At the University of Brighton
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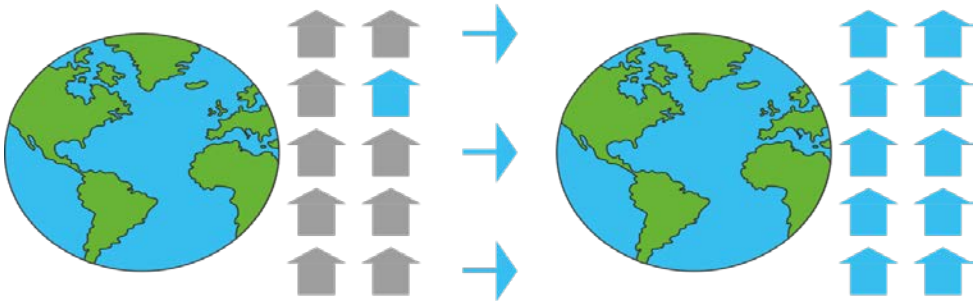
Water Efficiency Conference 2015

The Potential Utilization of Grey Water in Family Houses



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Introduction

"BLUE to GREEN"

By adopting 2 basic principles we can increase the benefits of coming changes and our future:

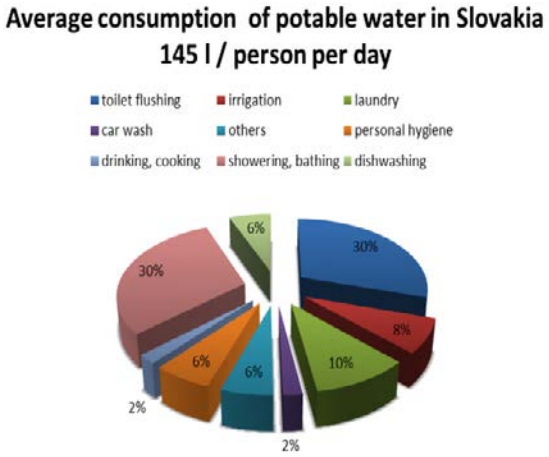
1. **The care of the**
2. **Care of people**

- only confirm the need for evolving **new technologies, approaches** and **solutions** as a proposal for blue alternatives for the transition to a sustainable society.

We need to change the thinking of the society which will be in balance with nature and magnitude of the problems arising from the advent of climate variability, environmental risks, increasing urbanization and energy saving.

Design for Water

- not have to be the first choice for a water source
- it shows that about 60% of drinking water may be replaced by alternative water source



- rain/ storm water
- well water
- grey water

[%]	Country	Optimize Site Potential	Optimize Energy Use	**Protect and Conserve Water**	Use Environmentally Preferable Products	Enhance IEQ	Optimize Operational & Maintenance Practices	Other
CASBEE	Japan	15	20	2	13	20	15	15
BREEAM	UK	18	19	**6**	12.5	25	-	19.5
SBTool	28 countries	12.5	20.8	-	-	16.7	16.6	33.4
Green Globes	Canada	11.5	36	**8.5**	10	20	-	12.5
LEED	USA	27	36.5	**10.4**	6.3	15.6	-	4.2
HK-BEAM	Hong Kong	13.2	41.3	6.3	12.3	25.9	-	2.6
NABERS	Australia	16.7	16.7	**6.7**	13.3	6.7	-	40
SABA	Jordan	10.8	23.1	**27.7**	10.3	11.8	-	16.3
BEAS	Slovakia	14.7	21.5	**8.8**	21	23.6	5	5.4

This fact gives credit to reuse of potable water in closed in-building water cycle and better percentage weight in building environmental assessment

