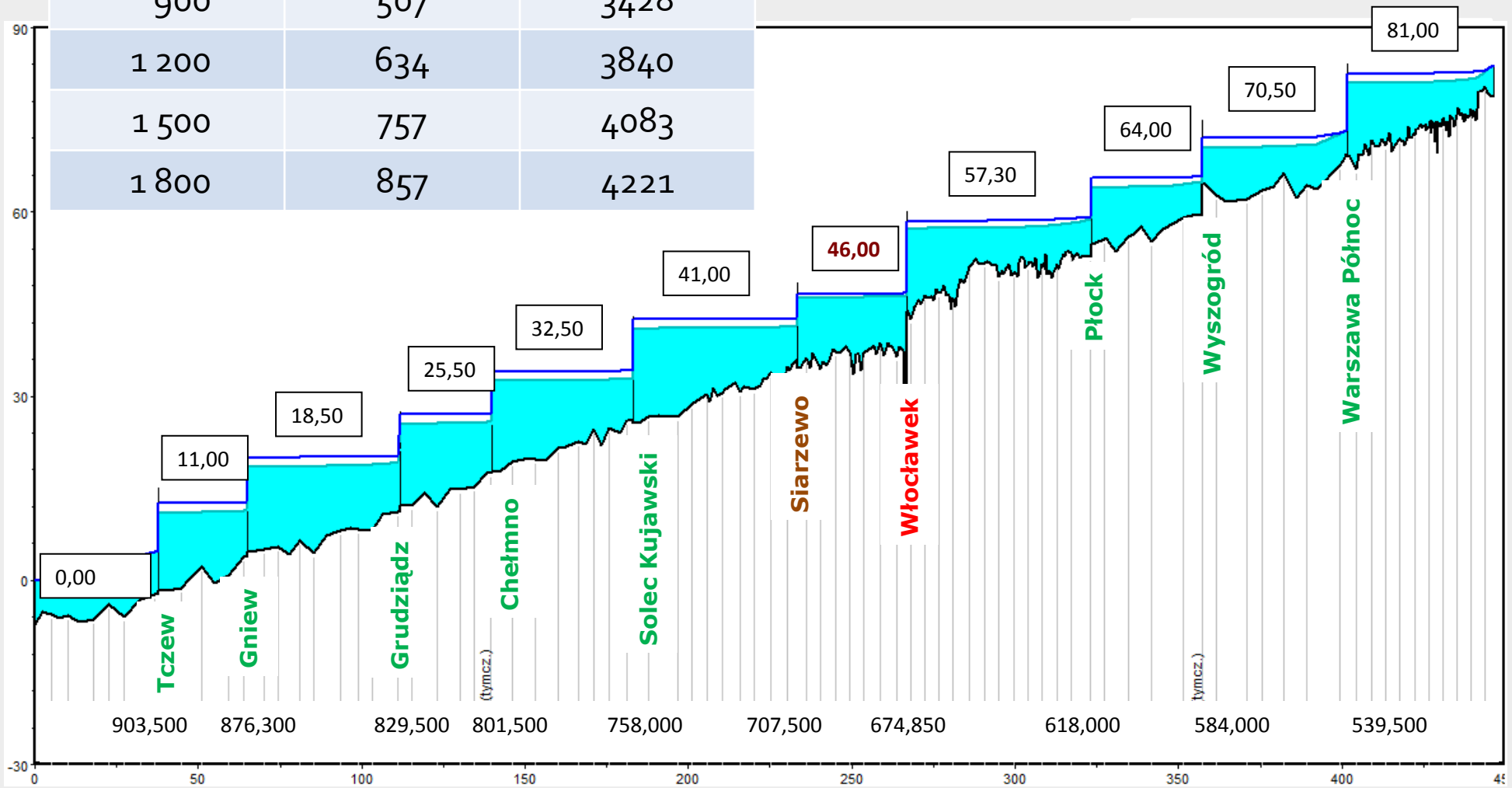
installed power 857 MW

annual generation 4200 GWh

Opportunities

Lower Vistula cascade: options under consideration (2017)

Discharge	Capacity	Generation
$Q_{max,}$ m³/s	$P_{max,}$ MW	E, GWh
900	507	3428
1 200	634	3840
1 500	757	4083
1 800	857	4221



J.Granatowicz: *Complex development of Lower Vistula,* Wloclawek/Wieniec, April 2017 (in Polish)

ActaEnergetica

Socio-economic impact of the development **of the lower Vistula**

Direct energy related profit - only 12-14 % of the total one!

