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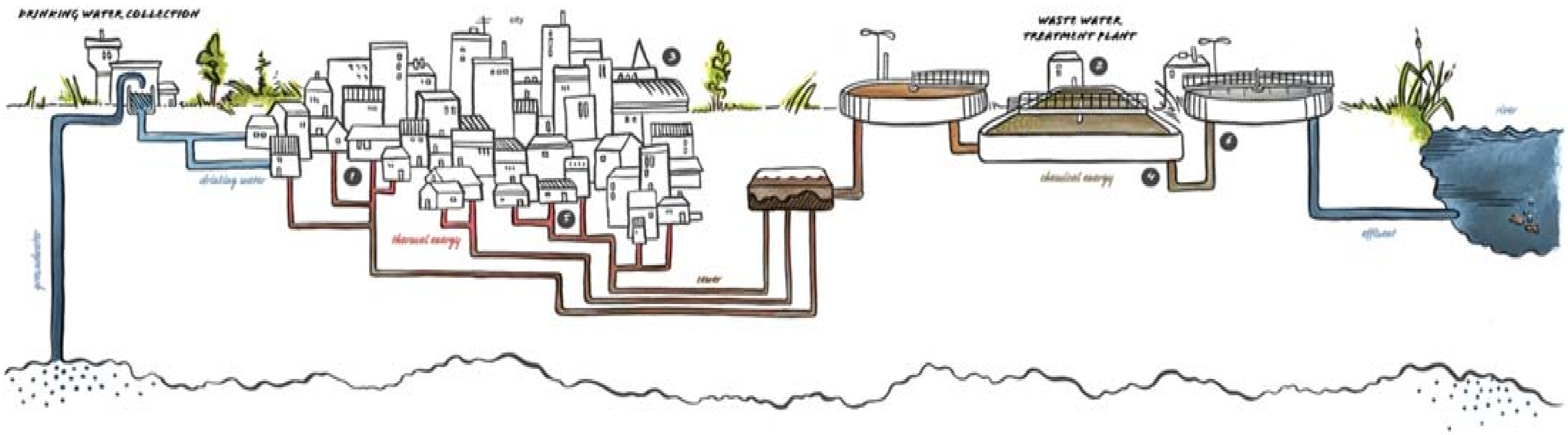
Energy Balance Assessment Tool

Energy Balance
Assessment Tool (EBAT)

Outline:

- Development rationale
- Overview of tool
- Conclusions



Rationale

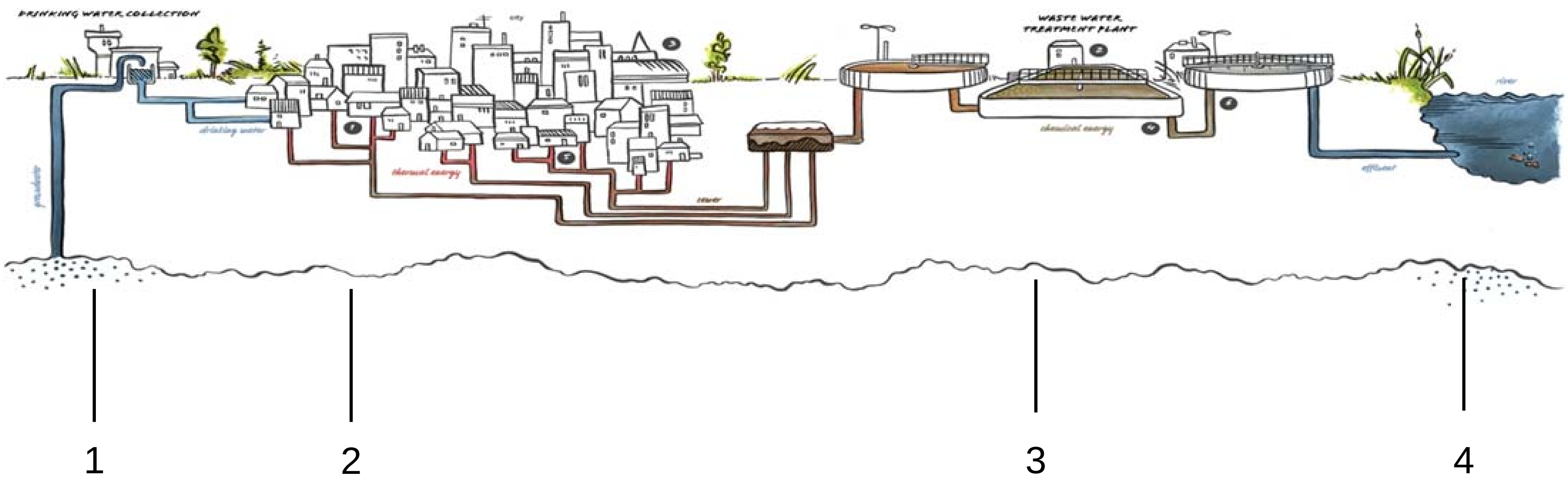
EBAT was developed to track energy consumption across the following four parts of the urban water cycle:

