Institute of Automatics, Electronics
and Electrical Engineering
University of Zielona Gora

UNIVERSITY
OF ZIELONA GÓRA

Development of e-mobility in Poland

Robert Smoleński

e-mobility related projects

Gazeta Lubuska

UNIWERSYTET ZIELONOGÓRSKI

PL·BB 2007-2013

b-tu Brandenburgische Technische Universität Cottbus - Senftenberg

Cooperation of UZ and BTU in the field of "green energy",
Program Operacyjny Współpracy Transgranicznej Polska (Województwo Lubuskie) – Brandenburgia

EV Charging Infrastructure

EKO ENERGETYKA
SMART ENERGY SYSTEMS

Barcelona

Malme

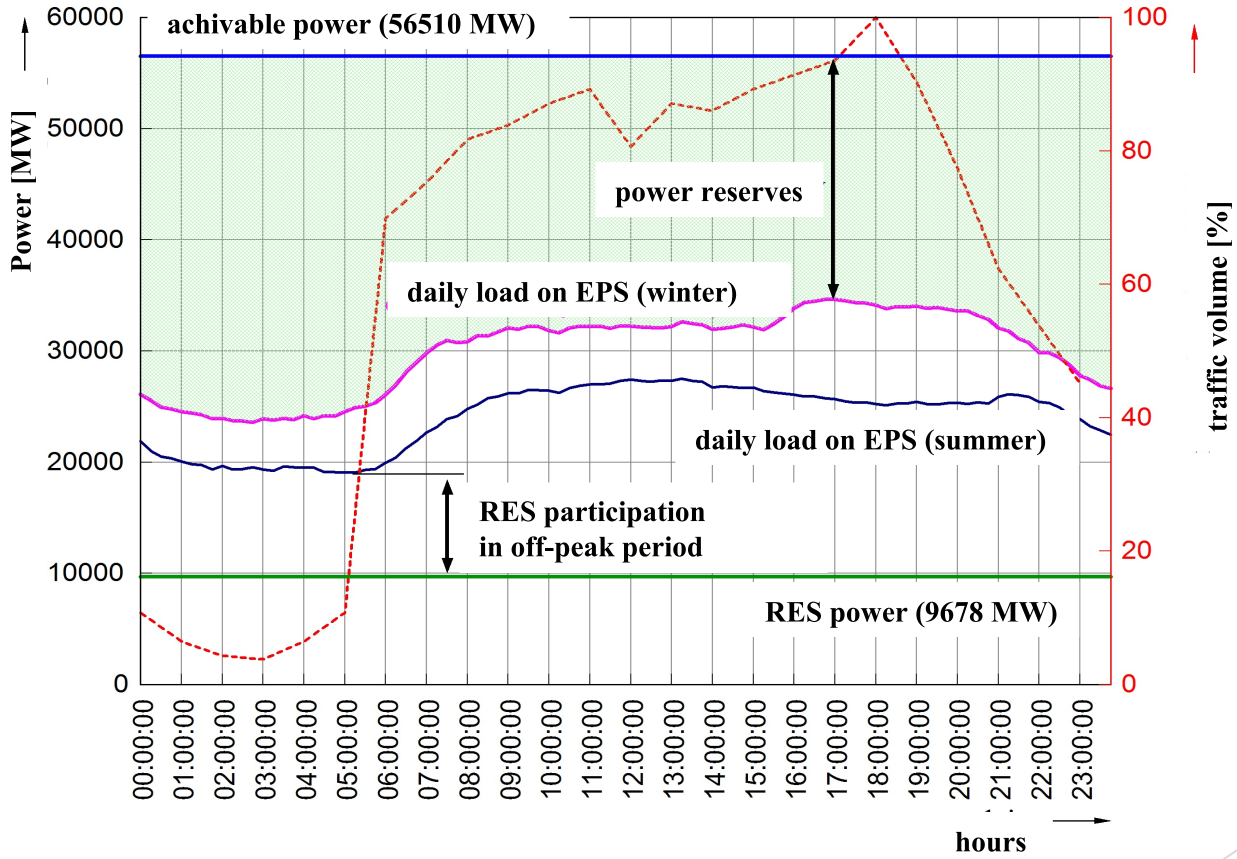
Tampere

- The biggest supplier of bus charging infrastructure in Europe
- Smart Grid solutions
- Close R&D cooperation with the Institute
- Development of innovative multiport charging stations

www.ekoenergetyka.com.pl

e-mobility development limitations

Corelation of EPS daily load and city traffic characteristics (Poland case)



