WATenERgy CYCLE
Urban water full cycle: from its source to its end-users and back to the environment
WP5 Joint Pilot Actions
Joint Del. 5.1 Ex-Ante Water efficiency evaluation

Interreg
Balkan-Mediterranean
EUROPEAN UNION
WATenERgy CYCLE

PP3 - Municipal Enterprise for Water Supply and Sewerage of Kozani

PP4 - University of Thessaly-Special Account Funds for Research-Department of Civil Engineering

PP2 - General Secretariat for Natural Environment and Water

WP5: Joint Pilot Actions

- Responsible partners:
  - **PP3 - Municipal Enterprise for Water Supply and Sewerage of Kozani**
  - **PP4 - University of Thessaly-Special Account Funds for Research-Department of Civil Engineering**
  - **PP2 - General Secretariat for Natural Environment and Water**

- Partners involved: ALL

- Budget: 885,021.23 €

WP5: Joint Pilot Actions

WP5 includes Joint Pilot Actions

- Evaluation of the pilot case prior to the pilot actions. General presentation and description of the pilot case and the pilot action; identification of problems; water and energy audit (Water Balance and Pis); conclusion

- Evaluation of the pilot case after the pilot actions. Description of the pilot action implementation; water and energy audit after the implementation of the pilot action; discussion related to the new PIs values; problems encountered during the pilot action implementation; costs estimation; conclusions

- Summary report on the implementation of the pilot action (per partner).

WP5: Joint Pilot Actions

	Beneficiary	Pilot action	Equipment	Water Use Efficiency	Energy Efficiency
LP	DEYA Larissas (Greece)	Purchase & Installation of Energy Recovery System (three IE3 High Energy Efficiency Motors 250 KW two Inverters, one Softstarter: & Installation Service) at the Central Pumping Station for Larisa Water Utility	three IE3 High Energy Efficiency Motors 250 KW two Inverters, one Softstarter: & Installation Service		√
PP3	DEYA Kozanis (Greece)	Purchase of Energy Recovery System (ENR) and Automated Meter Reading (AMR) (700 AMR, 2 mobile reading systems, software, 3 ENRs DN150 & 2 ENRs DN200, training) for Kozani Water Utility	700 AMR; 5 small hydroturbines	√ Apparent losses	√
PP5	UKKO (Albania)	Water leak detection car (equipped with facilities), Leak detection equipment flow analysis, aquaphone, analysis secorr 300. Water losses measurement database and decision support system. Korça City Zone Pressure no. 3 will represent the UKKO JSC study area that will be our pilot action area	Leak detection car with incorporated Water Leak detection Equipment	√ Real losses	
PP6	WBN (Cyprus)	Purchase of equipment for water pressure management (PRVs) and smart water meters SCADA, PILLAR, software including training of personnel. Monitor operating parameters (pressure, flow, quality parameters). Water Balance calculation	· 700 AMR in DMA25 · PRV installation in DMA 15 · Electronic sensors for water quality monitoring · Electronic power generators	√ · Apparent losses · Real losses	√
PP7	BWA (Bulgaria)	Purchase of leak detection, monitoring and sewerage network inspection equipment. Training purposes	Water leak detection equipment to be used for training & educational purposes	√ Horizontal training	
PP8	Prilep (N. Macedonia)	Purchase of leak detection system and measuring equipment, GIS software for "Water supply and drainage". Water losses measurement database and decision support system	GIS software and leak detection system and measuring equipment	√ Real losses	

WP5: Joint Pilot Actions – Water or Energy Efficiency?

Water use efficiency

- PP3-DEYAK
- PP5-UKKO
- PP6-WBN
- PP7-BWA
- PP8-JKP ViK Prilep

Energy efficiency

- LP/PP1 - DEYAL
- PP3 - DEYAK
- PP6-WBN

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Water Audit: Water Balance is the tool