Design for Water

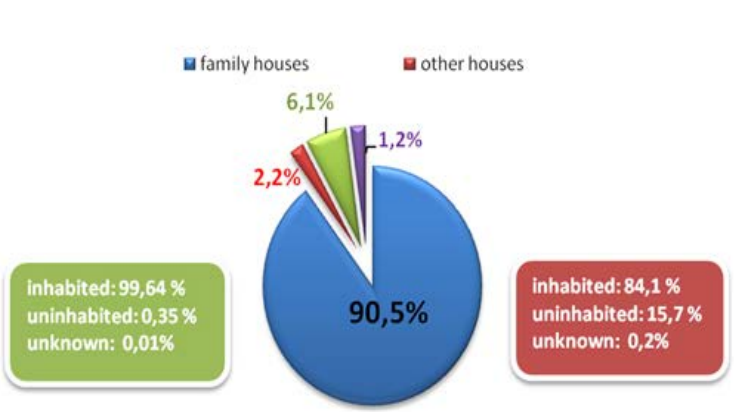
AIMS

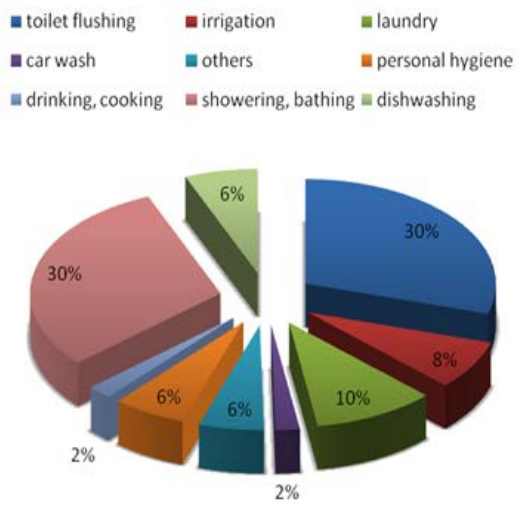
To assess the potential utilization of grey water for non - potable purposes we addressed three specific aims:

1. **to identify the water habits of users in the world compared to Slovakia users by questionnaire**

2. to investigate the potential of grey water production in family house by estimation method and measurements

3. **to show the saving potential (economic and environmental) in water management portfolios**