G. Benysek and M. Jarnut, “Electric vehicle charging infrastructure in Poland”, Renew. Sust. Energ. Rev., 16, 320–328 (2012).

e-mobility development limitations

Daily load of EV charging infrastructure

Parameter	Symbol	Value
Number of EV (in 2025)	N_{EV}	200.000 lub 1.000.000
Battery capacity [MWh]	E	0.03
Time of slow charging [h]	T_W	10
Time of fast charging [h]	T_S	0,5
EV usage cooficient	k_j	0,5
Traffic factor	k_S	daily characteristic
Motion factor	k_R	k_{R1} = 0,2 (fast charging) k_{R2} = 0,041 (fast charging) k_{R2} = 0,83 (slow charging)

$$P_{EPSEV}(t) = P_{EPS}(t) + P_{EV}(t)$$

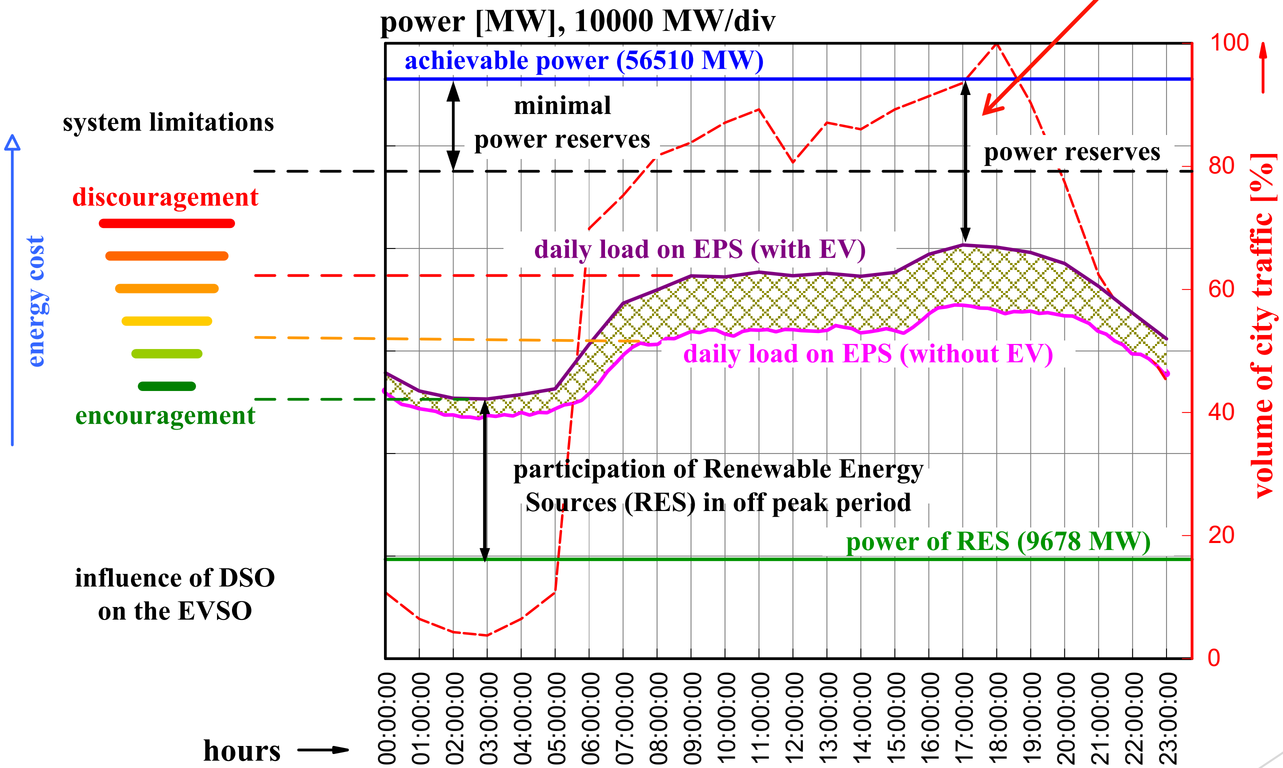
$$P_{EV}(t) = \underbrace{k_j \cdot k_S(t) \cdot k_{R1} \cdot N_{EV} \cdot \frac{E}{T_S}}_{\text{active type vehicles}} + \underbrace{k_j \cdot \left(1 - k_S(t)\right) \cdot k_{R2} \cdot N_{EV} \cdot \frac{E}{T_W}}_{\text{passive type vehicles}}$$