System Input Volume (A3)	Authorized Consumption (A14=A10+A13)	Billed Authorized Consumption (A10=A8+A9)	Billed Metered Consumption (A8)	Revenue Water (A20=A8+A9)	Revenue Water (water billed & paid for) (A24=A8+A9-A23)
			Billed Un-Metered Consumption (A9)		Water billed but NOT PAID for (apparent NRW) A23
		Unbilled Authorized Consumption (A13=A11+A12)	Unbilled Metered Consumption (A11)	Non- Revenue Water (NRW) (A21=A3-A20)	Accounted for Non-Revenue Water (A26=A3-A24-A23-A25)
			Unbilled Un-Metered Consumption (A12)		
	Water Losses (A15=A3-A14)	Apparent Losses (A18=A16+A17)	Unauthorized Consumption (A16)		
			Customer Meter Inaccuracies & Data Handling Errors (A17)		
		Real Losses (A19=A15-A18)			Water Losses generating revenues (MCD) A25

WP5: Joint Pilot Actions – Water Use Efficiency

Real Losses

- PP5: Supply of leak detection car and equipment
- PP6: PRV in DMA 15
- PP6: electronic sensors for monitoring water quality (indirect effects on pipes)
- PP7: theoretical and practical education of water leak detection equipment
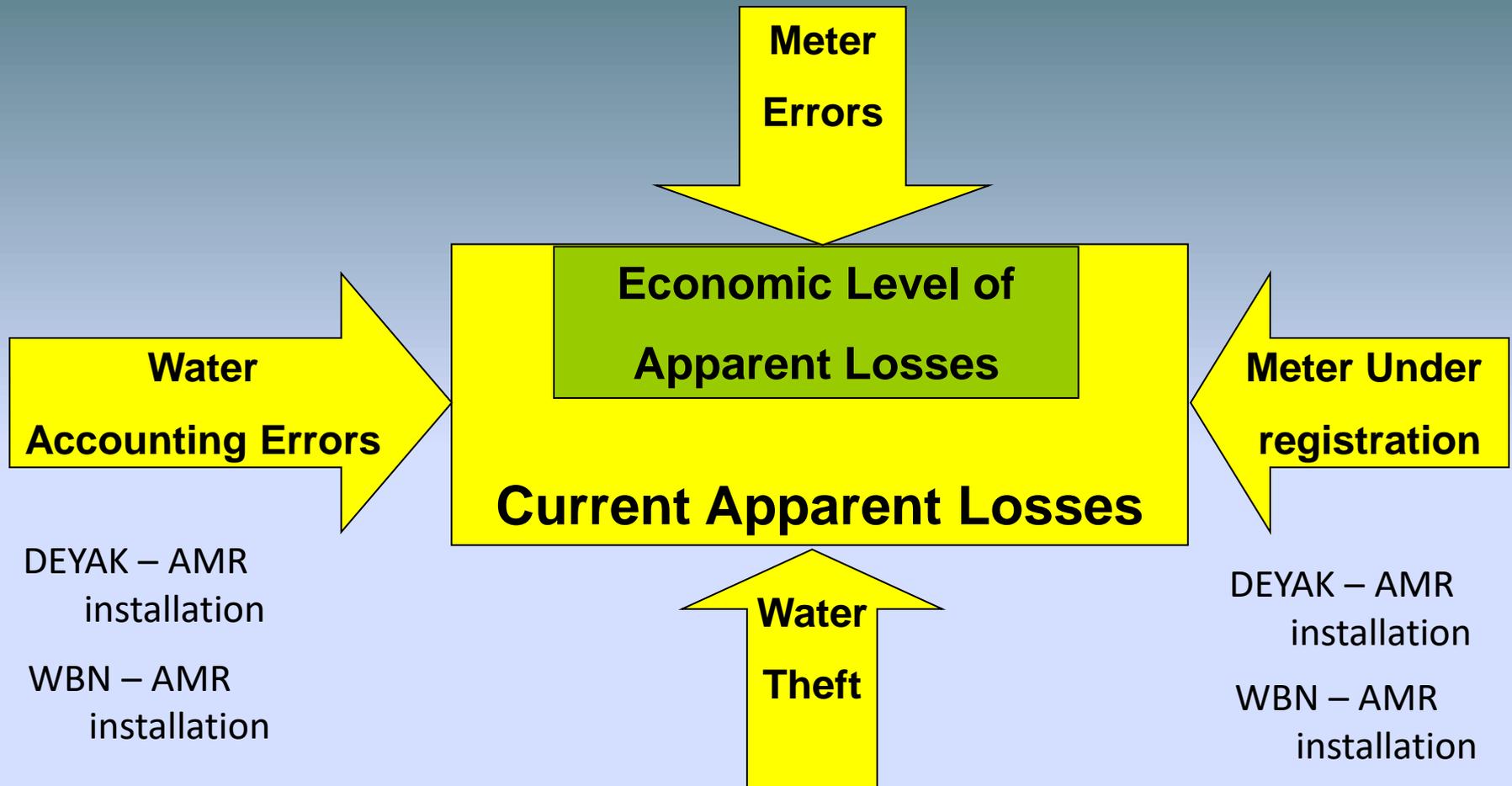- PP8: GIS software
- PP8: leak detection equipment