1.Abstraction, treatment and supply of potable water

2.Energy used in the end user environment associated with water

3.Transportation and treatment of domestic and industrial wastewater

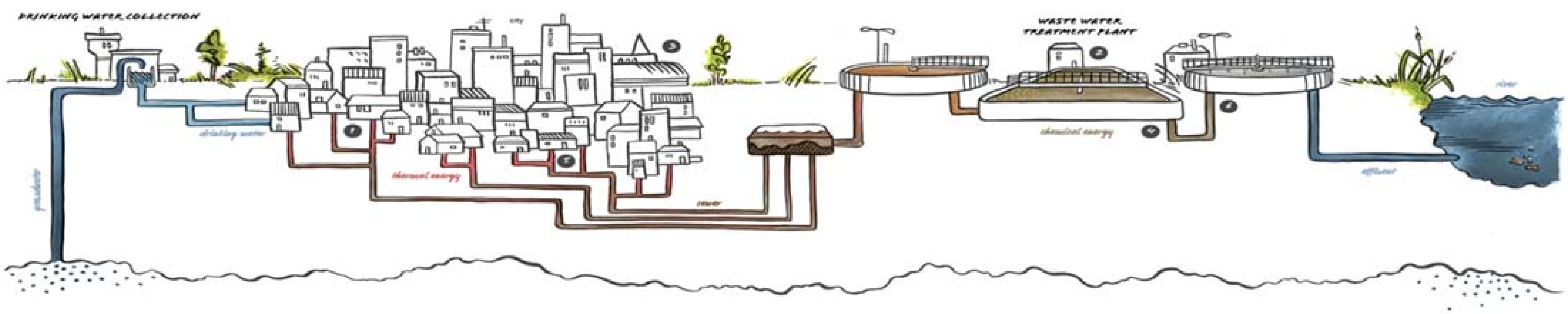
4.Return of treated effluent to the natural water cycle



EBAT was developed to provide:

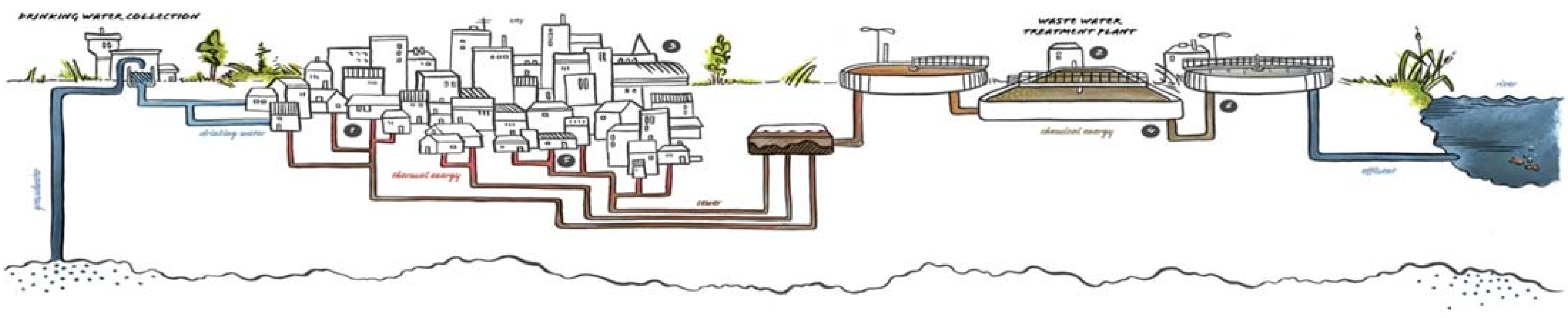
- A means of identifying where within the urban water cycle potential energy savings or opportunities for energy recovery exist.
- User input parameters for catchments within the range (0 - 10,000,000 homes)
- A visual representation of annual energy usage and associated carbon emissions (CO2eq)
- The ability to select accepted national values or catchment specific values for energy use associated with different stages

