

# Trolley

Promoting **clean** public transport



## TROLLEY – 4.1.10. Transport mode efficiency model

Marcin Wołek,  
Ernest Czermański  
University of Gdańsk  
TROLLEY Final Conference

## 4.1.10. Transport mode efficiency analysis

Comparing partner cities TB-systems

Common defining financial and economical cost in urban transportation

City	Country	Trolejbuses	Diesel-busses	CNG-buses	Hybrid-buses	Tramways
Gdynia	PL	Yes	Yes	Yes	No	No
Szeged	H	Yes	Yes	No	No	Yes
Parma	I	Yes	Yes	Yes	No	No
Eberswalde	D	Yes	Yes	No	No	No
Brno	CZ	Yes	Yes	No	No	Yes
Leipzig	D	No	Yes	No	Yes	Yes
Salzburg	A	Yes	Yes	No	No	No

# Comparison of PP's operators - overview



Indicator	Unit	Value for:			
		Salzburg	Parma	Gdynia	Eberswalde
No. of inhabitants	Pers.	147.685	175.789	248.574	41.331
No. of trolleys	Veh.	102	29	84	12
No. of passenger places	Pcs.	13.593	2.837	8.690	1.536
Av. capacity of 1 vehicle	Pcs.	133,3	97,8	103,5	128
Av. yearly distance of 1 veh.	km	58.823,5	41.379,3	58.993,0	62.905
Yearly transportation capacity	Veh/km	6.000.000	1.200.000	4.955.415	754.858
Yearly transportation capacity	Placekm	799,8 M	117,4 M	512,9 M	96,6 M
Total yearly transportation work	Pax	38,4 M	7.292.565	25.145.874	2.816.226
Total yearly transportation work	Paxkm	218,88 M	26,25 M	133,0 M	86.170.796
Av. distance for 1 pax	Km	5,7	3,6	5,29	6,81
Av. costs of 1 paxkm (theoretical)	EUR	0,81	0,69	0,44	0,033
Av. costs of 1 vkm	EUR	1,92	2,09	2.19	3,77
Depretiation period	years	25	25	20	18

# Model assumptions

- ▶ Analysis period – 30 years
- ▶ 1 km of track
- ▶ Discount rates
  - ▶ Financial rate - 5%
  - ▶ Economic rate - 8%
- ▶ Residual value – 35%
- ▶ Fixed prices
- ▶ Time of use:
  - ▶ Diesel busses – 12 years
  - ▶ Trolleybuses – 20 years
- Comparison : diesel bus (with euro 5 norm engine) versus trolleybus (energy based on coal)
- External costs included:
  - Pollution,
  - Noise,
- \* By average 20 hours per day using

4 PLN = 1 EUR

Grey numbers are calculated from other values

Trolleybus infrastructure costs	
Overhead wires [PLN/km]	1 500 000
Substation [PLN]	1 300 000
Substations/km	0,29
Substations [PLN/km]	371 429
Overall construction	1 871 429
Yearly network maintenance [PLN/km]	100 000
Network residual value (30 years)	35%

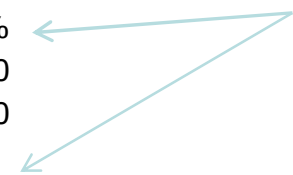
Vehicle costs	
Bus - purchase [PLN]	770 000
Trolley - purchase [PLN]	980 000
Bus - lifetime [years]	12
Trolley - lifetime [years]	20
Bus - maintenance [PLN/km]	1,05
Trolley - maintenance [PLN/km]	1,35

Energy costs	
Bus - consumption [l/100km]	40
Bus - price of fuel [PLN/l]	4,00
Bus - real dynamics of energy price [%/year]	4%
Trolley - consumption [kWh/100 km]	190,00
Trolley - price of fuel [PLN/kWh]	0,30
Trolley - real dynamics of energy price [%/year]	2%

All data in black should be city-specific



The model is very sensitive to these two values!