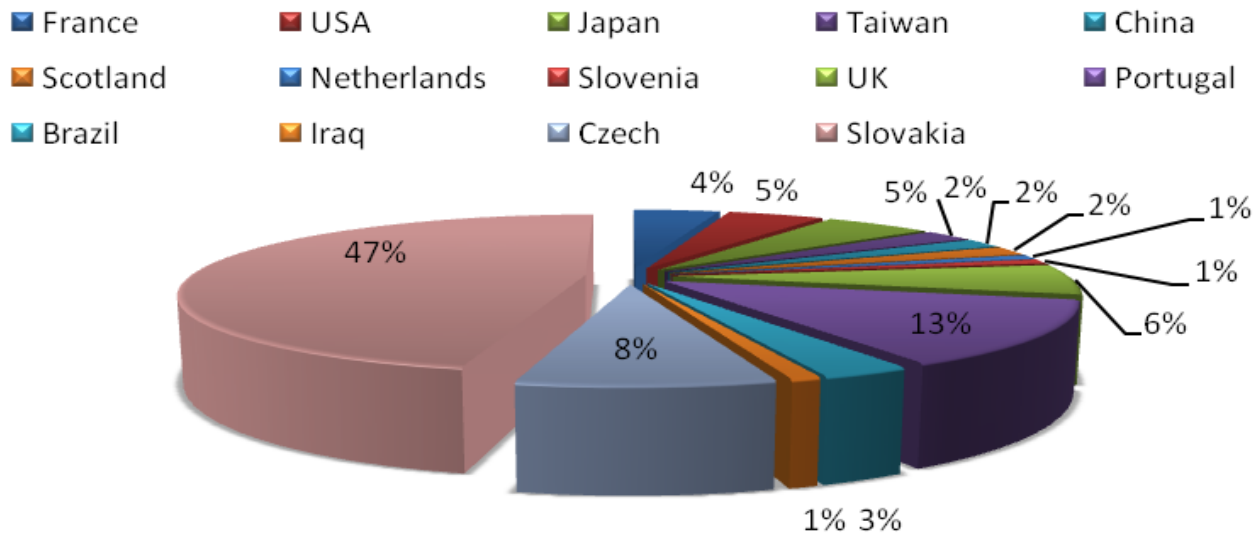




1. Questionnaire on water use

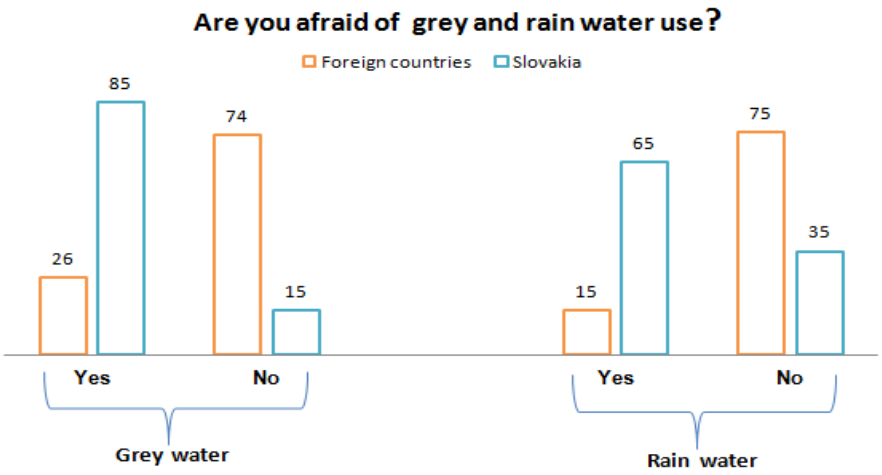
A quick overview of final results will show the attitude and differences between the Slovak respondents (SK) and respondents from foreign countries (FC)

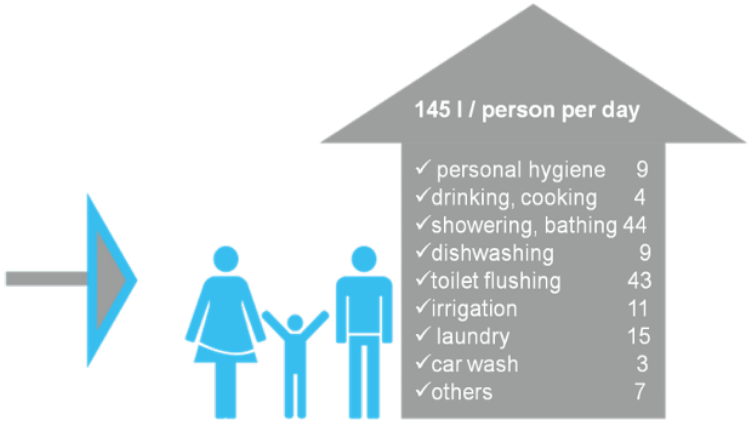
- questionnaire was completed by the group of **200 people** from different spheres of society divided to 85 male and 115 female respondents.
- average age - 43 years.
- 75% of them live in the family houses
- the questionnaire consisted of 10 questions and the last one was about their opinion on water-energy nexus.



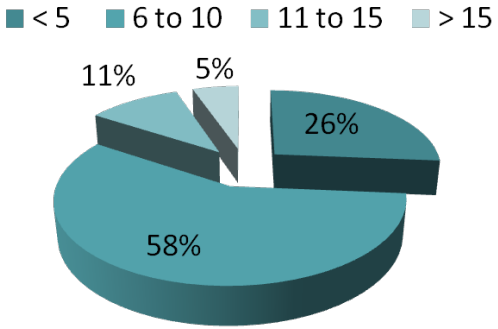
Questionnaire on water use

The important fact is that 80 % of respondents use potable water for all domestic purposes such as flushing toilets and watering the garden or washing their cars.

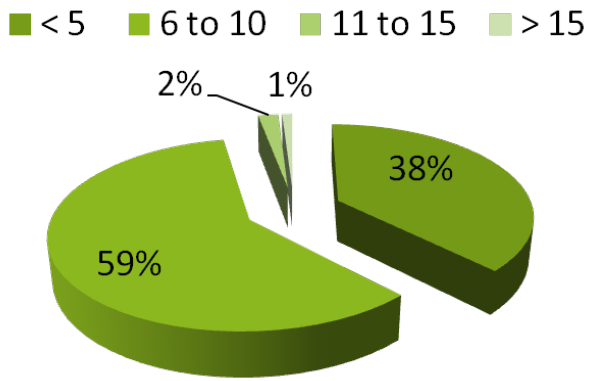




Would you consider installing a greywater reuse system if the return on an investment were ?