Microsoft Excel was selected to support EBAT, as it is the spreadsheet application common to the European Computer Driving License and is widely available to many users, e.g. engineers, business analysts



EBAT was structured:

- To follow the energy use of a specific volume of water
- Energy needed in transport and treatment processes was estimated using either national values or user input values
- Data sources: INNERS: An Overview of Energy Used in the Urban Water Cycle, Pheasant R, Tait S; Potential for Energy Optimisation on WwTP in NWE a Benchmark Study, Heins S, Becker M., Hansen J., Taudien Y., Schirmer G., Kolish G.
- The ability to select accepted national values or catchment specific values for energy use associated with different stages
- Losses accounted for, ability to take into account industrial and rainfall inputs
- Overall accounting of energy and water fluxes



EBAT Stages 1 & 2 (Control Parameters and the Supply of potable water)

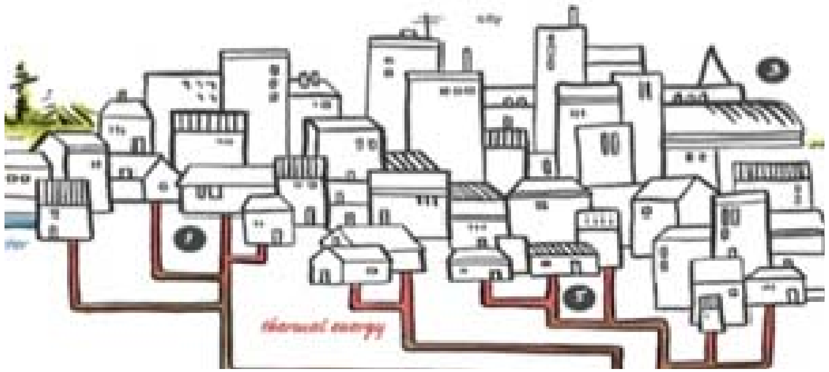
1. Control Parameters

Select country of interest	UK		*n_Country*	

2. Supply	*Default*	*User*	*Final*	*Units*
% of potable water leaked from the supply system prior to delivery	33.33%		33.33%	%
Average depth from which groundwater is abstracted	9		9	m
% of groundwater sourced	40%		40%	%
% of energy used in pumping	60%		60%	%
% of energy used in treatment	Calculated		40%	%
% of energy used in supply that is renewable and generated onsite	0%		0%	%

- Groundwater/surface water sources
- Treatment/pumping energy costs/ losses in distribution
- Ability to offset against renewable sources

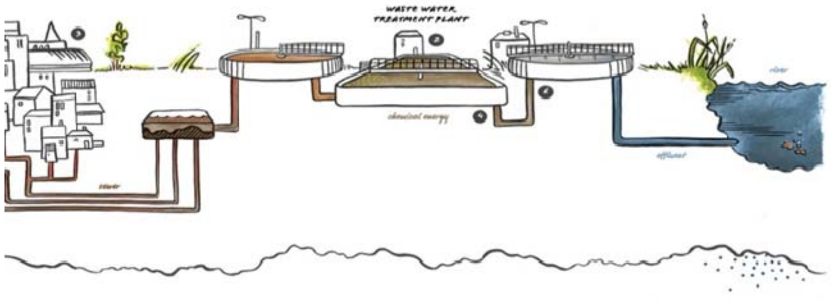
EBAT Stage 3 (Users)



