Hydropower in the East European region - challenges and opportunities

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Purpose

- Incomprehensive overview of the Polish and regional hydropower sector

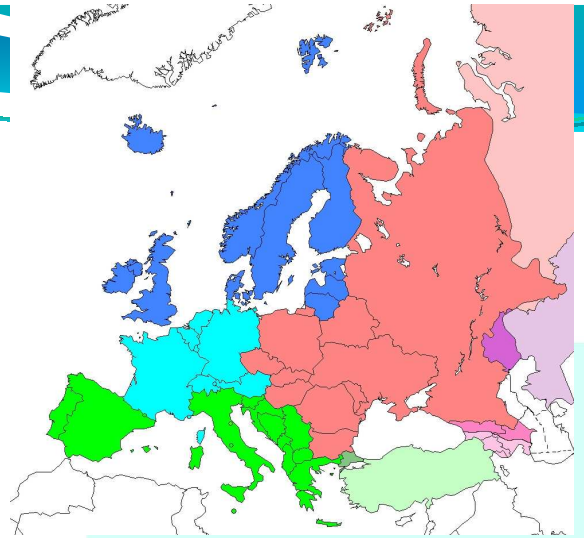
Background

- Collaboration of regional associations on hydropower sector survey projects

Scope

- Eastern Europe as a region – general overview
- Hydropower in Eastern Europe – potential and assets
- Hydropower in Poland – 120 years of hydroelectric schemes at Polish territory
- Challenges – instability, environmental aspects, economic constraints
- Opportunities – navigation routes and pumped storage schemes
- Conclusion

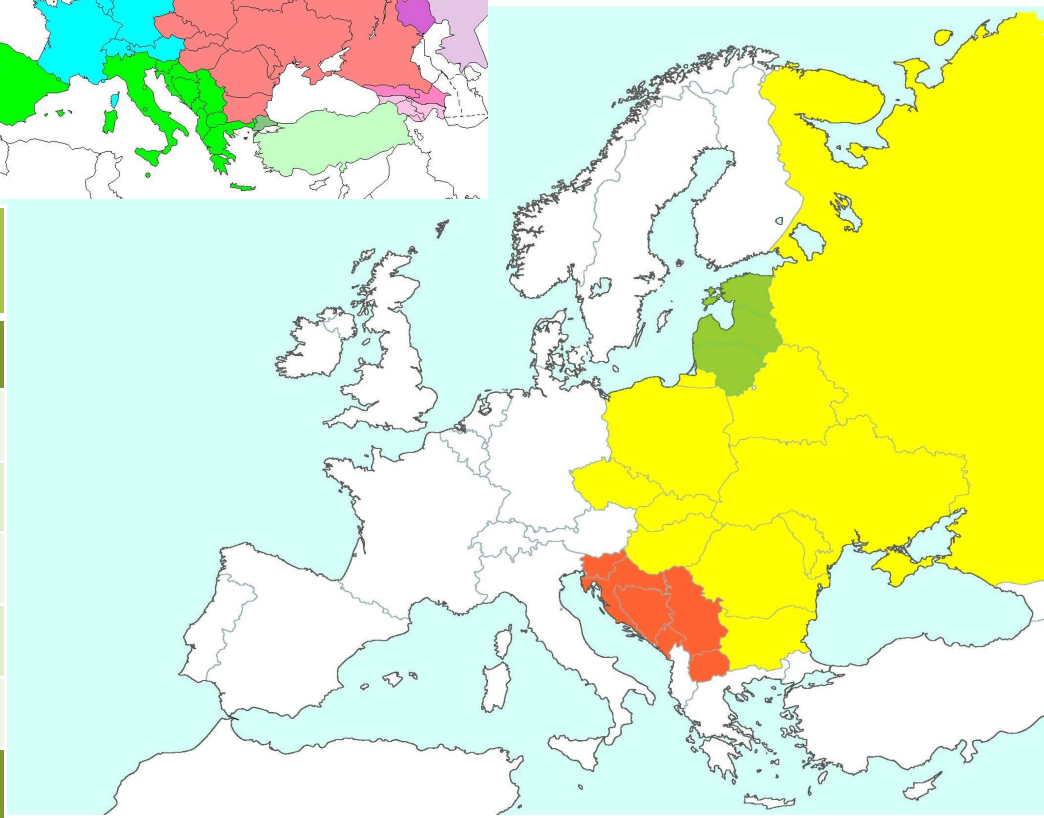
Eastern Europe 2016



Great European Regions
according to the UN classification

WSHPDR approach

Subregion	Area	Population	GDP	Electricity generation
	10^3 km^2	thousand	M€	TWh
Eastern Europe-9	1 701	146 397	1 149 433	618,3
RF – European Part	4 000	110 000	n/a	807,6
Eastern Europe-10	5 701	256 397	n/a	1425,9
Baltic States	175,1	6 081	84 692	22,6
Former Yugoslavia	255,9	21 672	156 709	101,2
Eastern Europe -20	**6 132,1**	**284 150**	n/a	**1 550,6**



Region under consideration - this report

Significant rivers

Danube
(technical potential 43 TWh/a)

Volga
(economic potential 42 TWh/a)