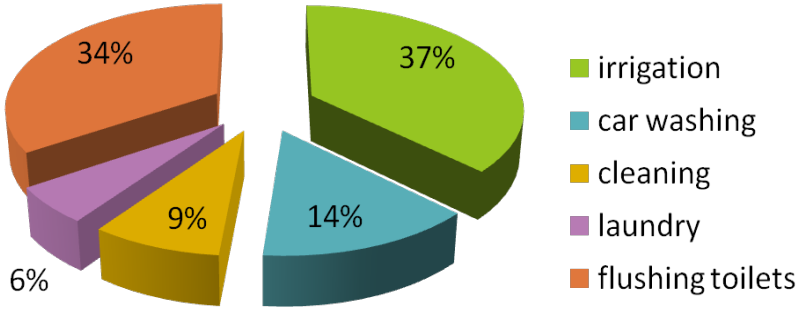
Slovakia

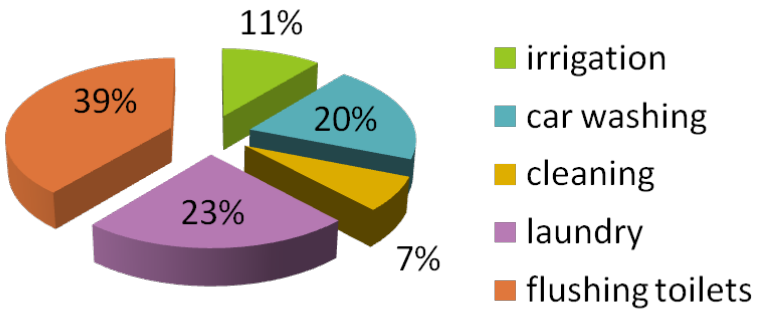


Questionnaire on water use

Would you use greywater for:

Slovakia





grey water for flushing toilets

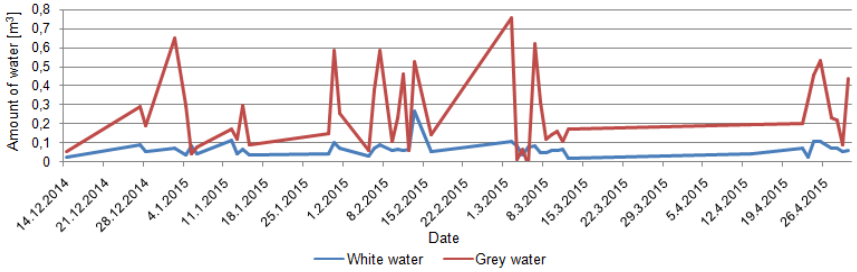
- Slovaks are afraid of reuse of water but around 85 % of them would think about sustainable solutions if they built a new house

- the main reasons for water saving was the water bill reduction in 49% of respondents, 41% for sustainability and reservoirs saving only 10%.

2. CALCULATION method versus Measurements

Grey water systems depend significantly on the behavior of the people using the collection appliances, as well as the quality and volume of water collected.

- family house in Važec, Slovakia - three persons (2 adults, 1child)
- appliances located on the first floor are: three sinks, shower, washing machine, and toilet and there are sanitary appliances (two sinks, bathtub, and toilet) on the second floor
- in calculation we used all of the sanitary appliances for grey water production
- treated water will be used for flushing the toilets
- the measurements were recorded for a six- month period and will continue through one year to consider the seasonal changes of habits in water use
- monitoring of the daily amount of water used for toilet flushing (white water demand) and total water c.



To indicate the potential of grey water system suitability for each building, it is important to meet the following condition:

$$YG \geq C$$

YG - volume of produced grey water per day (L)
C - volume of white water demand per day (L)

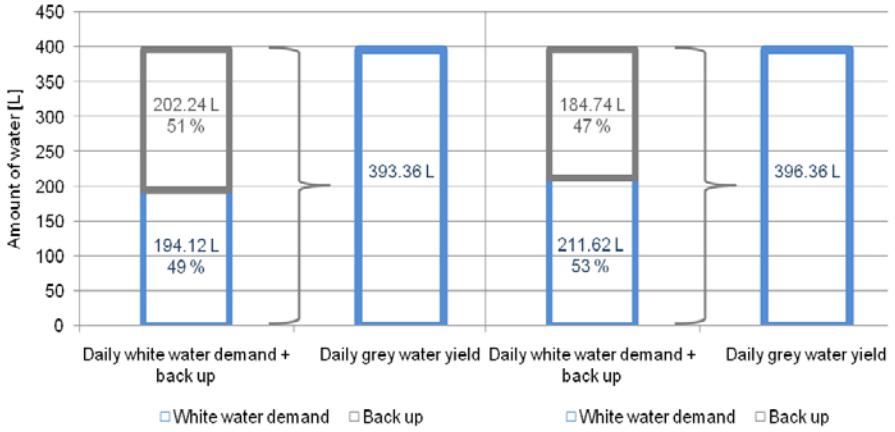
CALCULATION method versus Measurements

White water demand without laundry

396.36 L ≥ 194.12 L

White water demand without laundry

396.36 L ≥ 211.62 L



Daily amount of water in grey water system - with and without water use in laundry