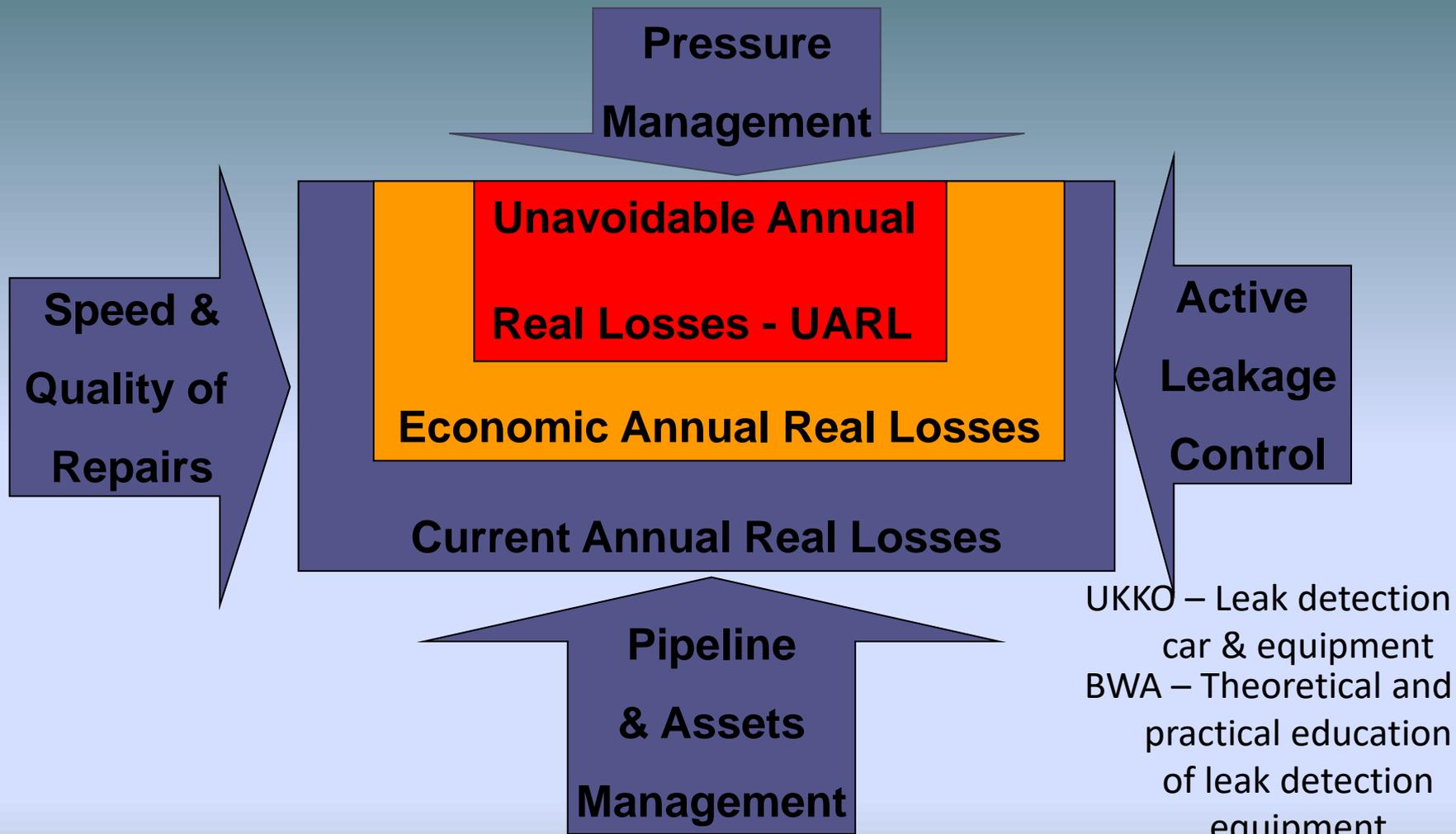## Apparent Losses

- PP3: Installation of 700 AMR
- PP6: Installation of 700 AMR

Apparent Losses Reduction

Meter Errors

Economic Level of Apparent Losses

Current Apparent Losses

Water Accounting Errors

Meter Under registration

Water Theft

DEYAK – AMR installation

WBN – AMR installation

DEYAK – AMR installation

WBN – AMR installation

Real Losses Reduction Pillars

WBN – PRV in DMA 15

Pressure Management

Speed & Quality of Repairs

Unavoidable Annual Real Losses - UARL

Economic Annual Real Losses

Current Annual Real Losses

Active Leakage Control

Pipeline & Assets Management

UKKO – Leak detection car & equipment

BWA – Theoretical and practical education of leak detection equipment

WBN – water quality sensors

JKP ViK Prilep – GIS software

JKP ViK Prilep – Leak detection equipment

Initial status – pilot areas characteristics

General Data	Larissa (GR)	Kozani (GR)	Korca (AL)	WBN (CY)	BWA (BG)	Prilep (FYROM)
Total population served	162,591 (2011 census)	3,462	4,150	2,100	207,386	1,800
Total area covered (Km²)	335.12	0.433 Km²	1.2	1.96	6,400	4.0
Total pipes' length (Km)	1,078	9.696	25	21.5	1,497	7.092
Mean altitude (m)	67	672.9	945	330 (310-345)	400	642
Mean operating pressure (atm)	4.3	4 atm	6-8	1.75	7	3.9
Age of pipes (per material, diameter)	1930-1970 pipe networks from cast iron; 1970 – today: steel & PVC; 2007 – today: PE	PVC as follows: (Diameter / Length (mm) / Age (years)) 63 / 7,428 / 20 — 75 / 165 / 20 — 90 / 575 / 20 — 200 / 1,529 / 20 — Total / 9,697				
Diameter	Length (m)	Age (years)				