Dnieper

Pechora, Northern Daugava, Kama, Terek and Sulak

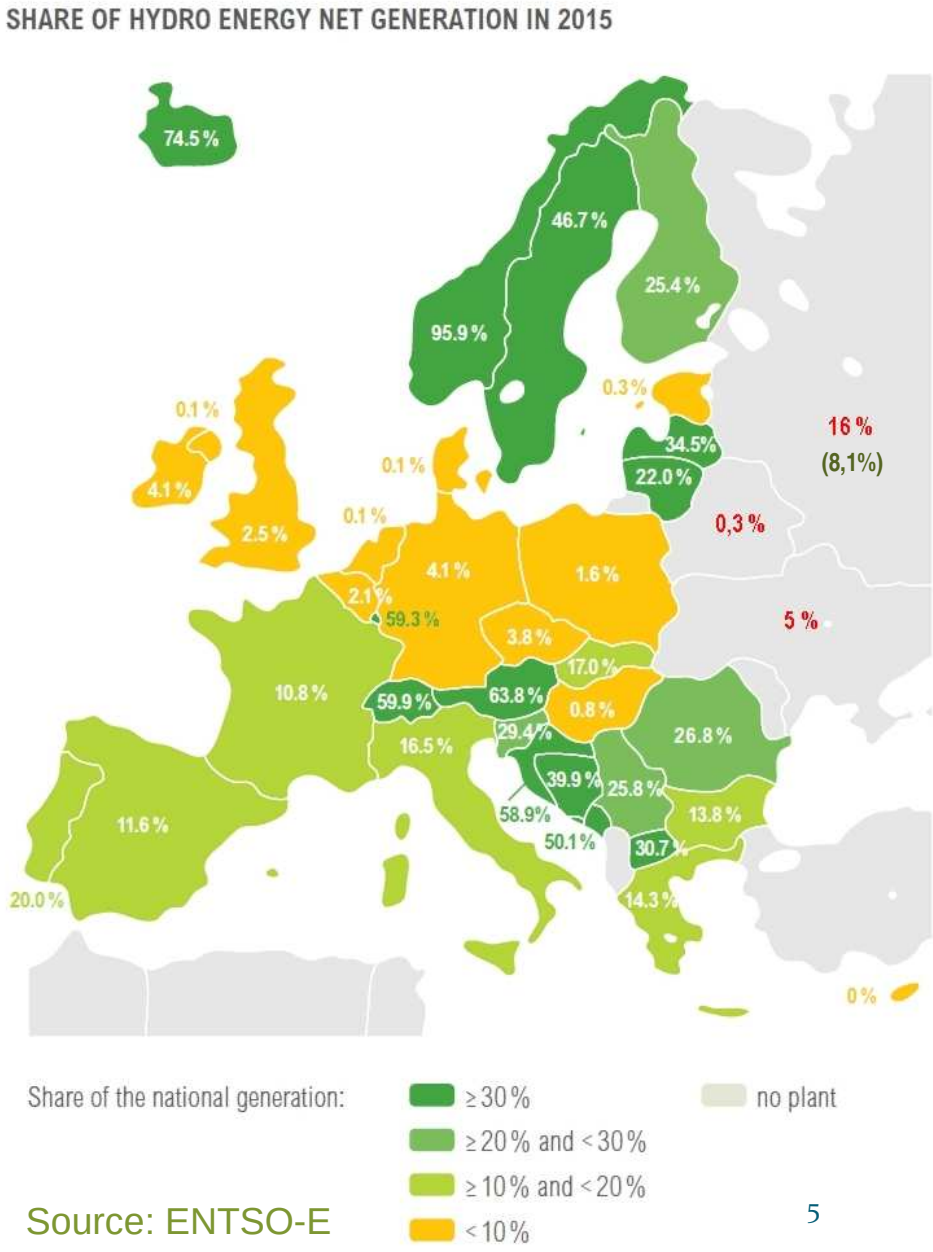
Daugava, Nemunas

Vistula, Oder and Elbe

Vah, Sava

Prut and Dniester

Subregion	Technical potential	Normalised generation	Total capacity	Potential use
	TWh/a	GWh/a	MW	%
Belarus	2,5	114	50	4,6
Bulgaria	15,1	3 718	3 223	24,7
Czech Republic	4,0	2 276	2 071	56,9
Hungary	8,0	225	57	2,8
Moldova	1,0	361	64	36,1
Poland	12,0	2 318	2 385	19,5
Romania	36,0	16 798	6 744	46,7
Slovakia	7,0	4 537	2 493	64,8
Ukraine	22,0	11 380	6 162	51,7
Eastern Europe-9	**107,6**	**41 555**	**23 149**	**38,6**
RF - Total	1670,0	180 524	50 624	10,8
RF – European Part	229,0	65 300	19 465	28,5
Eastern Europe-10	**336,6**	**106 855**	**42 614**	**31,7**
Latvia	4,0	2 917	1 563	72,9
Baltic States	**6,4**	**3 368**	**2 597**	**52,6**
Former Yugoslavia	**78,5**	**31 080**	**9 890**	**39,6**
Total	**421,5**	**141 303**	**55 101**	**33,5**



Source: ENTSO-E

Major hydroelectric schemes Volga & Dnieper

Volga-Kama Cascades
12 100 MW, 38.5 TWh/a
Сергей Матанцев/ novostivolgograda.ru

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Dnieper Cascade, 3 985 MW, 10 TWh/a
Photo: DnieproGES

Major hydroelectric schemes Danube

Iron Gate I, 2 052 MW, 10.9 TWh/a (1972),
partly upgraded to **2192** MW
https://www.youtube.com/watch?v=4Jsu9cioHiU

HYDRO 2018

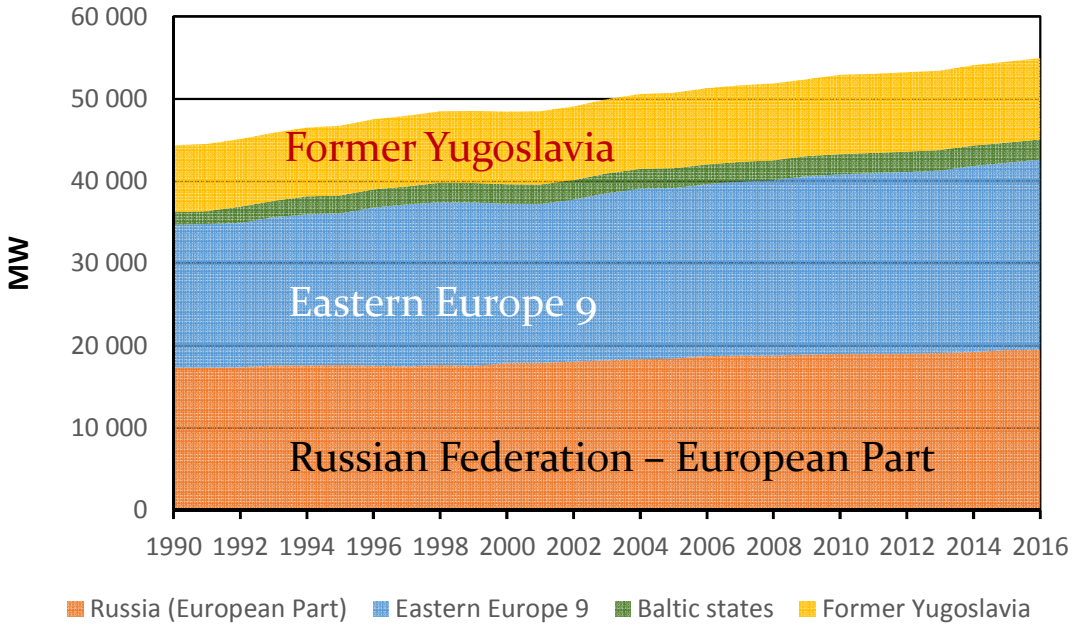
Gabčíkovo , 720 MW, 2.6 TWh/a (1996)
https://danubeonthames.wordpress.com