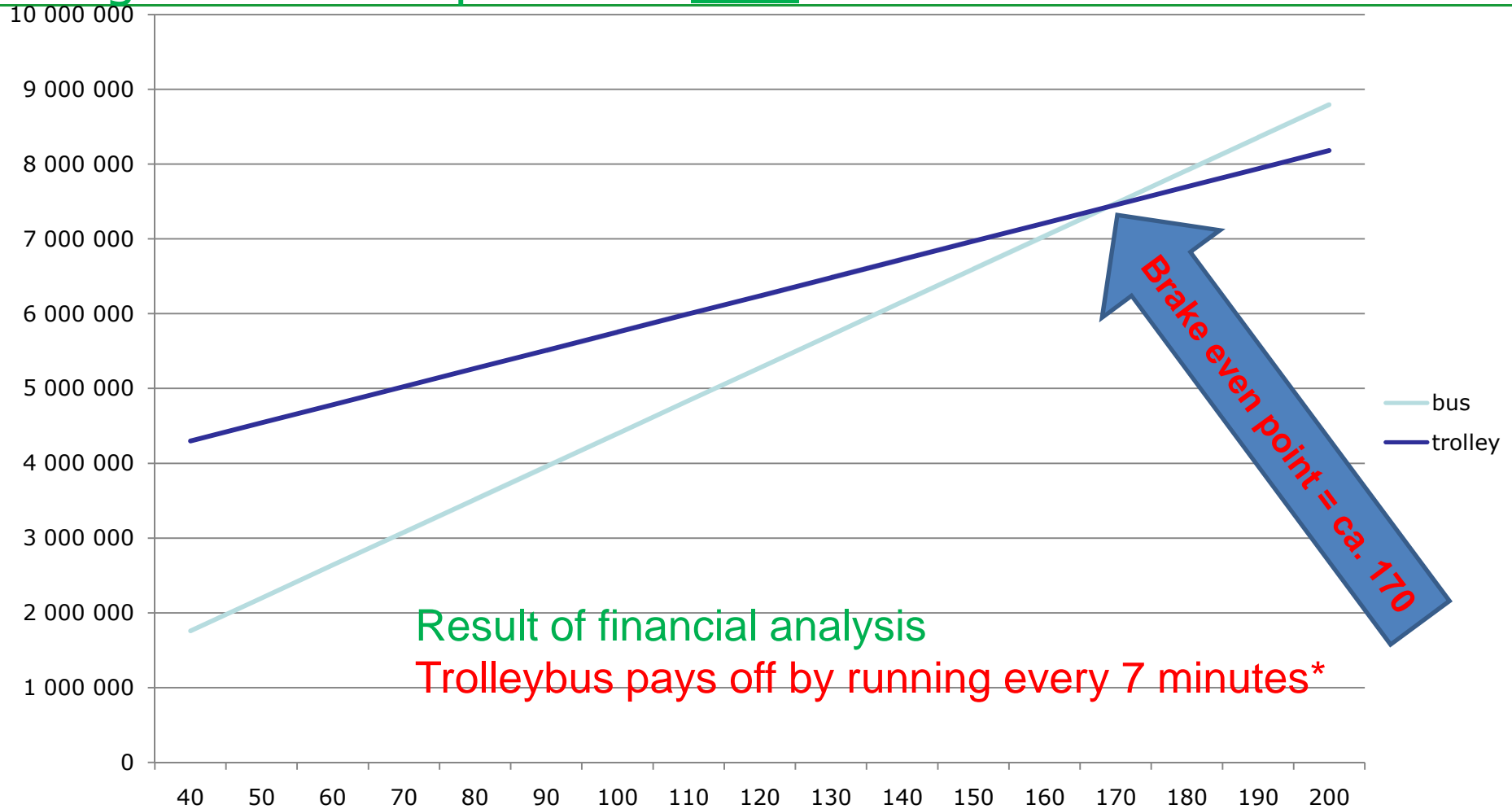
Emission	CO	NMHC	NOx	PM10	CO2		
Bus Euro 5 [g/vehkm]		0,040	0,110	2,830	0,030	1400,000	
Trolley [g/kWh]		0,086	0,000	1,822	0,220	811,300	
Trolley [g/vehkm]		0,163	0,000	3,462	0,418	1541,470	
kWh/vehkm		1,9					
Value [EUR/g]		0,00001	0,00100	0,00440	0,08931	0,00009	
						TOTAL	
Bus Euro 5 [EUR/vehkm]		0,00000	0,00011	0,01245	0,00268	0,12180	0,137042
Trolley [EUR/vehkm]		0,00000	0,00000	0,01523	0,03733	0,13411	0,093337
Share of no-emission-energy		50%					
Noise costs bus [EUR/vehkm]		0,06					
Noise costs trolley [EUR/vehkm]		0,012					
Total externalities bus [EUR/vehkm]		0,20					
Total externalities trolley [EUR/vehkm]		0,11					
EUR/PLN		4					
Total externalities bus [PLN/vehkm]		0,788					
Total externalities trolley [PLN/vehkm]		0,421					

Assuming 100% coal power plants

The model is sensitive to this value

If 100% coal energy is assumed instead – then trolley externalities are 0,186 – higher, than Euro5 bus!