63	7,428	20				
75	165	20				
90	575	20				
200	1,529	20				
Total	9,697		High Density polyethylene; since 2000	AC, PVC 100-200mm MDPE 15-50mm	Since 1936	AC - 300 ø – 50 years PVC - 160 ø – 40 years PE - 110 ø – 5-8 years PE - 90 ø – 5-8 years AC - 80 ø – 50 years PE - 63 ø – 5-8 years PE - 50 ø – 5-8 years
No. of service	37,500	235	965	700	52,083	461
	97,617	1,154	N/A	N/A	N/A	N/A

Ex ante – WB (2017 base year)

|	DEYAL (2017)	DEYAK (2017)	SH.A UKKO(2017)	WBN(2017)	BWA(2016)	JKP ViK Prilep
System Input Volume	15.899.359	509.522	258.258	174.305	27.273.600	115.125
Authorized Consumption	12.532.914	214.679	188.612	112.524	11.310.000	63.617
Billed Authorized Consumption	11.599.694	212.553	188.572	112.524	10.780.000	63.617
Billed Metered Consumption	11.599.694	212.553	188.572	112.524	10.555.400	61.637
Billed Unmetered Consumption	0	0	0	0	224.600	1.980
Unbilled Authorized Consumption	933.220	2.126	40	0	530.000	0
Unbilled Metered Consumption	933.220	0	35	0	150.000	0
Unbilled Unmetered Consumption	0	2.126	5	0	380.000	0
Revenue Water	11.599.694	212.553	188.572	112.524	10.780.000	63.617
Water Losses	3.366.445	294.843	69.646	61.781	15.963.600	51.508
Apparent Losses	1.550.957	26.350	31.302	4.360	2.750.000	7.315
Unauthorized Consumption	158.994	5.095	23.949	870	2.400.000	1.151
Meter and Metering Errors	1.391.963	21.255	7.353	3.490	350.000	6.164
Real Losses	1.815.488	268.493	38.344	57.421	13.213.600	44.193
Non-Revenue Water	4.299.665	296.969	69.686	61.781	16.493.600	51.508
MCD	3.001.845		0	26.334	0	0
Accounted for NRW	1.297.820	296.969	69.686	35.447	16.493.600	0