Major hydroelectric schemes
Pumped Storage

Kruonis PSPP, 900 MW (2004),
Kasiulis & Punys, *Hydropower in Lithuania: current status and potential for future development*, 2017

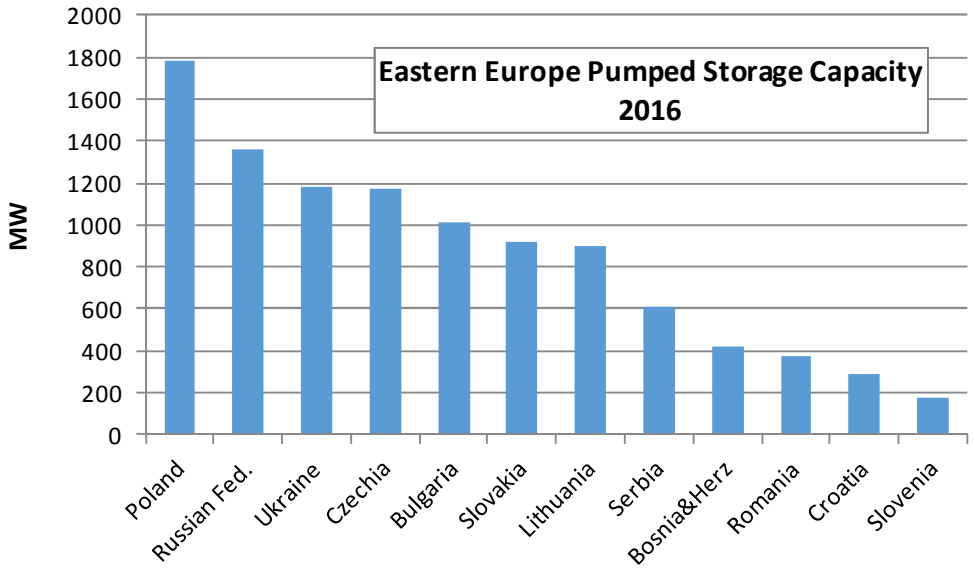
HYDRO 2018

Dniester PSPP, 7x324 MW (under construction)
Potashnik & al., *Golden Age of Ukrainian Hydropower*, 2017

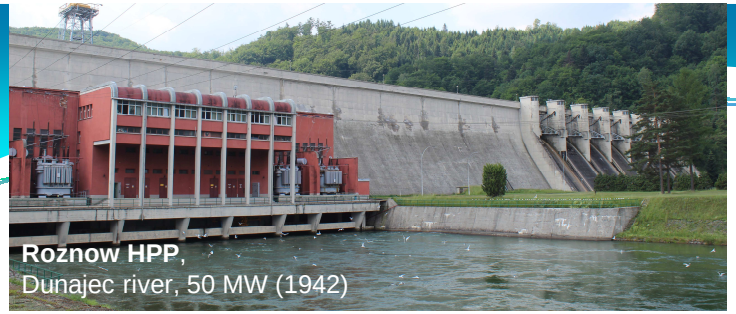


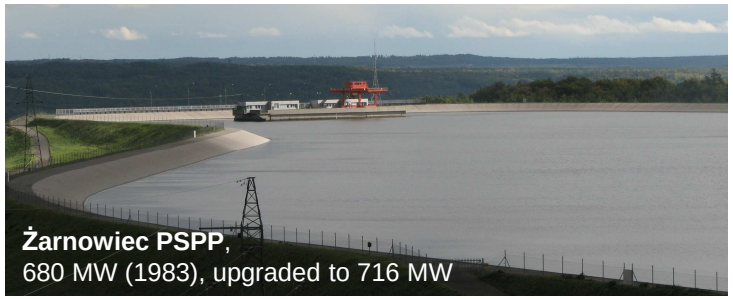
Assets and trends

steady growth
of 0.8 %/annum (400 MW/year)



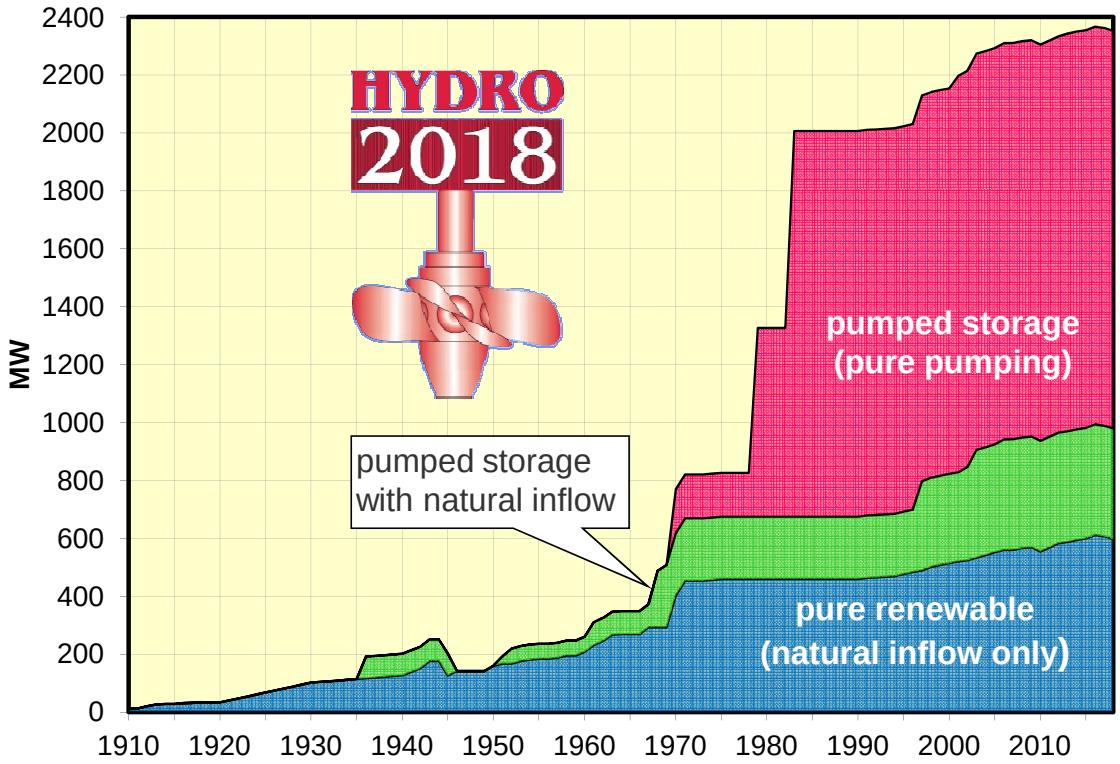
Cierny Vah PSPP, 734 MW (1982),
https://www.seas.sk/pve-cierny-vah