Krystyna Wojewódzka-Król
Ryszard Rolbiecki

Gdańsk 2017

source: J.Granatowicz,P.Sliwinski: *Lower Vistula Cascade - a whim or a necessity?*
Polish Hydropower Conference RENEXPO Poland 2016

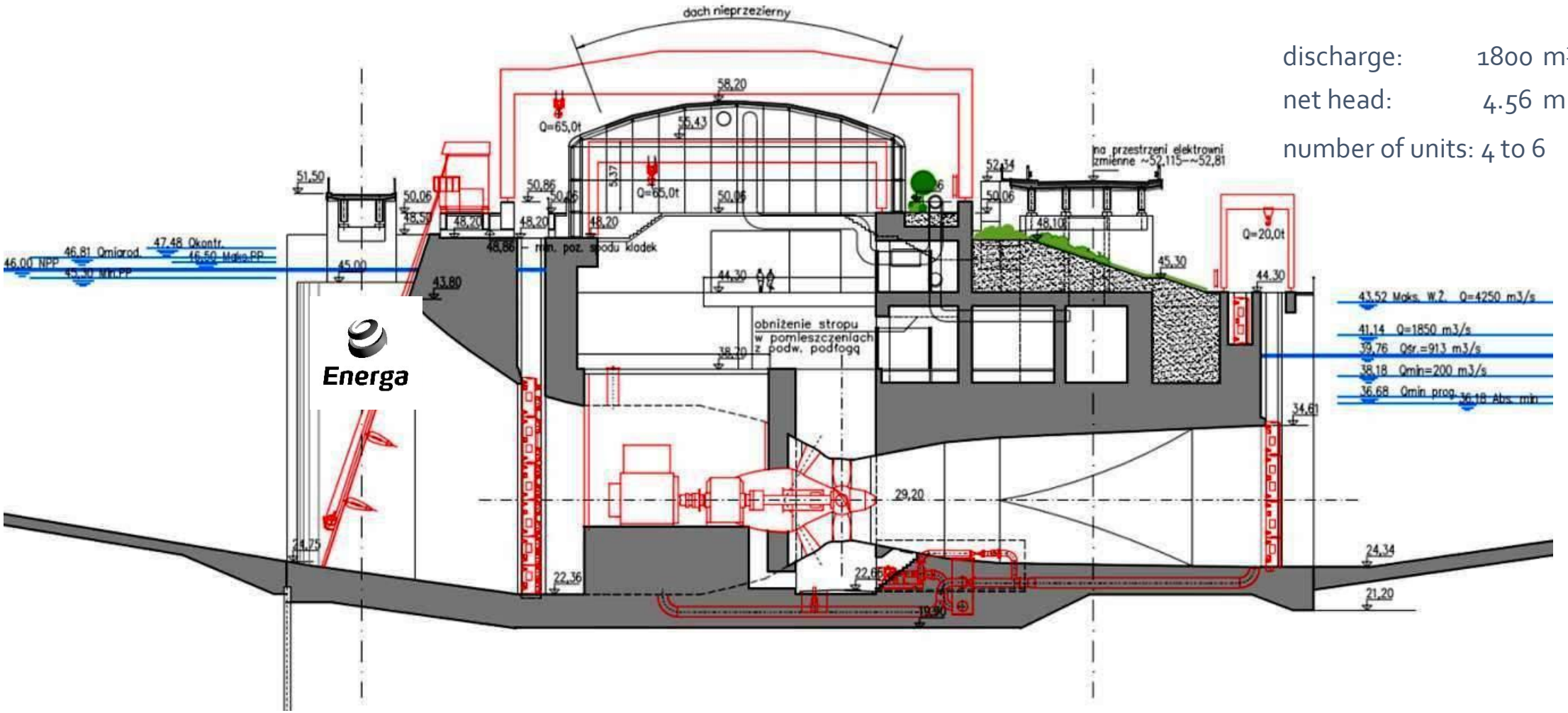
Economic Net Present Value in 30 years	**100,0 bill. zł;**
• increase of sea harbours revenue	**40,7 bill. zł;**
• decrease of flood related losses	**21,8 bill. zł;**
• increase of tourism profits	**17,0 bill. zł;**
• increase of profits due to electricity generation	**9,7 bill. zł;**
• decrease of drought losses in agriculture	**7,3 bill. zł;**