# Constant real electricity prices vs yearly real growth of oil prices on 5% level

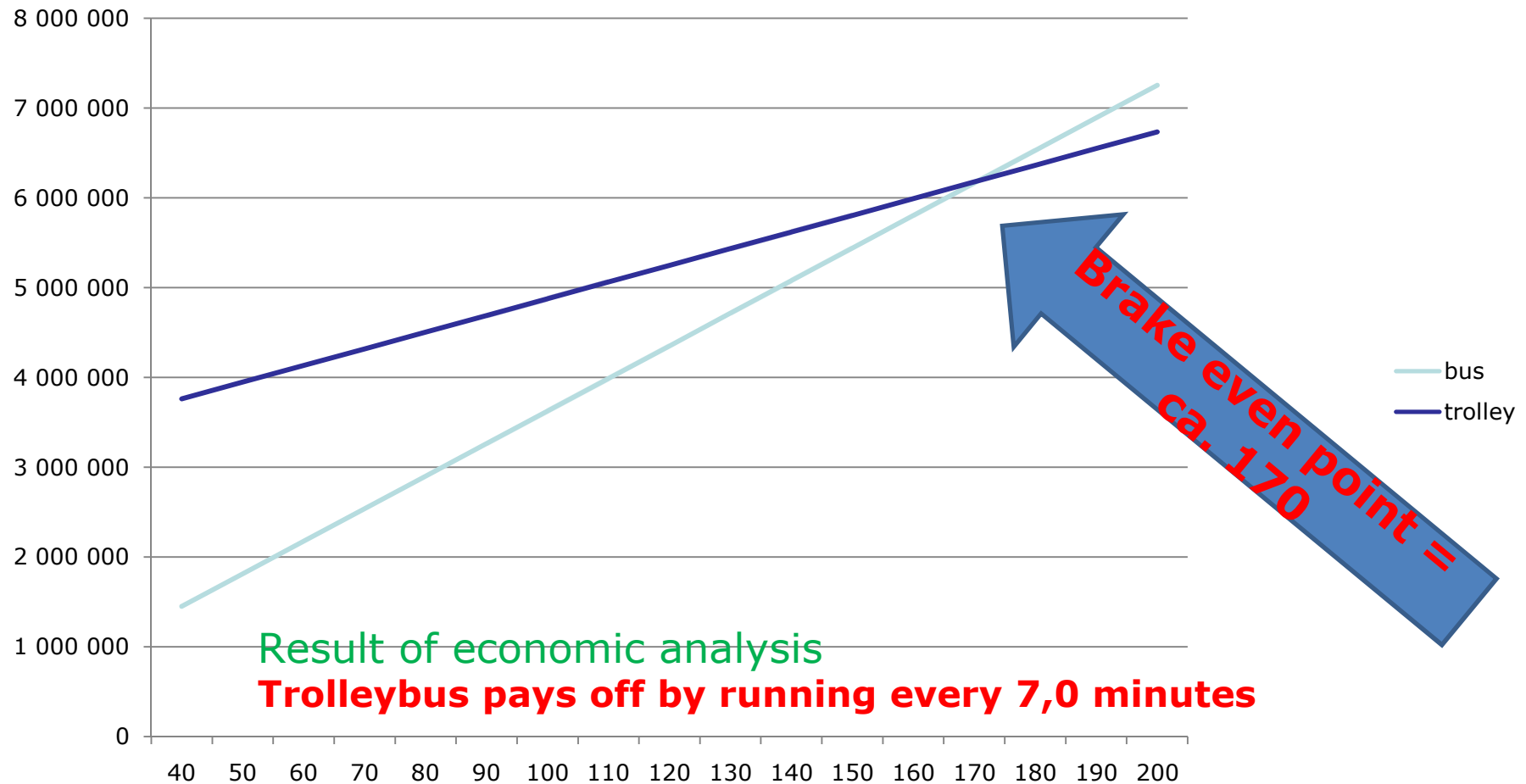


# Constant real electricity prices vs yearly real growth of oil prices on 5% level

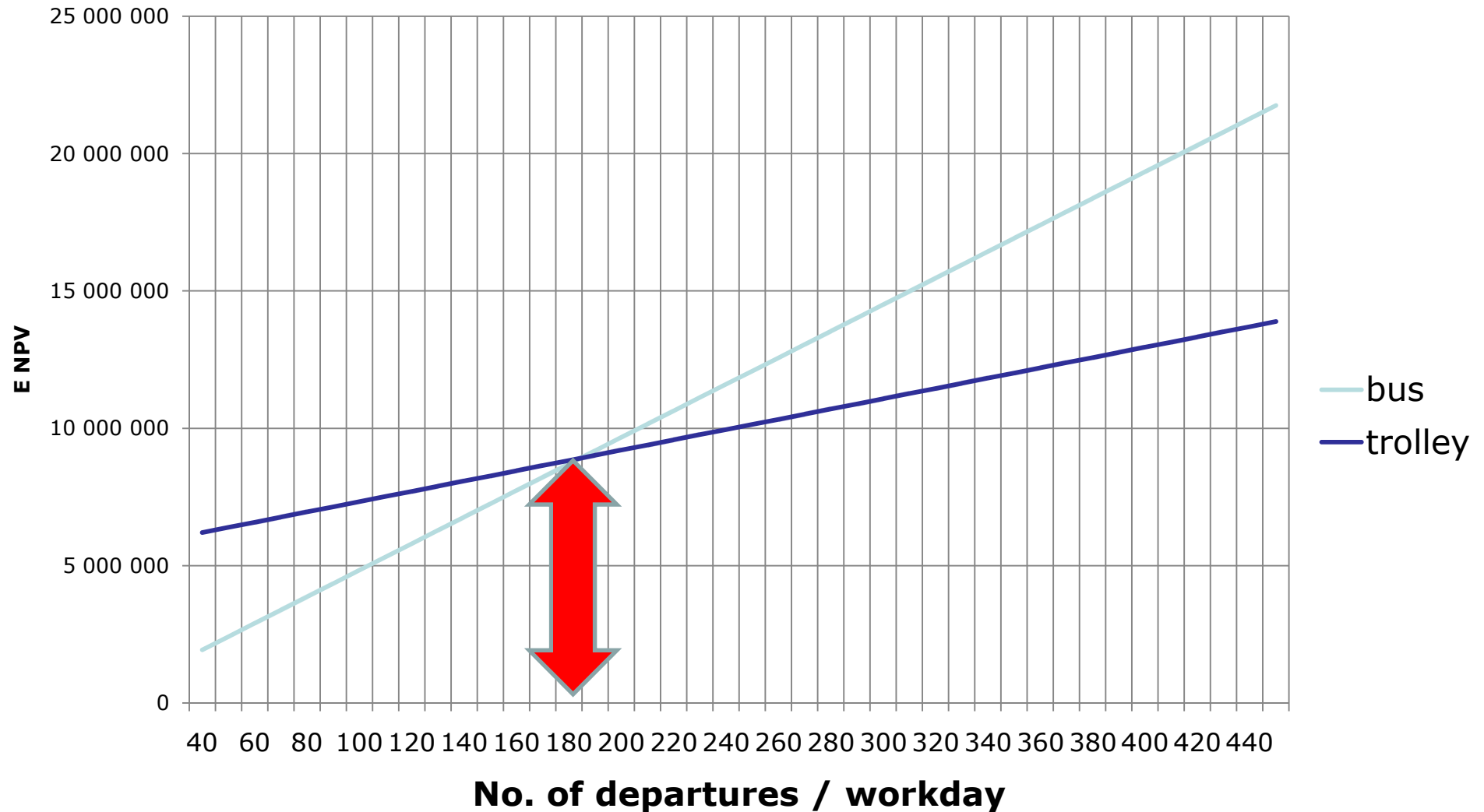