Case study POLAND

hydropower generation capacity at the current territory of the Republic of Poland



Case study POLAND

Large hydro status

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	157
pure pumped storage total	1373
large hydro total	**2058**

Challenges

- **Instability in the legal constraints**

  Instability in the rules of play, including retroactive impact of some acts of law and other regulations, is a true nuisance for numerous investors within the region.

- **Sustainable growth and environmental thinking – lack of balanced approach**

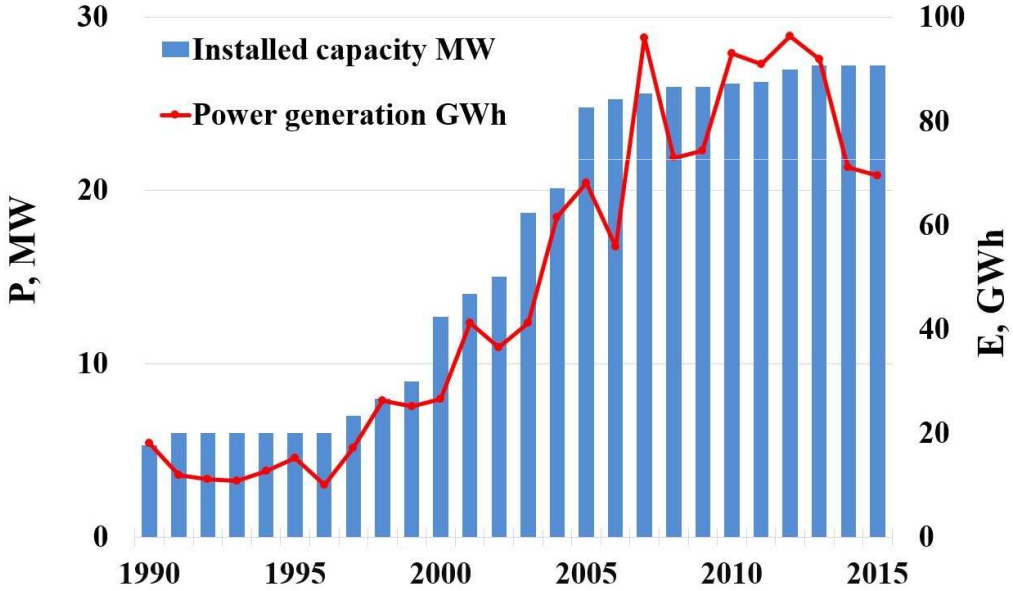
  Environmental priorities are often contradictory and globally balanced thinking is often lacking in the same way as readiness to a reasonable compromise.

- **Deterioration of business activity conditions**
  - cuttting or abandoning the renewable energy promotion programmes - especially in respect to the hydropower sector;
  - insufficient interest of state grid operator in ancillary services, including energy storage;
  - shrinking of energy storage capabilities due to environmental constraints;
  - heavy financial burdens due to fiscal duties and maintanence of the multipurpose civil works;
  - disregarding the hydropower sector characteristics when introducing new acts of law and detailed regulations .