COMPARISON

Calculation method **-** 396.36 L ≥ 194.12 L

0.396 m^3 ≥ 0.194 m^3

Measurements

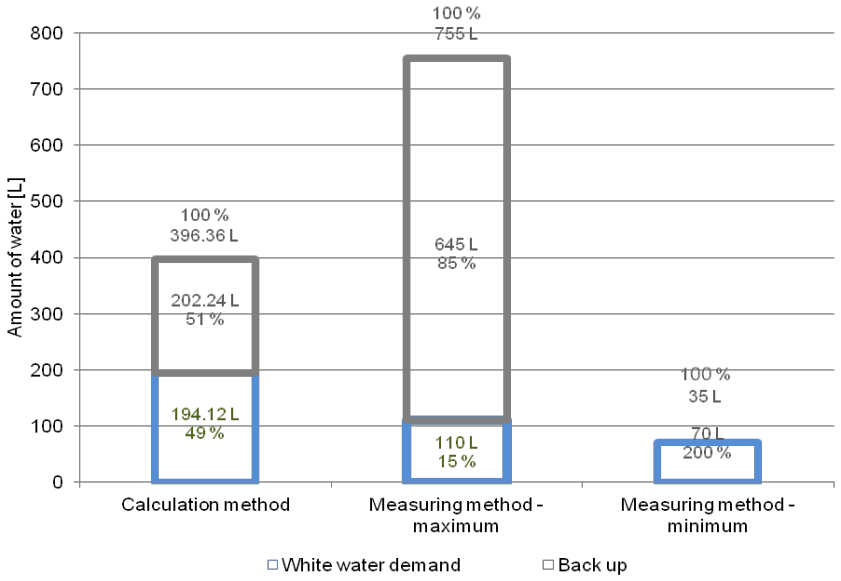
-maximum

755 L > 110 L

0.755 m^3 > 0.11 m^3

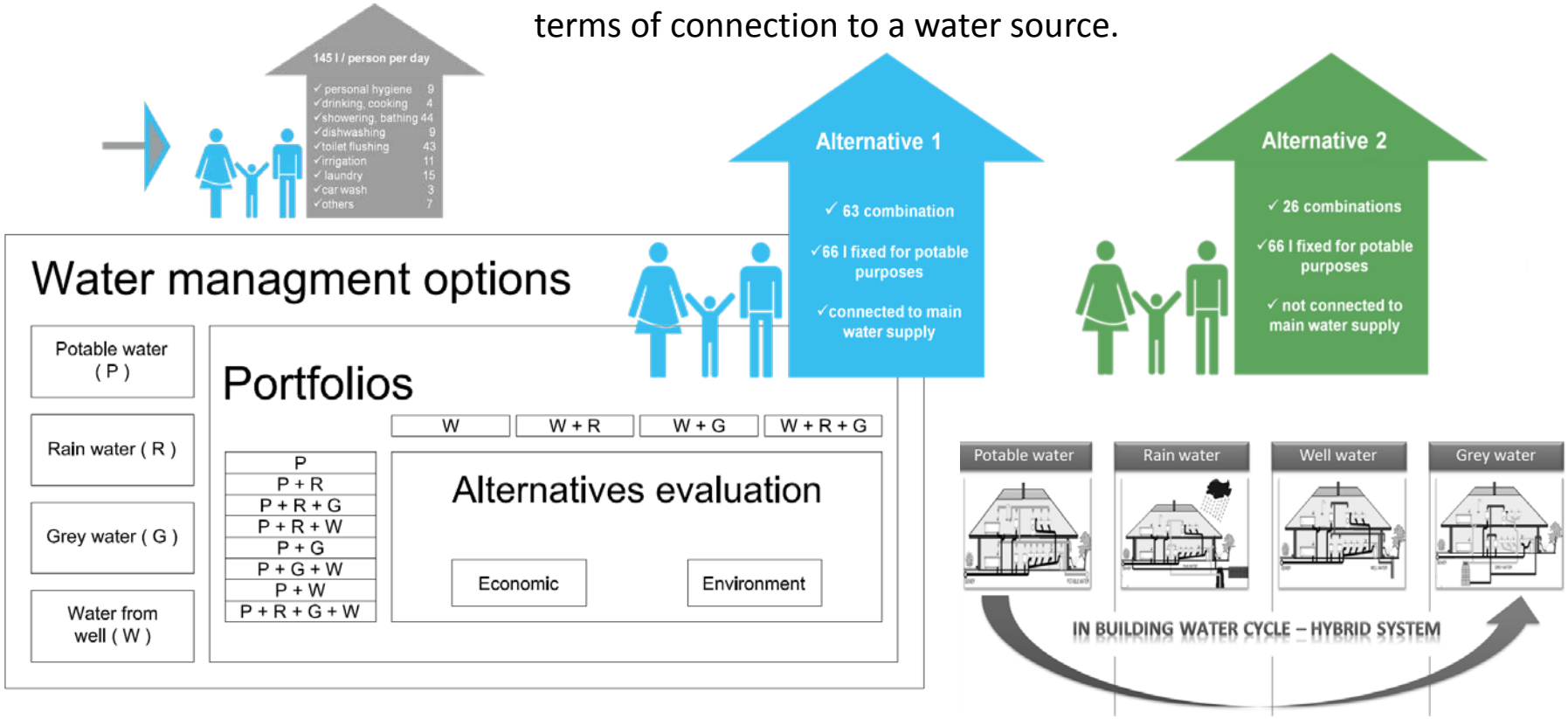
- minimum 35 L < 70 L

0.035 m^3 < 0.07 m^3



3. Water management portfolios *Combinatorial task*

The calculation resulted in **996** options which are from the practical point of view not applicable. boundary conditions related mainly to the removal of some "irrational" clusters of activities in terms of connection to a water source.