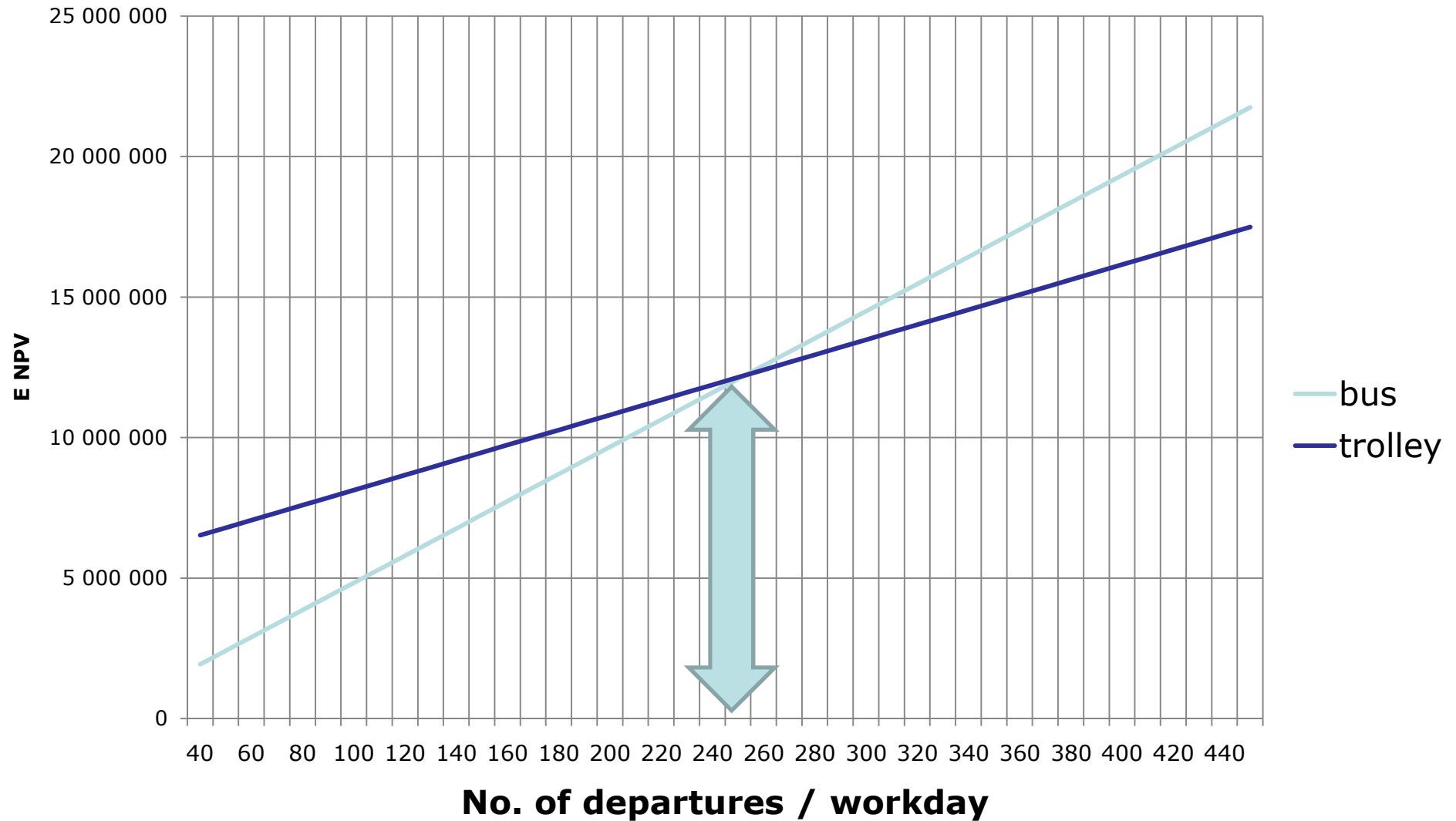
Constant real electricity prices + green energy vs. yearly real growth of oil prices on 5% level



# Case Salzburg – 100% green energy, expensive new TB's



# But by 10% renewable energy and other ass. const.



# Thank you for your attention!

Dr Marcin Wołek: [mwol@wp.pl](mailto:mwol@wp.pl)

Dr Ernest Czermański: [e.czermanski@gmail.com](mailto:e.czermanski@gmail.com)

[www.ug.edu.pl](http://www.ug.edu.pl); [www.econom.univ.gda.pl](http://www.econom.univ.gda.pl)