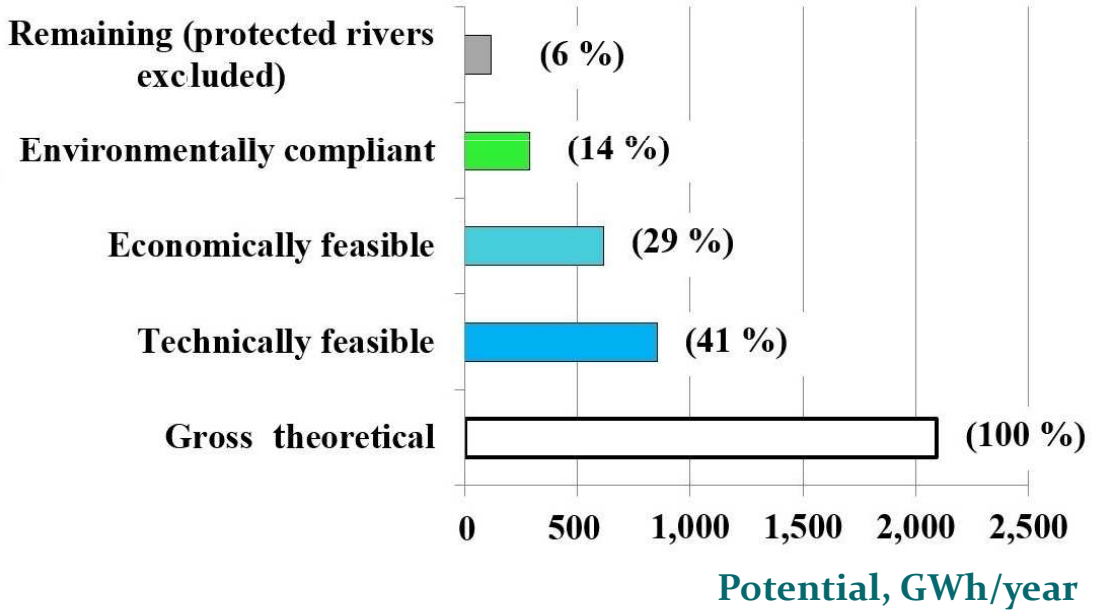
Challenges

Restrictive environmental law. Case study Lithuania

Installed capacity and annual generation in the small hydro sector



Hydropower potential according to different criteria

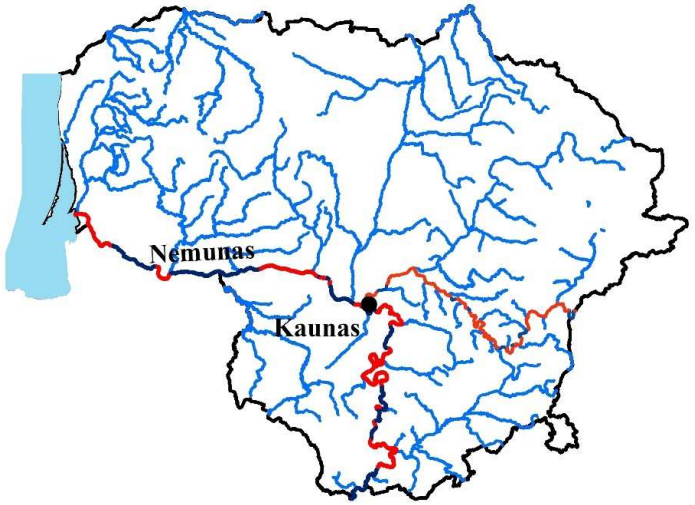


Kasiulis & Punys, *Hydropower in Lithuania: current status and potential for future development,* Salzburg, 2017

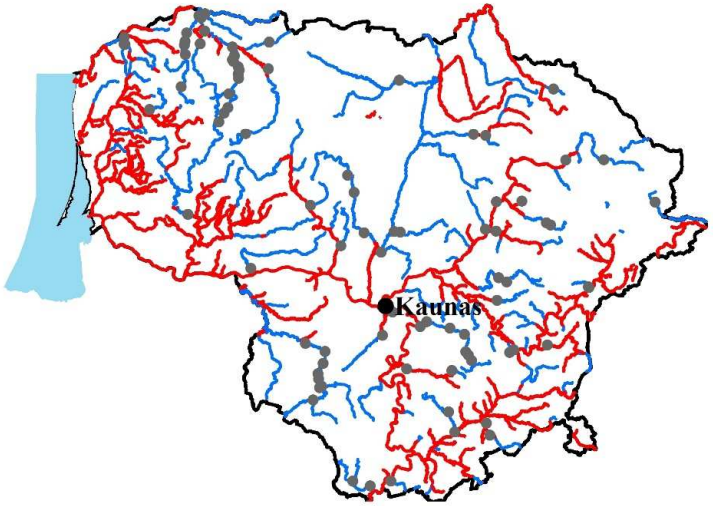
Challenges

Restrictive environmental law. Case study Lithuania

Rivers attractive for hydropower and inland navigation (approx. 120)



All protected rivers (red), rivers available for flow regulation (blue). Dots indicate HPPs



Kasiulis & Punys, *Hydropower in Lithuania: current status and potential for future development,* Salzburg, 2017

New opportunities

- increased **use of available energy storage capacities** in existing hydropower reservoirs;
- **pumped storage projects** aimed at further development of energy storage capacities and capabilities to compensate fluctuations of grid parameters;
- **multipurpose projects** oriented among others on development of inland navigation routes as well as new water and energy storage capacities in river cascades.

in the old background

- Climate change and its consequences stimulate development of unstable renewables and the demand for energy and water storage.
- The trend to increase energy safety and spare non-renewable source is another factor of significance.

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

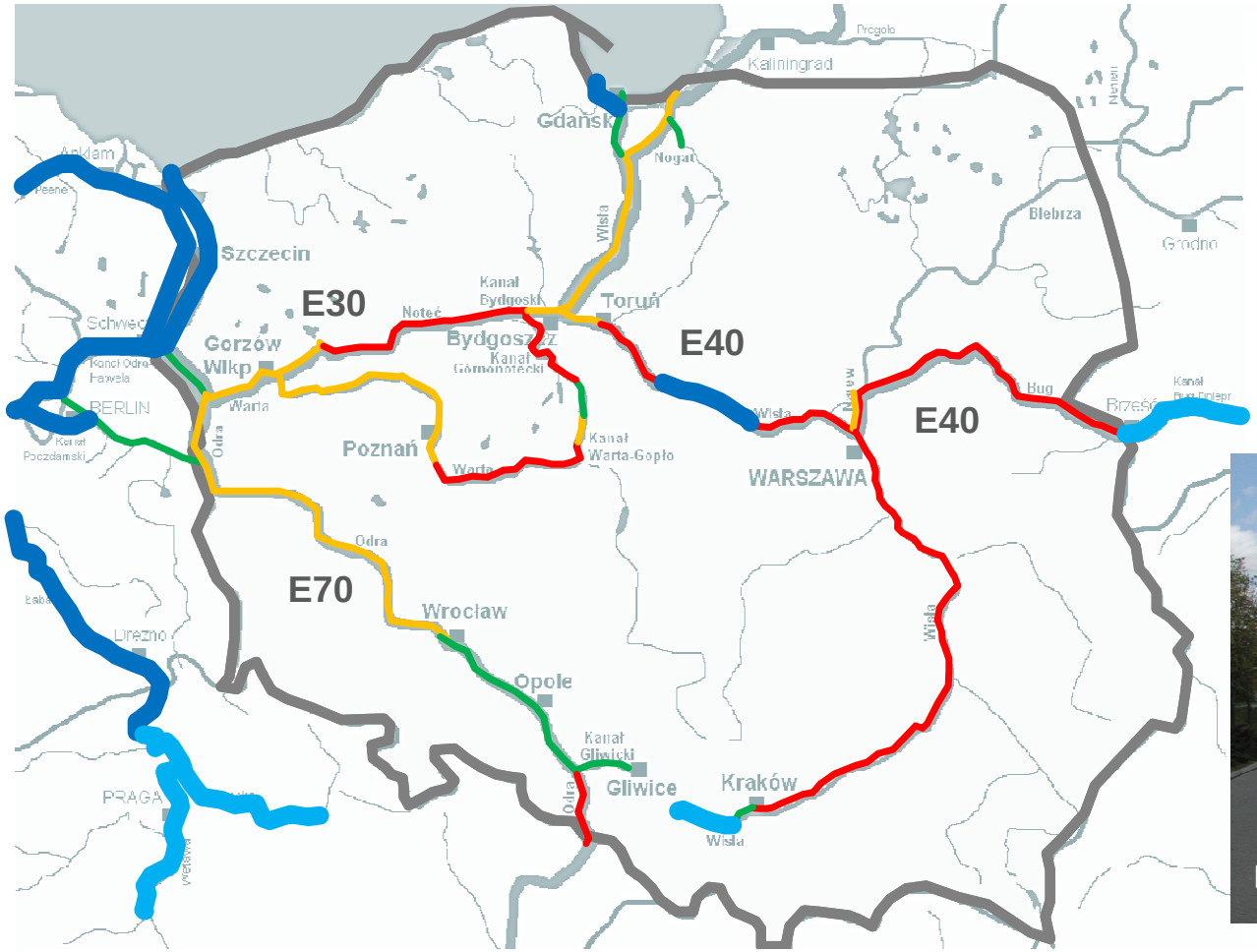
ЕВРОПЕЙСКОЕ СОГЛАШЕНИЕ О ВАЖНЕЙШИХ ВНУТРЕННИХ ВОДНЫХ ПУТЯХ МЕЖДУНАРОДНОГО ЗНАЧЕНИЯ (СМВП)