3. Households	*Default*	*User*	*Final*	*Units*
Average temperature of water entering households	12		12	C
Average temperature of hot water leaving the tap in households	52		52	C
Volume of potable water produced (including all leakage)	225		225	L/person/day
Number of inhabitants per household	2.3		2.3	persons/hh
Proportion of water not returned to sewer	7.5%		7.5%	
Rainfall received by combined sewers (if present)	0.0		0.0	ml/person/day
Volume of domestic wastewater discharged to sewer	Calculated		**319**	l/day/hh
Average volume of Domestic Hot Water (DHW) consumed	122		122	l/day/hh
Average domestic COD production	120		120	g/person/day
Energy intensity for COD removal	Looked up		1.17	kWh/kgCOD
Number of households being serviced within the catchment		50,000	50,000	households

- Domestic hot water heating
- Rainfall impacts can be included – combined/separate drainage systems
- Ability to change domestic COD production

EBAT Stages 4 & 5 (Industry and Treatment)



4. Industry	Default	User	Final	Units
Average volume of industrial effluent discharged to sewer	0		0	m^3/day
Average industrial COD produced	0		0	kg/day
5. Treatment	**Default**	**User**	**Final**	**Units**
COD discharge consent limit	40		40	mg/L
% of energy used in pumping	20%		20%	%
% of energy used in treatment	Calculated		80%	%
% of energy used in treatment that is renewable and generated onsite	0%		0%	%

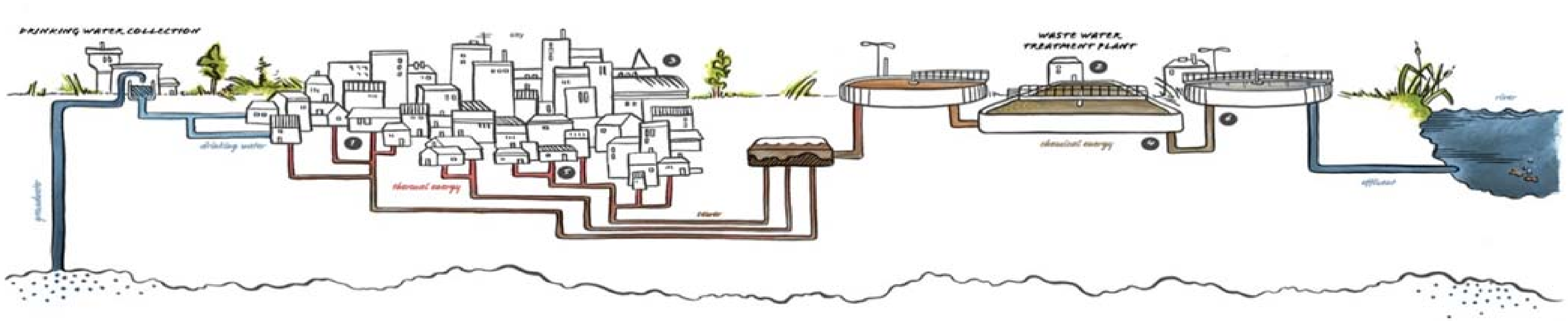
- Location specific inputs for industry
- Location specific discharge consent limit for COD

EBAT Stages 6 (Equipment Performance)

Equipment Performance	Default	User	Final	Units
Performance factor for pumping raw water	100%		100%	%
Performance factor for pumping wastewater	100%		100%	%
Performance factor for treating drinking water	100%		100%	%
Performance factor for treating wastewater	100%		100%	%
Performance factor for heating DHW	100%		100%	%

Location specific knowledge

- Local knowledge of system performance
- Impact of improving energy efficiency in various stages



EBAT Stages 7 (Results)