1 EUR = 4,3 PLN (zł)

Main quantitative profits

Opportunities

Siarzewo Dam in the Lower Vistula cascade – one of concepts



discharge: 1800 m³/s

net head: 4.56 m

number of units: 4 to 6

P.Śliwiński: *Erection of the Lower Vistula cascade with worldwide hydraulic civil engineering trends in the background,* Wloclawek/Wieniec, April 2017 (in Polish)

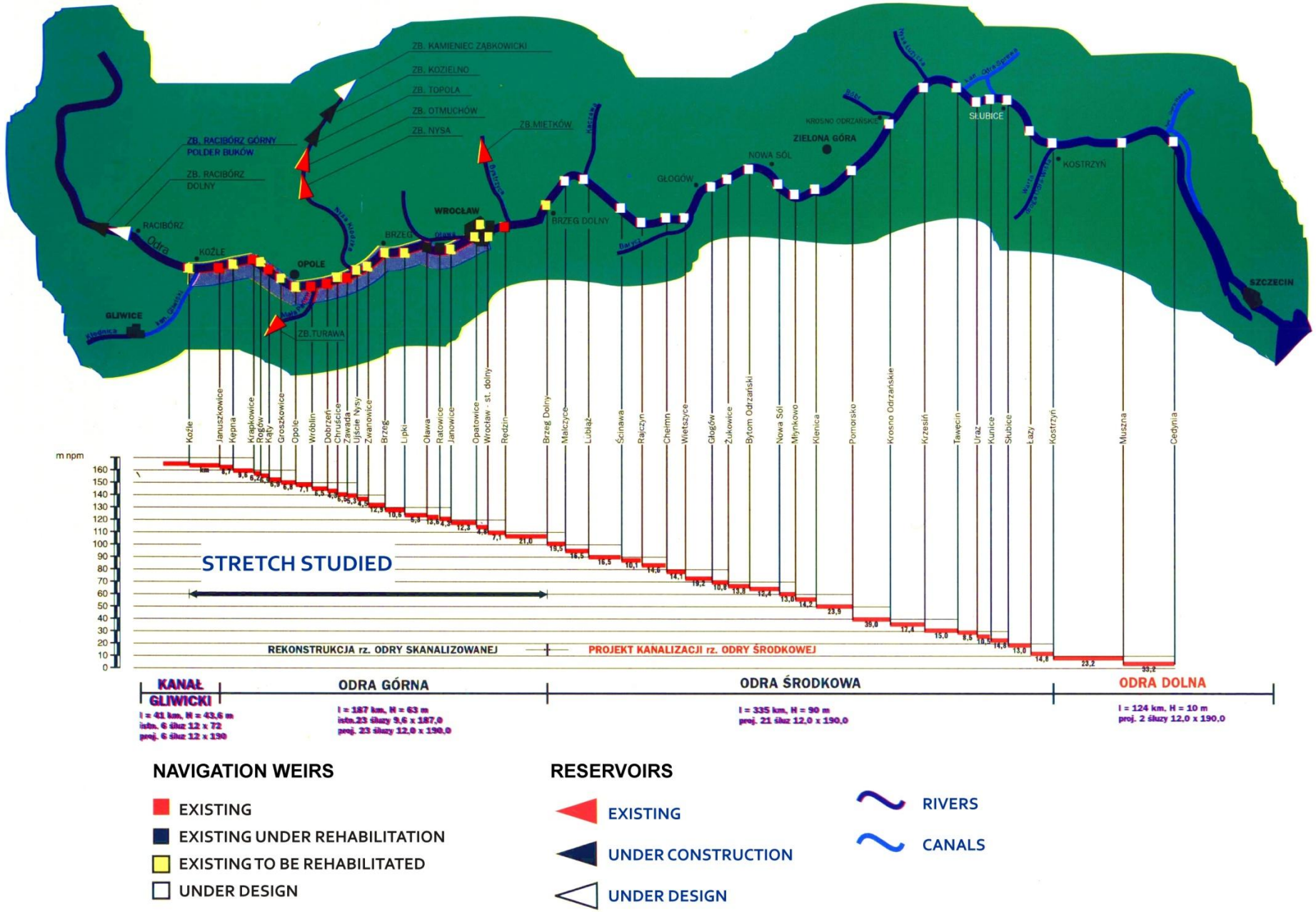
Lower Vistula Cascade

Siarzewo Dam & Power Plant: 70÷90 MW

environmental consent granted in the end of 2017

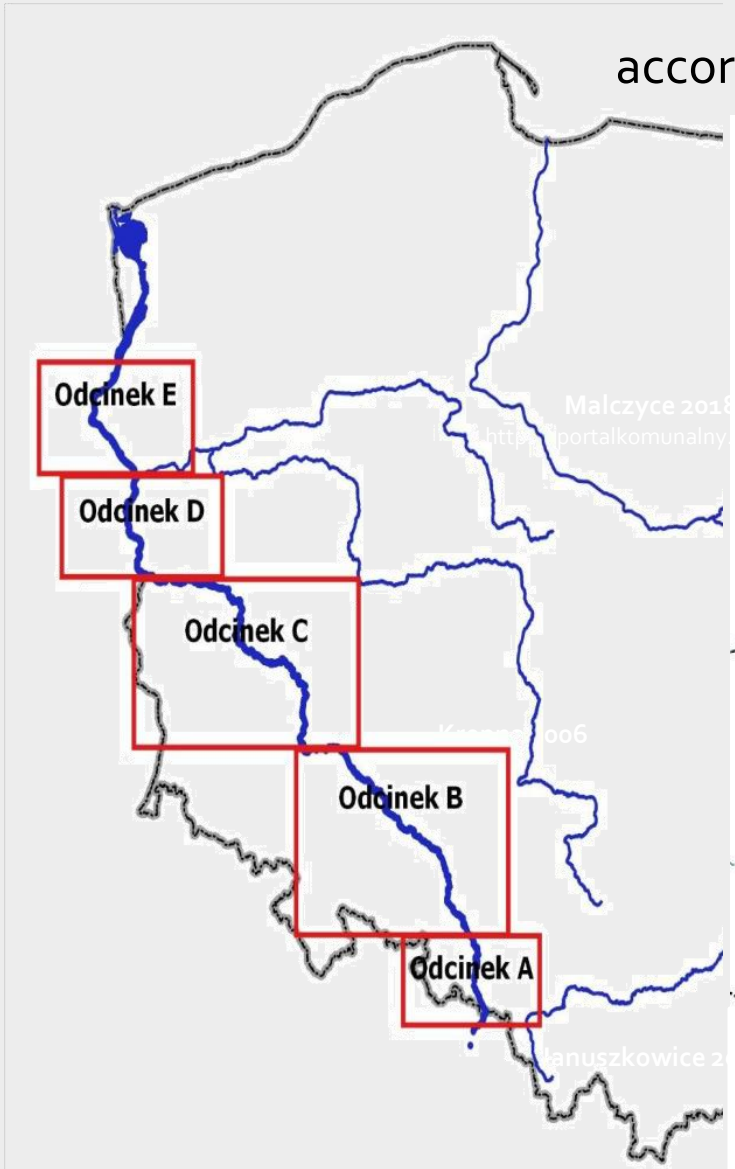