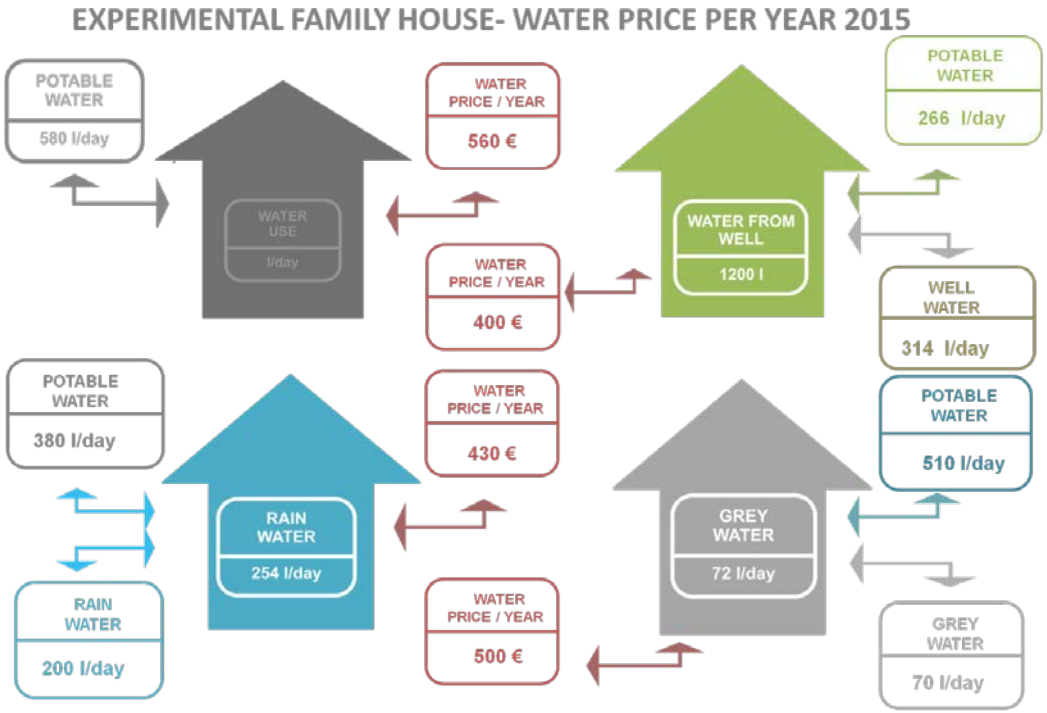


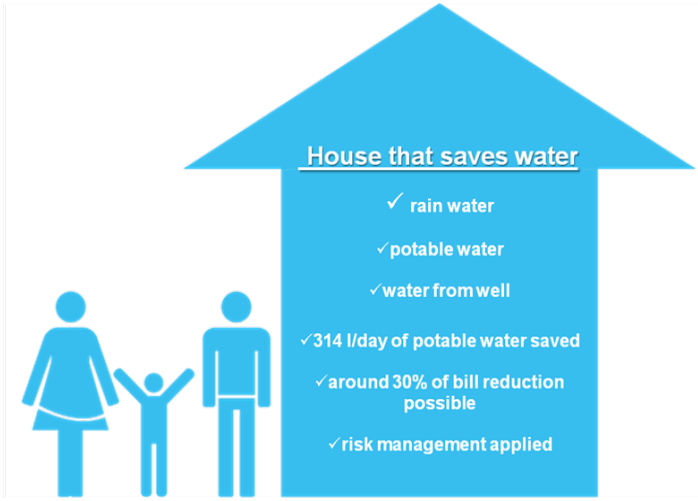
•a **classical combinatorial task** approach of all tetrads of nine elements without repetition. This number is expressed in mathematics standard combinatorial numbers in the form:
where *n* is the number of elements where the *k* number of *k-tuples*.

$$\binom{n}{k} = \frac{n!}{(n-k)!n!}$$

Economic and Environmental evaluation

The change of a classic family house to a BLUE house by implementing portfolio four led to reduction of water bills. The saved costs for water in the year 2016 will be around 160 € per year.





	Without grey water					Grey water reuse system				
Year	Metered water charges (€ VAT)		Σ € s VAT	W cons. (m3/Year)	PW price (€/Year)	White water consumption (m3/Year)	PW price (€/Year)	White water (€/Year) 1m3	WW price (€/Year)	WP white+grey (€/Year)	Savings (€/Year)
2015	1,57	1,08	2,65		561,43		492,48	0,41	47,83	540,31	21,12
2016	1,90	1,28	3,18		673,56		590,84	0,42	49,45	640,29	33,27
2017	2,00	1,34	3,34		707,73		620,81	0,43	50,56	671,37	36,36
2018	2,10	1,41	3,50		741,90		650,78	0,44	51,69	702,47	39,42
2019	2,19	1,47	3,67		776,06		680,75	0,45	52,87	733,62	42,44
2020	2,29	1,54	3,83		810,23		710,72	0,46	54,08	764,80	45,43
2021	2,38	1,61	3,99		844,39		740,69	0,48	55,33	796,02	48,37
2022	2,48	1,67	4,15		878,56		770,66	0,49	56,62	827,28	51,28