СОВЕРШЕНО В ЖЕНЕВЕ 19 ЯНВАРЯ 1996 ГОДА

Poland joined the agreement in 2017.

UNITED NATIONS NATIONS UNIES
ОРГАНИЗАЦИЯ ОБЪЕДИНЕННЫХ НАЦИЙ

New opportunities: development of Polish waterways



Polish waterways

class V	
class IV	
class III	
class II	
class I	

HYDRO 2018


Empty lock at Wloclawek Dam

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

Opportunities

Vistula cascades after concepts of 1970's

Babiński Z., Habel M.: Bird's eye view of the Lower Vistula valley, The Days of Science, Bydgoszcz, 2009

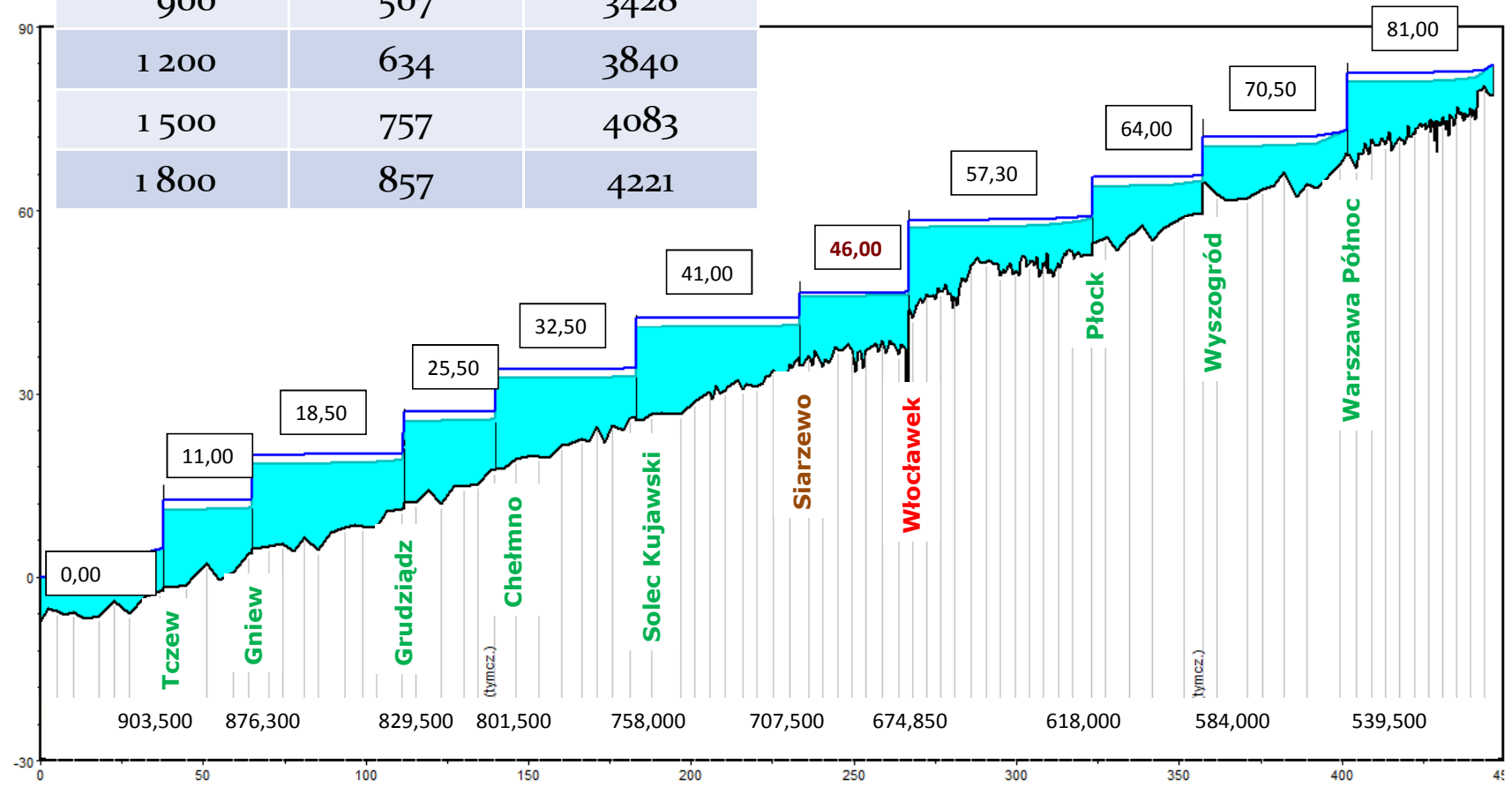
Cascade	Power MW	Generation GWh/year
Lower Vistula	1341	3884
Middle Vistula	554	1746
Upper Vistula	145	512
Total	2040	6142

Piskozub A. (Ed.): *Vistula. Monograph of the river*, Wydawnictwa Komunikacji i Łączności 1982 (in Polish)

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)

