INTERNATIONAL FINANCIAL INSTITUTIONS TECHNICAL WORKING GROUP ON GREENHOUSE GAS ACCOUNTING

IFI TWG - AHSA-004

Default Energy Intensity Factors for Water Supply Systems

Version 01.0

Date: October 2020

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1. Introduction

1. *This is a living document maintained by the IFI TWG. Its purpose is to provide default energy intensity and other relevant data to IFIs whom are carrying out a GHG analysis for water supply systems.*

2. Default Energy Intensity Factors for Water Supply Systems

2. There are several ways to approach a GHG analysis for water supply projects depending on what data is available. One common occurrence is that the expected project and baseline scenarios' total volume of water is known, but the energy intensity or total amount of energy demand is not known before carrying out the GHG analysis. For such cases, the factors below are available to use as default energy intensity factors for sourcing, conveyance, various treatment technologies, and distribution. They should only be used when reliable and accurate local data are not currently available. Please note that the energy intensity of each of the equipment for each of the steps outlined below in the potable water production chain may change over time, especially due to improvements in energy efficiency of new pumps and treatment equipment.

3. When using the default energy intensity values below (kWh/m^3), the given figure should be multiplied by the average volume of water produced in a given period of time (such as m3/day or Million L/year converted to equivalent m^3/year) to determine the total average annual energy consumption necessary to deliver that service. This average volume of water should be inclusive of non-revenue water (NRW)[1]. The energy consumption figure should then be applied to either 1) the default IFI TWG grid emission factor for the given country/region[2] or 2) emission intensity of the electricity based on the local project-specific energy mix.

4. The primary sources of the figures below are from global averages derived from Cooley and Wilkinson (2012)[3] and from the World Bank experience of carrying out GHG analyses for water supply investment projects from FY17-FY19. When a range of values are available in Cooley and Wilkinson, the median value is given below.

5. Default energy intensity figures for wastewater reuse treatment and distribution will be added to this document once the IFI TWG guidance on wastewater has been finalized and approved to avoid creating conflicts with that process at this stage.

[1] NRW is defined as the difference between the volume of water put into a system and the amount of water billed and collected. NRW broadly consists of 1) unbilled, but authorized, consumption; 2) commercial losses; and 3) physical losses (leakages). For the purposes of GHG accounting, water-supply energy efficiency improvement projects should be inclusive of all three forms of NRW relevant to particular project or program design.

[2] Harmonized Grid Emission factor data set available here.

[3] Cooley, H., Wilkinson, R., Heberger, M., and L. Allen. 2012. *Implications of Future Water Supply Sources for Energy Demands.* WateReuse Research Foundation, Alexandria, VA. Technical Report. http://pacinst.org/publication/wesim/.

2.1. Sourcing

6. Source pumping can have a highly variable energy intensity depending on the heights required to lift water, particularly for groundwater extraction. In such cases, the site-specific average pumping heights will be required instead of using a default energy intensity factor. The default efficiency rating of pumping equipment is 70% when energy is used for sourcing. This has been the most common estimated efficiency rating encountered for World Bank groundwater projects across the expected economic lifetime of such projects from FY2017-FY2019.

7. For water supply systems that use surface water as the sole source and use 100% gravity for sourcing, the energy intensity is 0 kWh/m3.

2.2. Conveyance

8. Conveyance can vary greatly due to the distance between the source and the treatment plant or end users.

Table 1. Default energy intensity for different types Conveyance Systems

Conveyance System Type	Energy Intensity (kWh/m^3)	Source	Notes
Pumped Local Conveyance	0.029	Cooley and Wilkinson (2012)	
Pumped Long Distance Conveyance	0.79		Long distance here is defined as a minimum of 200 km for systems requiring pumping over the length of conveyance with little gravity usage. Expert judgment should be used when deciding if a system should be assessed as a local system or a long-distance system.
100% Gravity-Based System	0		Assuming no energy use required. For systems that use a combination of gravity and pumping for conveyance, the energy use for the pumping portion should still be estimated.