7. Results	Energy use	Units	CO_2e emissions	Units
Abstraction, treatment and pumping of potable water to households	3.81	GWh/yr	1,996.42	t CO2e/yr
Abstraction, treatment and pumping of potable water lost through leakage	1.90	GWh/yr	998.21	t CO2e/yr
Treatment and pumping of potable water, including water lost through leakage	**5.71**	**GWh/yr**	**2,994.63**	**t CO2e/yr**
Heating Domestic Hot Water (DHW)	**103.56**	**GWh/yr**	**54,328.07**	**t CO2e/yr**
Pumping of rainwater received by combined sewers	**-**	**GWh/yr**	**-**	**t CO2e/yr**
Pumping of domestic wastewater	1.12	GWh/yr	589.33	t CO2e/yr
COD removal from domestic wastewater to meet discharge consent	4.49	GWh/yr	2,357.32	t CO2e/yr
Pumping of industrial wastewater	0.00	GWh/yr	0.00	t CO2e/yr
COD removal from industrial effluent to meet discharge consent	0.00	GWh/yr	0.00	t CO2e/yr
Reduced energy demands as a result of dilution of COD (if any)	0.00	GWh/yr	0.00	t CO2e/yr
Pumping and treatment of all wastewater including rainwater	**5.62**	**GWh/yr**	**2,946.64**	**t CO2e/yr**
The urban water cycle	**114.88**	**GWh/yr**	**60,269.34**	**t CO2e/yr**
The urban water cycle minus DHW	**11.32**	**GWh/yr**	**5,941.27**	**t CO2e/yr**
Per m3 of water as it passes through the urban water cycle, accounting for losses (minus DHW)	1.9445	KWh	1.02	Kg CO2e
Heating of DHW per m3	46.51	KWh	8.56	Kg CO2e
Total per m3	48.46	KWh	9.58	Kg CO2e

<u>Result Format</u>

- Total energy/ $CO_{2\ eq}$
- per m^3

Energy to CO_2 eq conversion – country specific

EBAT Stages 7 (Further Results)

Further Results

This sheet summarises the results for the whole water cycle and also the whole water cycle excluding heating of DHW

All areas	*Energy consumed*	*Units*	*% of Total*	*Carbon emitted*	*Energy*	*% of Tota*
Heating Domestic Hot Water (DHW)	103.56	GWh/yr	90.1%	54,328.07	t CO2e/yr	90.1%
Abstraction, treatment and pumping of potable water to households	3.81	GWh/yr	3.3%	1,996.42	t CO2e/yr	3.3%
Abstraction, treatment and pumping of potable water lost through leakage	1.90	GWh/yr	1.7%	998.21	t CO2e/yr	1.7%
Pumping of rainwater received by combined sewers	0.00	GWh/yr	0.0%	-	t CO2e/yr	0.0%
Pumping of domestic wastewater	1.12	GWh/yr	1.0%	589.33	t CO2e/yr	1.0%
COD removal from domestic wastewater to meet discharge consent	4.49	GWh/yr	3.9%	2,357.32	t CO2e/yr	3.9%
Pumping of industrial wastewater	0.00	GWh/yr	0.0%	-	t CO2e/yr	0.0%
COD removal from industrial effluent to meet discharge consent	0.00	GWh/yr	0.0%	-	t CO2e/yr	0.0%
Total	**114.88**	**GWh/yr**		**60,269.34**	**t CO2e/yr**	