Opportunities

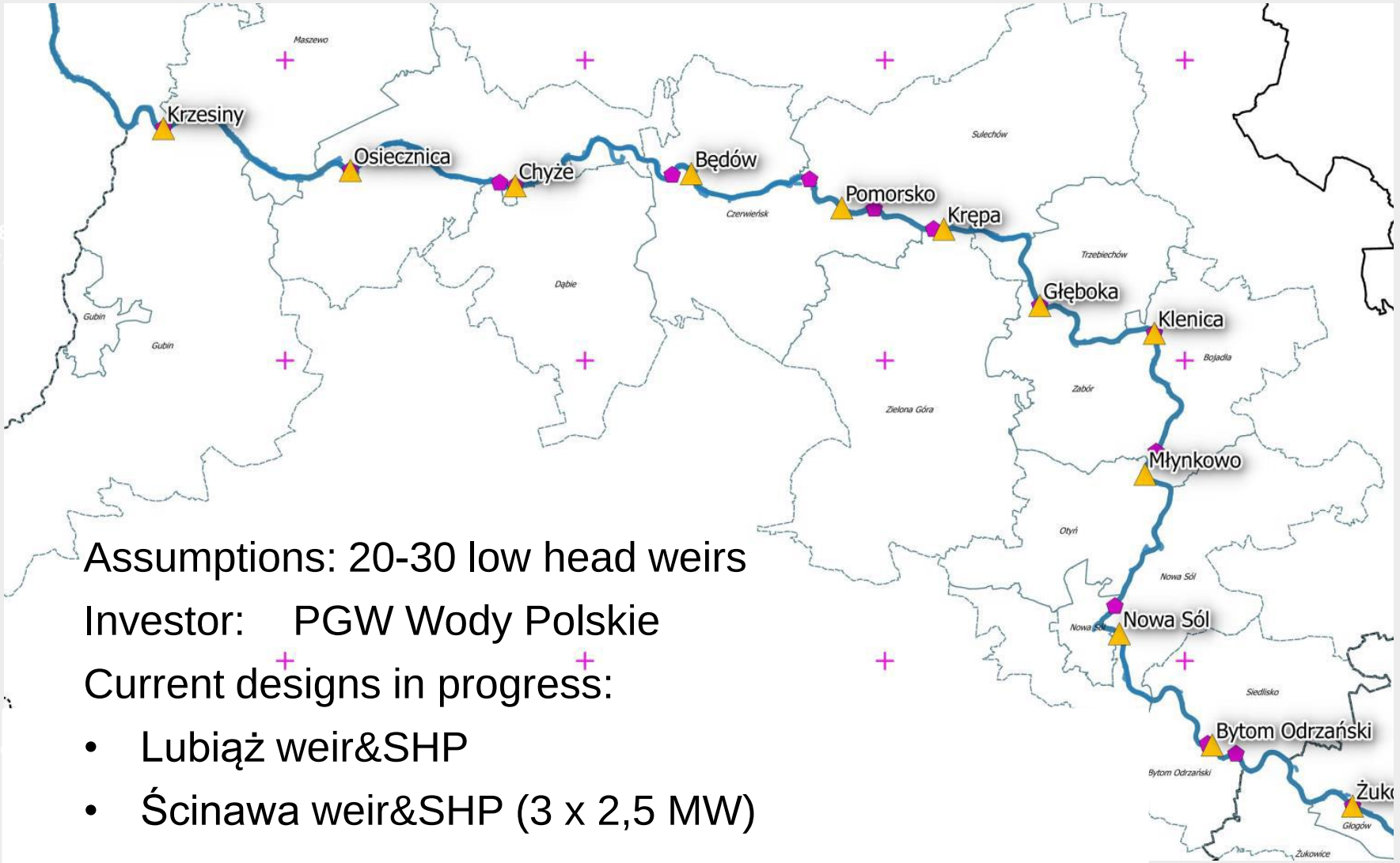
Development of Oder river according to the Oder 2006 roadmap



Opportunities

Development of Oder Inland Navigation Route according to the plans of the Ministry of Maritime Economy and Inland Navigation