G. Benysek and M. Jarnut, “Electric vehicle charging infrastructure in Poland”, Renew. Sust. Energ. Rev., 16, 320–328 (2012).

e-mobility development limitations

Worst case analysis in case of different participation of EV in automotive market in Poland – 2025 year perspective

Power reserves drope below 14 % means problem with EPS stability



G. Benysek and M. Jarnut, "Electric vehicle charging infrastructure in Poland", Renew. Sust. Energ. Rev., 16, 320–328 (2012).

EnergyStore Project

Summary of the parameters of energy storage systems in a frame of the EnergyStore project

	AC/DC	DC/DC	Energy	Mass power density	Volumetric power density	Estimated weight*	Estimated volume*
System 1 (EDLC)	100 kW	100 kW	1,5 kWh	3,3 Wh/kg	3,5 Wh/l	455 kg	430 dm^3
System 2 (LIC)	100 kW	100 kW	2,12 kWh	9,5 Wh/kg	7,5 Wh/l	224 kg	283 dm^3
System 3 (LFP)	100 kW	100 kW	101,4 kWh	100 Wh/kg	160 Wh/l	1014 kg	634 dm^3
System 4 (LTO)	100 kW	100 kW	46 kWh	45 Wh/kg	80 Wh/l	1023 kg	575 dm^3
System 5 (VRLA)	100 kW	100 kW	200 kWh	78 Wh/kg	171 Wh/l	3861 kg	1471 dm^3
* szacowana waga i objętość uwzględnia tylko magazyn energii, nie uwzględnia połączeń pomiędzy ogniwami oraz układów balansujących i zarządzających BMS							

POIR.01.02.00-00-0232/16 Innovative services of the energy storage improving the quality and efficiency of energy use - EnergyStore.

EnergyStore Project

Summary of investment and operating costs of energy storages in selected technologies

Typ zasobnika	Koszt inwestycyjny K_{INV} [PLN/kWh]	Koszt operacyjny LCOE [PLN/kWh]
VRLA	670	2,63
LiFePO4	1 600	0,69
LTO	3 800	0,25
EDLC	190 000	0,26
LIC	175 000	0,09

$$LCOE = \frac{K_{INV}}{\frac{DOD}{100} \cdot N_{C(DOD)} \cdot \frac{\eta_N}{100}}$$

POIR.01.02.00-00-0232/16 Innovative services of the energy storage improving the quality and efficiency of energy use - EnergyStore.

EnergyStore Project

VRLA

LTO

Conclusion

- ✓ E-mobility development has significant influence on distribution system.
- ✓ Limitation of a negative impact of a charging infrastructure will require development of new technical solutions.
- ✓ Optimiziation of developed solutions will be possible thanks to the work of interdisciplinary teams.
- ✓ The use of B2U-based stationary energy storage can significantly reduce the connection capacity of the charging infrastructure.