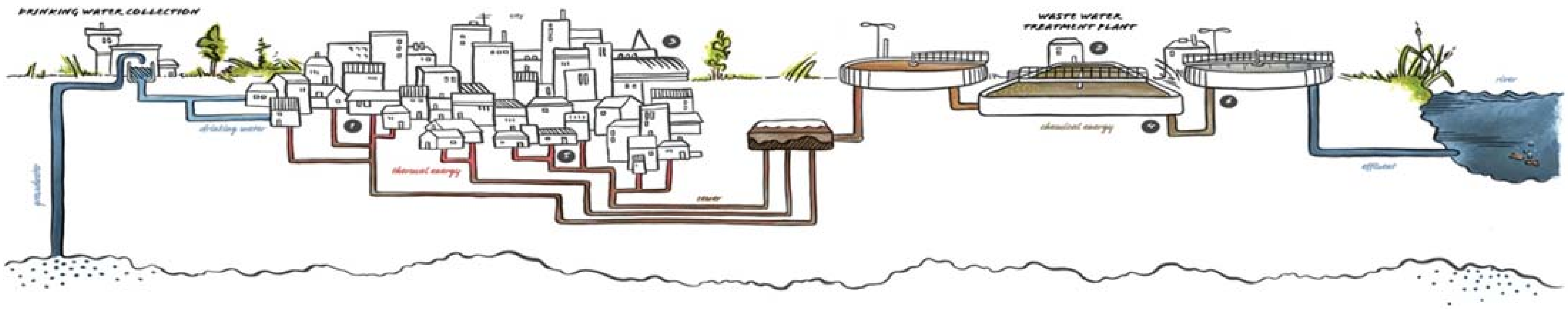
All areas excluding heating of DHW	*Energy consumed*	*Units*	*% of Total*	*Carbon emitted*	*Energy*	*% of Tota*
Abstraction, treatment and pumping of potable water to households	3.81	GWh/yr	33.6%	1,996.42	t CO2e/yr	33.6%
Abstraction, treatment and pumping of potable water lost through leakage	1.90	GWh/yr	16.8%	998.21	t CO2e/yr	16.8%
Pumping of rainwater received by combined sewers	0.00	GWh/yr	0.0%	-	t CO2e/yr	0.0%
Pumping of domestic wastewater	1.12	GWh/yr	9.9%	589.33	t CO2e/yr	9.9%
COD removal from domestic wastewater to meet discharge consent	4.49	GWh/yr	39.7%	2,357.32	t CO2e/yr	39.7%
Pumping of industrial wastewater	0.00	GWh/yr	0.0%	-	t CO2e/yr	0.0%
COD removal from industrial effluent to meet discharge consent	0.00	GWh/yr	0.0%	-	t CO2e/yr	0.0%
Total	**11.32**	**GWh/yr**		**5,941.27**	**t CO2e/yr**	
Reduced energy demands as a result of dilution of COD (if any)	0.00	GWh/yr		-	t CO2e/yr	

EBAT Stages 7 (Further Results)

All areas excluding heating of DHW, including effluent dilution	*Energy consumed*	*Units*	*% of Total*	*Carbon emitted*	*Energy*	*% of Total*
Pumping of domestic wastewater	1.12	GWh/yr	9.9%	*589.33*	*t CO2e/yr*	9.9%
COD removal from domestic wastewater to meet discharge consent	4.49	GWh/yr	39.7%	*2357.32*	*t CO2e/yr*	39.7%
Pumping of industrial wastewater	0.00	GWh/yr	0.0%	*0.00*	*t CO2e/yr*	0.0%
Treatment of all waste water (reflecting any reduced energy demands due to dilution)	5.62	GWh/yr	49.6%	2946.64	t CO2e/yr	49.6%
Total	**11.23**	**0**		**5893.29**	**0**	

All areas including heating of DHW, including effluent dilution	*Energy consumed*	*Units*	*% of Total*	*Carbon emitted*	*Energy*	*% of Total*
Heating Domestic Hot Water (DHW)	103.56	GWh/yr	90.1%	54328.07	t CO2e/yr	90.1%
Abstraction, treatment and pumping of potable water to households	3.81	GWh/yr	3.3%	*1996.42*	*t CO2e/yr*	3.3%
Abstraction, treatment and pumping of potable water lost through leakage	1.90	GWh/yr	1.7%	*998.21*	*t CO2e/yr*	1.7%
Pumping of rainwater received by combined sewers	0.00	GWh/yr	0.0%	*0.00*	*t CO2e/yr*	0.0%
Treatment of all waste water (reflecting any reduced energy demands due to dilution)	5.62	GWh/yr	4.9%	2946.64	t CO2e/yr	4.9%
Total	**114.88**			**60269.34**		

EBAT (V3)