Ex ante – WB (2017 base year)

- DEYAL:

  - NRW level in 2017 is 4,299,665m^3, representing 27.04% of SIV

- DEYAK:

  - NRW level in 2017 is 296,969 m^3, representing 58.3% of SIV

- Korce UKKO:

  - NRW level in 2017 is 69,686 m^3, representing 26.98% of SIV

- WBN DMA 25:

  - NRW level in 2017 is 61,781 m^3 /year representing 35.44% of SIV (much higher than the average)

- Blagoevgrad (BWA pilot area):

  - NRW level in 2016 is 16,493,600 m^3 /year representing 60.47% of SIV

- JPK ViK Prilep: NRW is estimated to be 51,508 m^3 for 2017, representing 44.74% of the SIV.

- In the cases of Larissa and WBN the MCD is estimated showing that NRW levels are underestimated due to high MCD levels: 69.81% of NRW for Larissa and 42.62% in the case of WBN. The other utilities did not provide this information.

Ex ante – PIs (2017 base year)

| Performance Indicators	Units	DEYAL (2017)	DEYAK (2017)	SH.A UKKO(2017)	WBN (2017)	BWA (2016)	JKP ViK Prilep
Inefficiency of use of water resources	%	11.42	N/A	24.02	N/A	48.44	38.39
Water losses per connection	m³/conn/day	89.77	1,254.78	72.17	88.26	306.5	111.73
Water losses per mains length	m³/Km/year	8.56	83.36	7.63	7.87	29.2	19.90
Apparent losses	%	9.75	5.17	2.95	2.5	10.08	6.35
Apparent losses per system input volume	%	9.75	5.17	2.95	2.5	10.08	6.35
Real losses per connection	L/conn/day	132.64	3,130.55	176.1	225	695.07	262.64
Real losses per mains length	L/Km/day	4,614.04	75,912	6,797.5	7,317	24,182.8	17,072.29
Infrastructure Leakage Index (ILI)	-	2.14	11.6	16.2	8.7	6.8	5.60
Unmetered water	%	21.17	N/A	26.97	N/A	60.75	46.46
Non-revenue water by volume	%	27.04	58.28	26.98	35.44	60.47	44.74
Revenue Water as % of SIV	%	72.96	41.72	73.02	64.56	39.53	55.26
Real Losses as % of SIV	%	11.42	52.70	24.02	32.94	48.45	38.39
Real Losses as % of NRW	%	42.22	90.41	89.01	92.94	80.11	85.80
Apparent Losses as % of NRW	%	36.07	8.87	10.93	7.06	16.67	14.20