Opportunities

Lower Vistula Cascade

Siarzewo Dam according to the Ove Arup concept, 2014

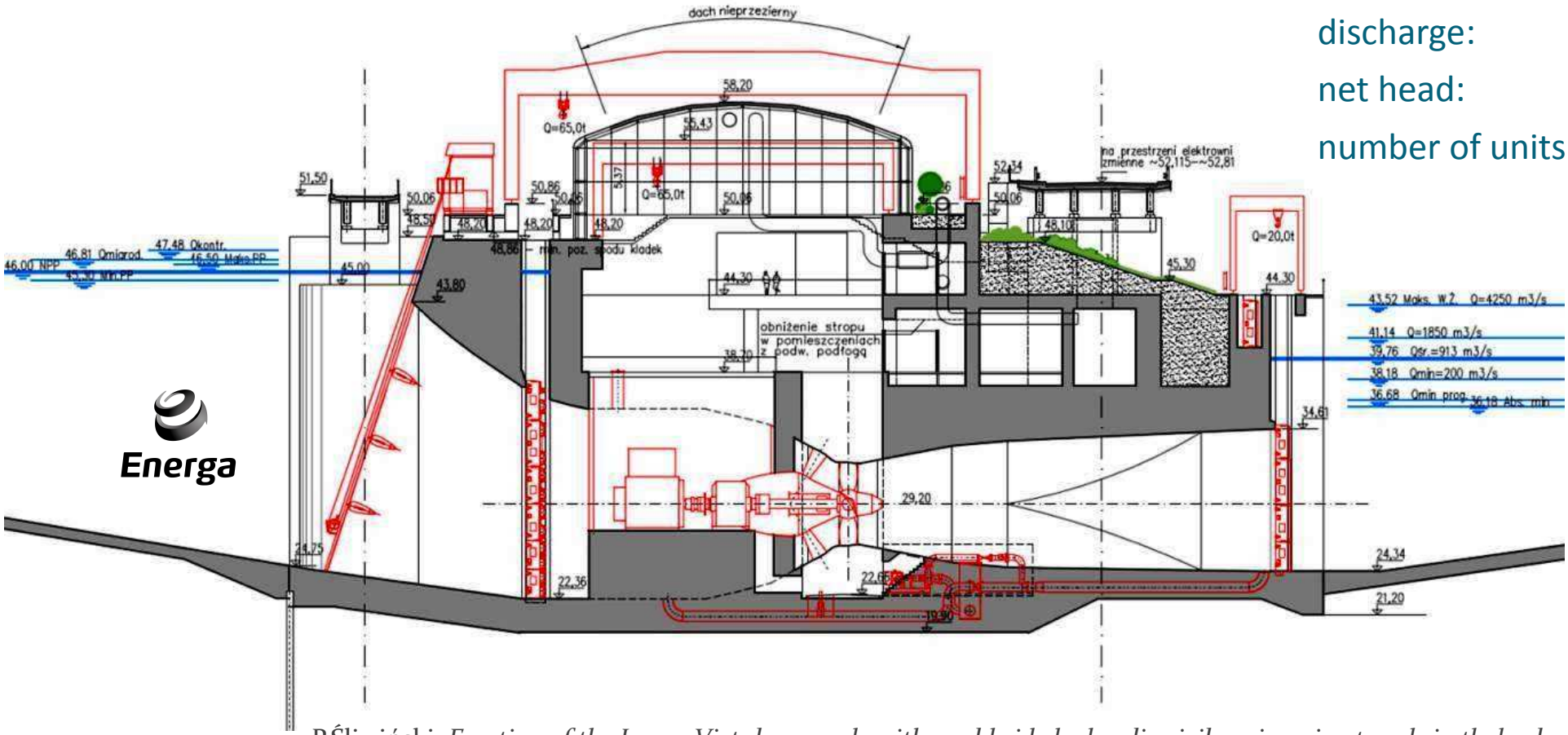
Opportunities

Siarzewo Dam in the Lower Vistula cascade – one of concepts

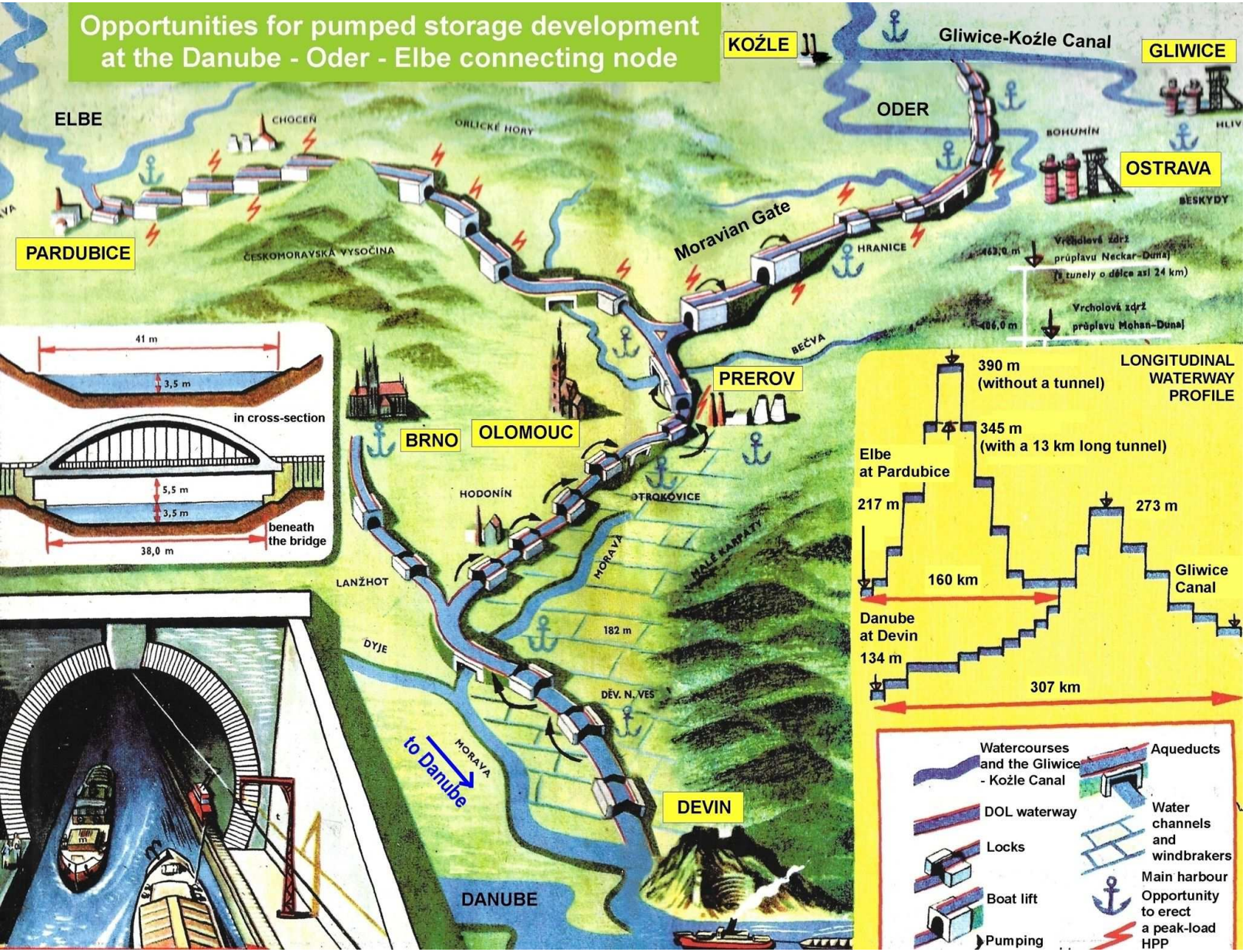
discharge: 1800 m^3/s

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 th background,* Wloclawek/Wieniec, April 2017 (in Polish)



Opportunities

DOE node project

pumped storage
at navigation canals
and classic plants
at Elbe and Oder rivers

Pumped storage scheme

pumping energy required
190 GWh/annum
total turbine capacity
300 MW

Podzimek, J. et al:
Meeting of three seas. Water corridor Danube-Oder-Elbe. Plavba a vodní cesty o.p.s., Prague, 2015 (in Czech)

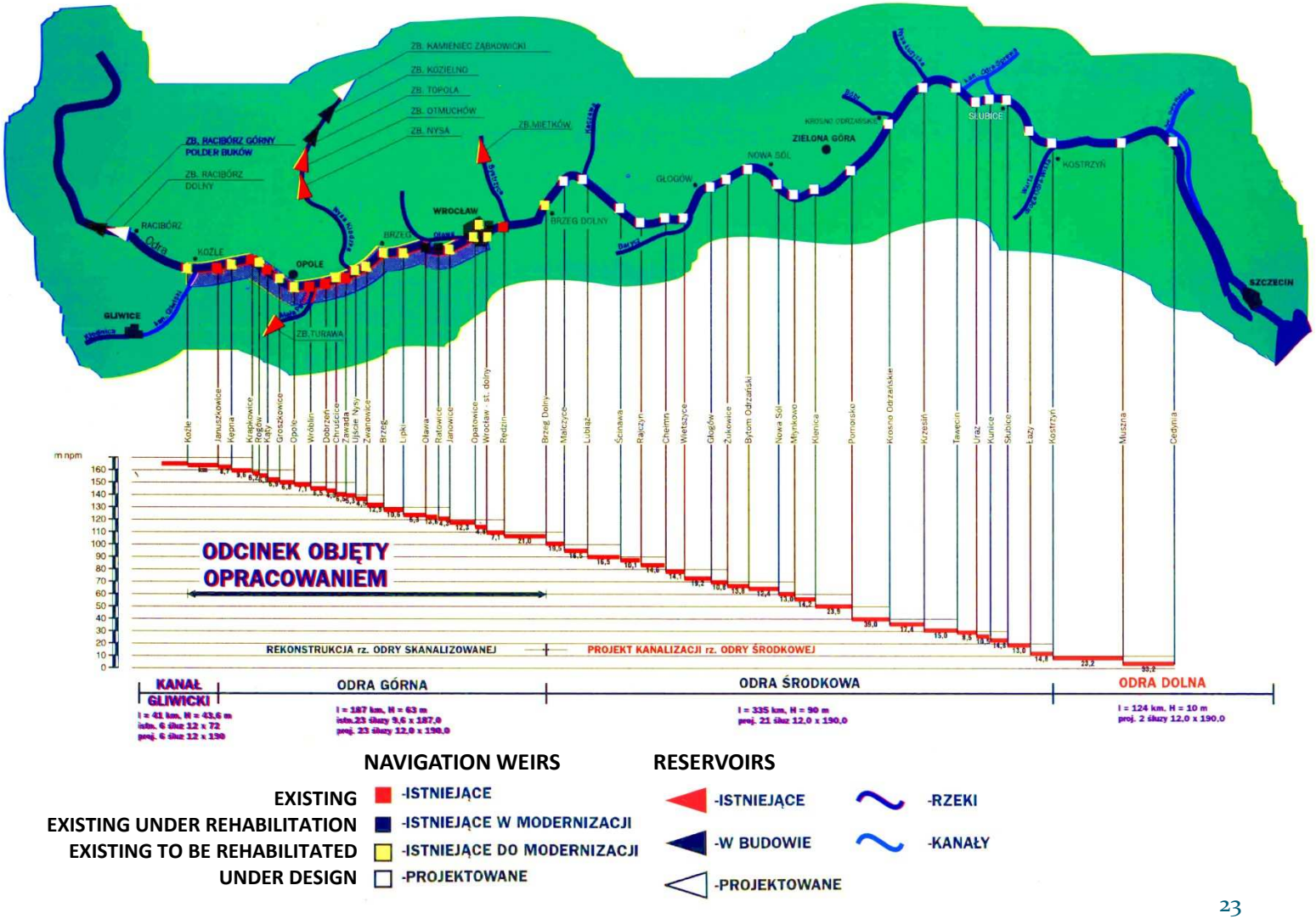
Map reproduced from
"Věda a technika mladeži", 8, 1958

Opportunities: development of Oder river according to the Oder 2006 programme


Malczyce 2018,
https://portalkomunalny.pl


Krępna 2006


Januszkowice 2006



Conclusion

- Despite high differentiation in the hydropower potential density and economic status, the hydropower sector in the East European EU member and candidate states suffers from non-technical constraints very similar to those in the western part of Europe
- The most promising opportunities for hydropower sector in countries with restrictive environmental legislation follow from the multipurpose and pumped storage projects.
- Small hydro installations at already existing barrages remain also an option in most East European countries.

Thank you for your attention!