2.3. Treatment

9. A water treatment plant or water supply system may use only one treatment technology (if any) or multiple technologies. For projects that use multiple treatment technologies, all of the relevant default energy intensity factors should be used in conjunction with the volume of water treated using each individual technology (inclusive of NRW).

Table 2. Default energy intensity for Treatment Technologies

Treatment Technology	Energy Intensity (kWh/m^3)	Source	Notes
Conventional Standard Treatment	0.198	Cooley and Wilkinson (2012)	
Chlorine Treatment (Mechanized)	0.0025		
Chlorine Treatment (Muscle Power)	0		To be applied only when no electricity is required for chlorine injection
Ozone Disinfection	0.042	Cooley and Wilkinson (2012)	
UV Disinfection (Low-Pressure Lamps)	0.017		
UV Disinfection (Medium-Pressure Lamps)	0.04		
Low-Pressure Membrane Treatment	0.13		

2.4. Desalination

10. The default energy intensity **of brackish water desalination** depends on the pre-treatment salinity level. The chart below provides default energy intensity values for a range of salinity levels from 1,000 – 10,000 mg/L. Desalination in general tends to be highly energy-intensive.

Table 3. Default energy intensity for brackish water desalination

Brackish Water Salinity Level (mg/L)	Energy Intensity (kWh/m^3)	Source
1,000-3,000	0.951	Cooley and Wilkinson (2012)
3,000-5,000	1.255	
5,000-7,000	1.545	
7,000-10,000	1.942	

11. The default energy intensity of **seawater desalination using reverse osmosis** is 4.0 kWh/m^3.

Table 4. Default energy intensity Seawater Desalination Technology

Seawater Desalination Technology	Energy Intensity (kWh/m^3)	Source
Reverse Osmosis	4.0	Cooley and Wilkinson (2012)

2.5. Distribution

Table 5. Default energy intensity for Water Distribution Systems

Distribution System Type	Energy Intensity (kWh/m³)	Source	Notes
Pumped Distribution	0.14	Cooley and Wilkinson (2012)	
100% Gravity-Based System	0		Assuming no energy use required. For systems that use a combination of gravity and pumping for distribution, the energy use for the pumping portion should still be estimated.

2.6. Note on Estimating the Energy Intensity for a Complete Municipal System

12. The data points above are separated out into different parts of the service chain to allow for fine-grained analysis of changes in energy intensity. For brownfield energy efficiency improvements, the potential energy efficiency savings may not be distributed equally between sourcing, conveyance, treatment, and distribution. In such cases, care should be taken to assess each of these steps separately to ensure accuracy in the analysis. For some projects, only municipal-wide or utility-wide energy intensity data may be available. This is acceptable data to use as long as the analysis is limited to the portion of the utility relevant to the investment.

2.7. Country-specific Local Data (World Bank projects)

13. The data below is a sample of local data that has been derived from World Bank water supply projects that were approved since FY18. The client either directly provided the data points below or World Bank staff derived the data from client-provided data points (except where noted). It is available for members of the IFI TWG to apply to their own analyses when local data is not available.

14. This table will be expanded covering other countries by the IFI TWG, when latest information becomes available.

Table 6. Country-specific local data from World Bank projects

Location	Activity	Energy Intensity (kWh/m³)	Notes
Luanda, Angola	Treatment and Distribution (combined)	1.15	Baseline Data
Karachi, Pakistan	Conveyance	0.232	Baseline Data
Karachi, Pakistan	Conveyance	0.197	Project Data
Karachi, Pakistan	Conventional Treatment	0.117	Baseline Data
Karachi, Pakistan	Conventional Treatment	0.1	Project Data
Karachi, Pakistan	Distribution	0.132	Baseline Data
Karachi, Pakistan	Distribution	0.083	Project Data
Tegucigalpa, Honduras	Conventional Treatment	0.01134	Project Data

Location	Activity	Energy Intensity (kWh/m³)	Notes
Baghdad, Iraq	Household Pumping (coping with baseline low-pressure situations)	0.5115	Baseline Data
Cambodia (Rural)	Home Boiling	1.274 tCO2-eq per household per year	Baseline Data from existing CDM application

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Document information

Version	*Date*	*Description*
01.0	7 October 2020	Initial adoption.