Ex ante – PIs (2017 base year)
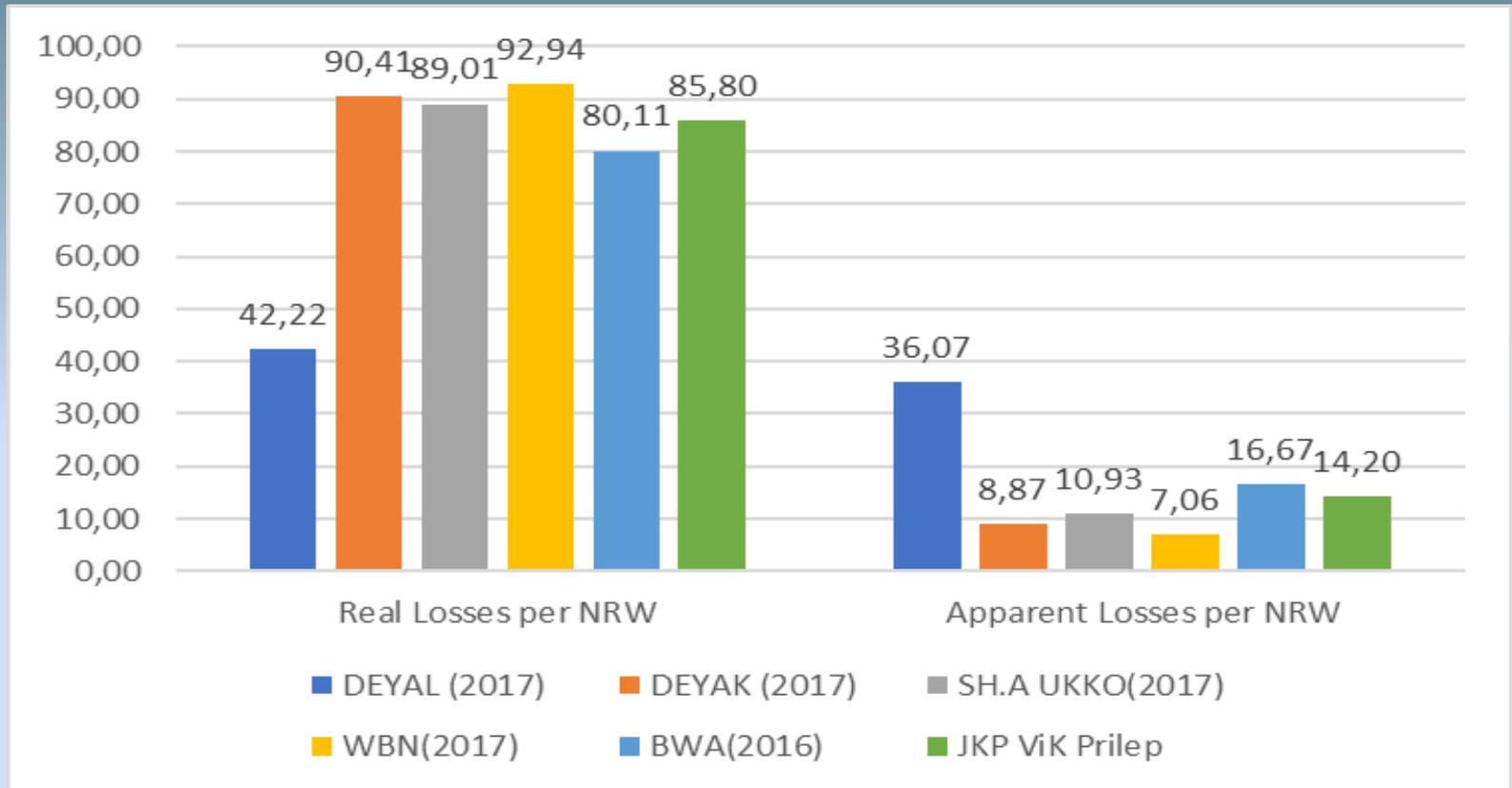## Revenue Water, Apparent Losses, Real Losses, NRW