2023	2,58	1,74	4,31	211,70	912,72	116,435	800,63	0,50	57,96	858,58	54,14
2024	2,67	1,80	4,47		946,89		830,60	0,51	59,33	889,93	56,96
2025	2,77	1,87	4,63		981,05		860,57	0,52	60,75	921,31	59,74
2026	2,86	1,93	4,80		1015,22		890,54	0,53	62,21	952,74	62,48
2027	2,96	2,00	4,96		1049,39		920,50	0,55	63,72	984,22	65,16
2028	3,05	2,06	5,12		1083,55		950,47	0,56	65,27	1015,75	67,80
2029	3,15	2,13	5,28		1117,72		980,44	0,57	66,88	1047,32	70,40
2030	3,25	2,19	5,44		1151,88		1010,41	0,59	68,53	1078,95	72,94
2031	3,34	2,26	5,60		1186,05		1040,38	0,60	70,24	1110,62	75,43

Conclusion

As grey water systems become more popular, there is a need for standardization to protect the public and to ensure that reliable systems are designed, installed and maintained.

Questionnaire shows people's willingness to use **alternative water source for non-potable purposes** rather than potable water.

The public expects to have **safe water and sanitation**; therefore, when recycling water, it is essential to **protect public health and the environment**.

The guidelines and risk management framework for beneficial and sustainable management of water recycling systems is missing in Slovakia.

On the basis of the scientific, policy, economic and social impacts, the study pointed out challenges and recommendations to strengthen and enhance future of alternative water sources, **especially grey water research in our conditions**.

Thank you!