DRINKING WATER COLLECTION
drinking water
thermal energy
WASTE WATER TREATMENT PLANT
chemical energy
effluent

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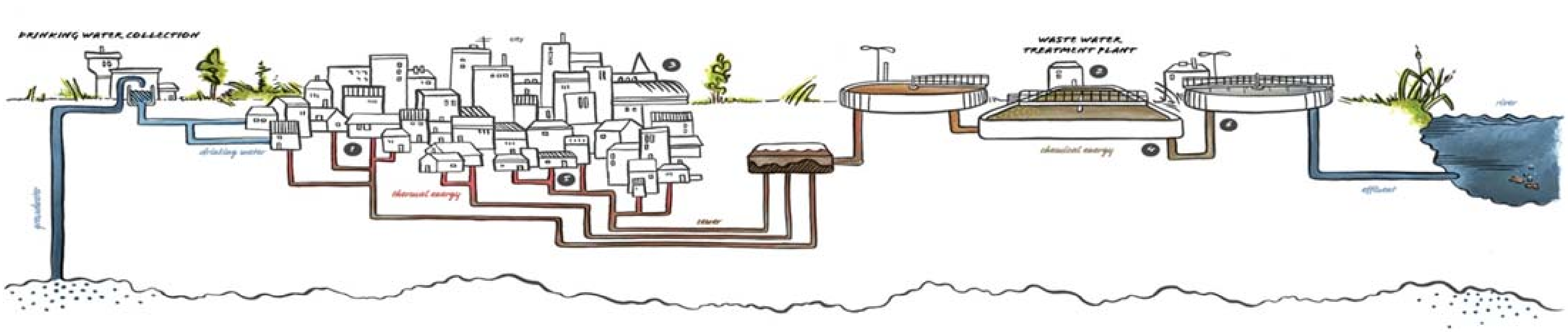
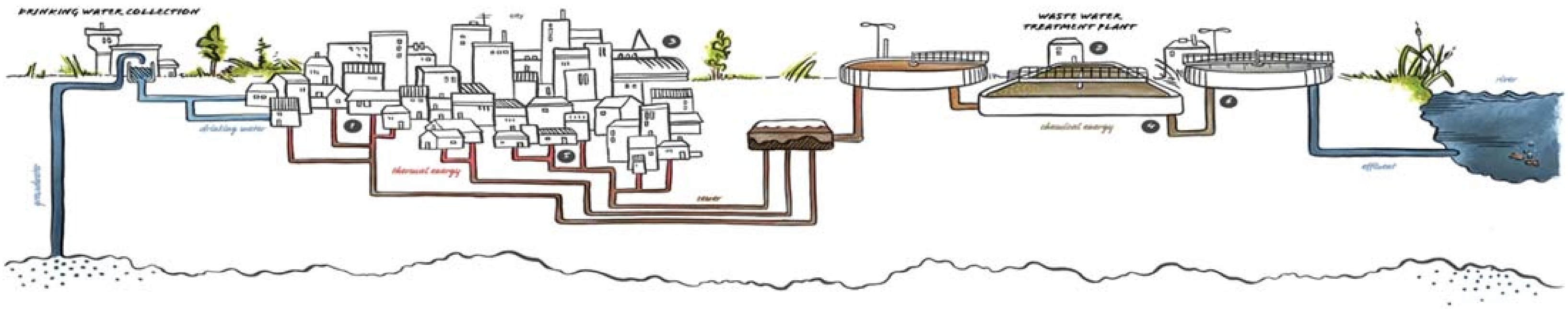


Conclusions

- Tool splits urban water cycle into 4 parts, water supply, use, water transport to disposal, treatment and disposal
- Water and energy fluxes accounted for through the whole cycle
- Energy fluxes estimated using data collected during project from a range of sources (e.g. country specific data)
- Capability to input location specific data
- Results output: total energy, CO_2 eq, per m3 or
- Early modelling studies that typical energy spilt is water supply, transport and wastewater treatment (~10%), domestic use (~90%) – catchment specific (industrial inputs/discharge consent/rainfall runoff/leakage)



Thank You

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