Ex ante – PIs (2017 base year)
ILI

ILI values in the pilot areas
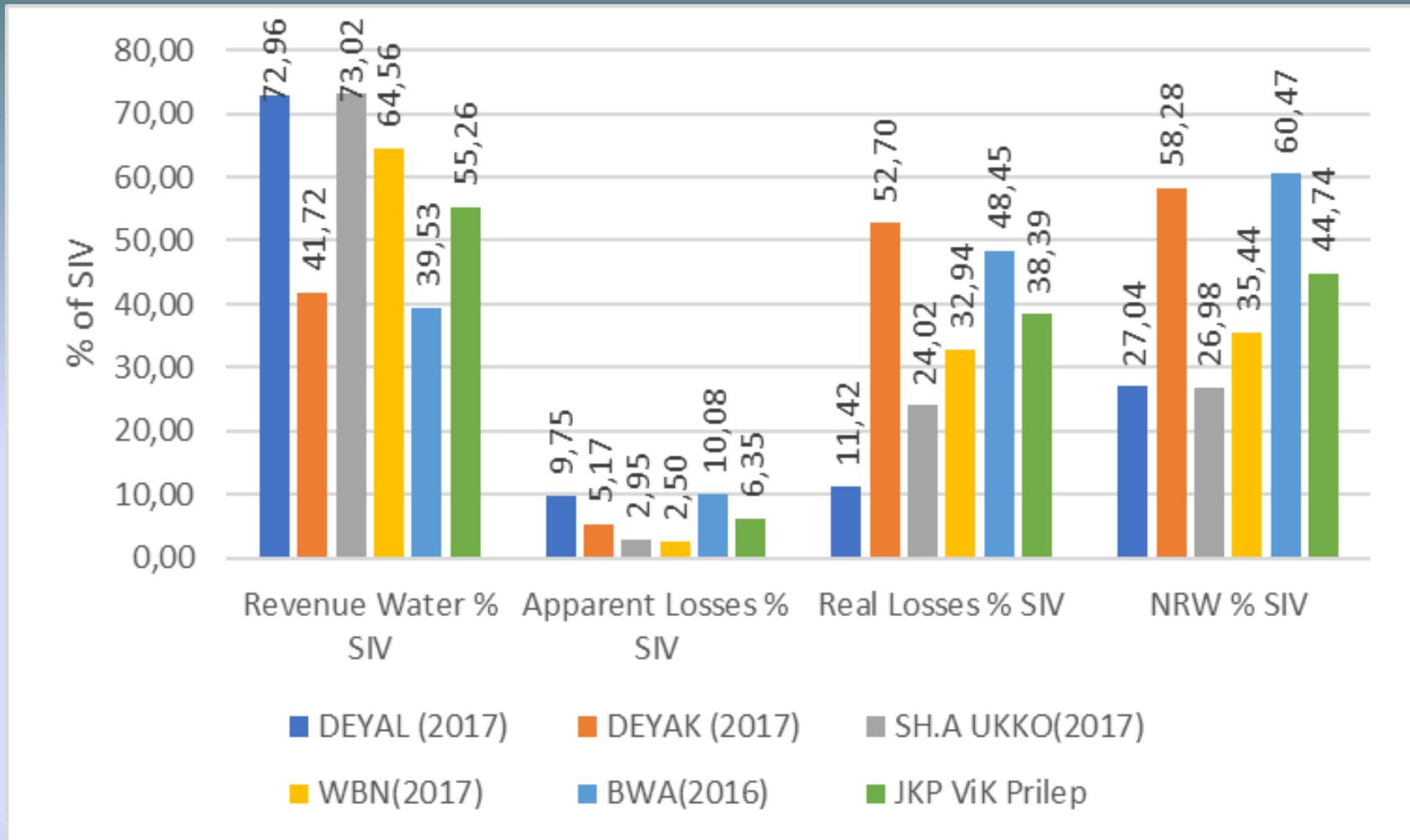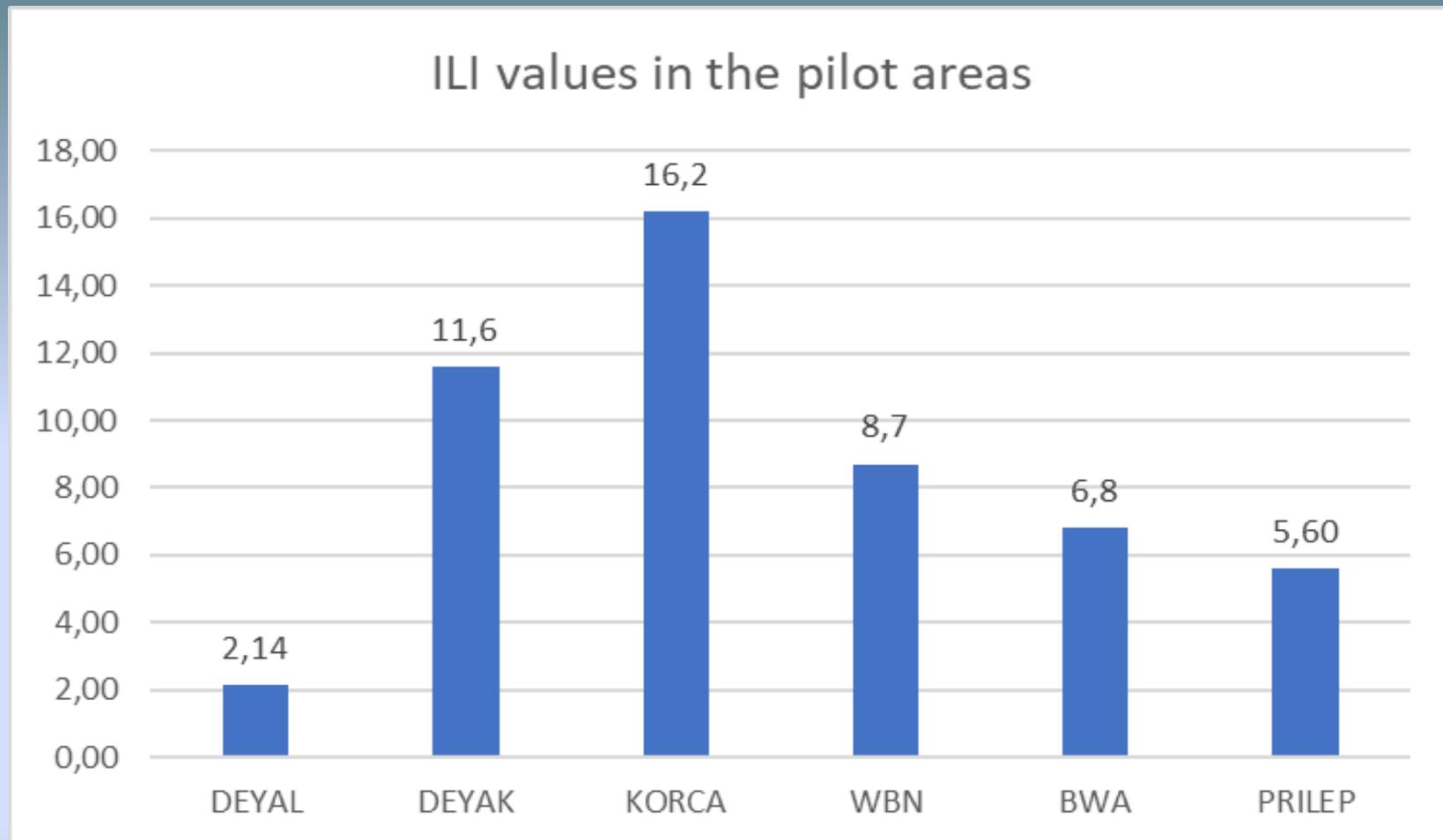
Ex ante – PIs (2017 base year)
Real Losses & Apparent Losses as % of NRW