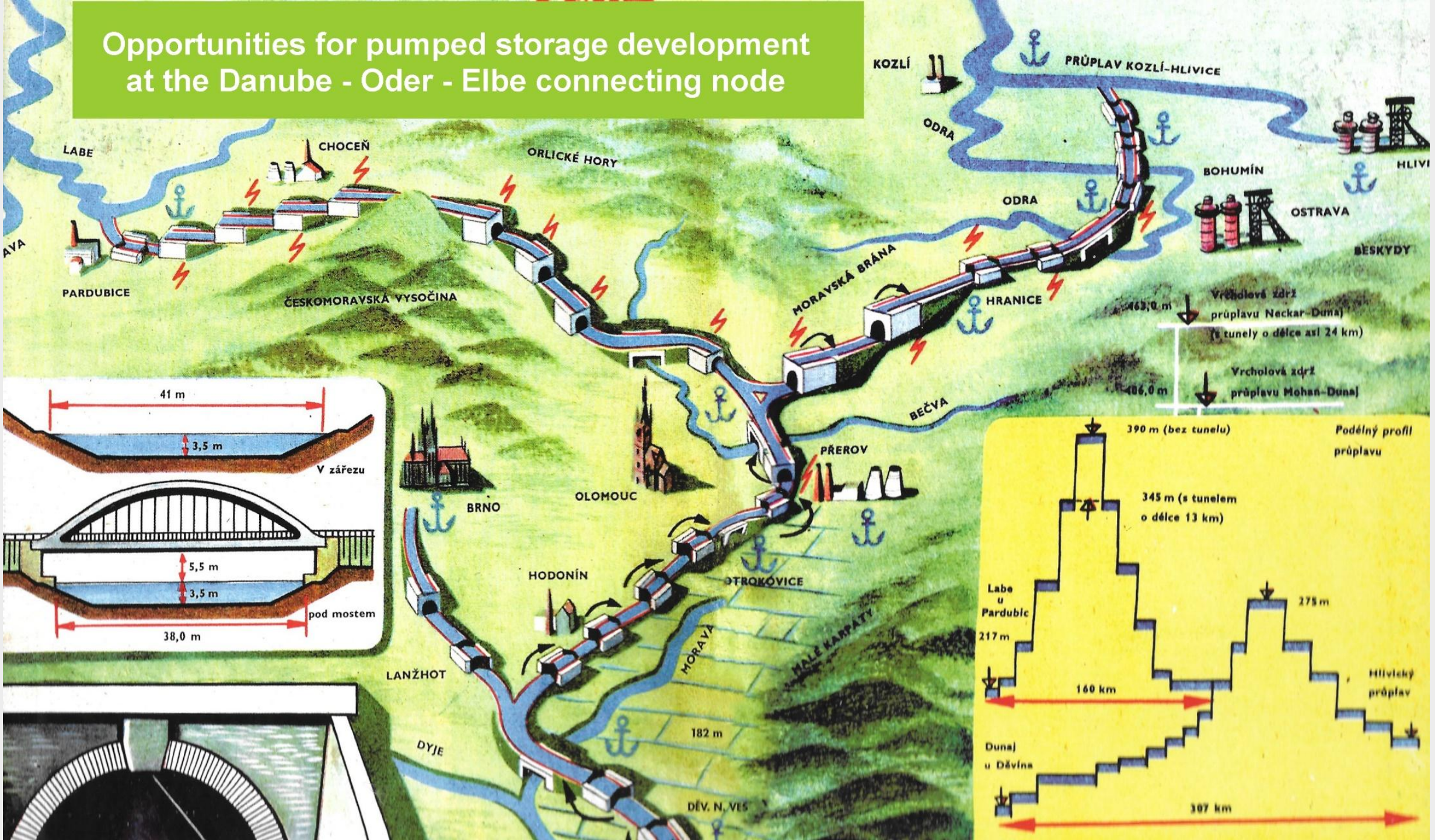
Assumptions: 20-30 low head weirs

Investor: PGW Wody Polskie

Current designs in progress:

- Lubiąż weir&SHP
- Ścinawa weir&SHP (3 x 2,5 MW)

Opportunities for pumped storage development at the Danube - Oder - Elbe connecting node



Opportunities

Investment memorandum of the Wroclaw Regional Water Management Authority

River	No. of plants	Capacity kW	Annual generation, MWh
Bóbr	4	1500	6 930
Bystrzyca	5	576	3 055
Kwisa	6	870	3 915
Nysa Kłodzka	4	1510	8 050
Oder	5	4987	29 403
others	4	149	924
Total	**28**	**9 592**	**52 276**

Państwowe Gospodarstwo Wodne Wody Polskie

Other projects studied

- Kadyny Pumped Storage Plant (PGE)
- Pumped storage
  using excavated lignite mine caverns
- Pumped storage in abandonded coal mines
- Other pumped storage locations

Existing opportunities are often disregarded by the policy-makers both in their activities and public statements.

Key message

- Poland has lost several decades and experience of its specialists after stopping development of its hydropower sector in the beginning of 80-ies and allowing to restore merely the SHP sector later on.

- The contemporary challenges, and especially the climate change with all its consequences require much higher attention to be paid to the water and energy storage and management.

Solina Dam (82 m) and Power Plant (200 MW)

Thank you for your attention!