Ex ante – Results (1/3)

- DEYAL:
  - real losses are the major part of NRW representing 11.50% of SIV or 129.29Lt/connection/day
  - Apparent losses represent 9.74% of SIV.
  - Real losses are reduced during the last 4 years due to specific activities performed by the water utility, such as the replacement of water pipes in the network.
  - ILI value for 2017 is 2.14.
- DEYAK:
  - real losses are the major part of NRW representing 52.7% of SIV or 3,130Lt/connection/day.
  - Apparent losses represent 5.17% of SIV.
  - ILI value for 2015 is 11.6.
  - Excessive amount of water is lost mainly as real losses in the water distribution network.
- Korce UKKO:
  - real losses are the major part of NRW representing 24.12% of SIV.
  - Apparent losses represent 2.84% of SIV, mainly due to meter under-registration.
  - ILI value for 2017 is 16.2.

Ex ante – Results (2/3)

- WBN:
  - real losses are the major part of NRW representing 32.94% of SIV or 225Lt/connection/day.
  - Apparent losses represent 2.5% of SIV.
  - ILI value for 2017 is 8.7.

- Blagoevgrad (BWA case):
  - real losses represent the major part of NRW, up to 48.45% of SIV or 695.07Lt/connection/day.
  - Apparent losses represent 10.08% of SIV.

- JKP Vik Prilep:
  - real losses represent the major part of NRW level, up to 38.39% of the SIV.
  - Apparent losses account for 6.35% of the SIV.
  - ILI value is 5.6

Ex ante – Results (3/3)

- The results showed that NRW levels are high for BWA pilot case (60.47%) followed by DEYAK (58.28%) while Korce has the lowest NRW level I26.98%).

- Real losses as % of SIV are high for DEYAK (52.7%) followed by BWA (48.45%) while the lowest values is the one of DEYAL (11.42%).

- Real losses as % of NRW are high for WBN (92.94%) followed by DEYAK (90.41) while the lowest one is from DEYAL (42.44%).

- The highest ILI values is the one from Korce (16.2) followed by DEYAK (11.6) and the lowest one is from DEYAL (2.14).

- Regarding apparent losses the highest values are the ones from BWA (10.08% of SIV) followed by DEYAL (9.75) and the lowest one is from WBN (2.5%).

- Water losses per connection highest value is the one from DEYAK (1,254.78m³/connection/day) followed by BWA (306.5) and the lowest one is from Korce (72.17)

- Inefficiency of use of water resources values are high for BWA (48.44%) and Prilep (38.39%) and low for DEYAL (11.42%). However, not all partners provided data for this PI.

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