INNOVATION OUTLOOK – WATER SERIES

Water Reuse and Tourism

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Executive summary

Water supply will be an important issue for decades to come. Increasing water consumption due to global trends such as urbanisation, demographic growth and ageing populations will lead, if not regulated, controlled or reused, to more wastewater production and is expected to threaten the environment with a diminution of available water sources, a situation exacerbated by droughts intensified by climate change. Wastewater will have to be treated to avoid environmental pollution and sanitary problems, but can also represent an important and promising source of water, with regards to the expected severe water scarcities worldwide, like the Euro-Mediterranean region.

From a business point of view, the wastewater market is therefore extremely interesting and is already currently fast growing, a growth boosted by new legislations in the domain of wastewater and water reuse in several countries and at international level. In this context, tourism is an important actor as it impacts water resources in several ways.

This mini report analyses the global water recycling and reuse challenges and links them with particular conditions of the tourist sector and the MEDA region.

WATER REUSE SECTOR

A global water issue

In the last 50 years, global water use has tripled (Figure 1) due to population increase, economic growth and changes in lifestyle, technologies and international trade (Gösling & all, 2012). These trends are likely to continue in the next decades with the following pressures on the water sector:

- **Demographic growth, ageing and urbanisation:** 90% of the 2 billion people that will be added to the worldwide population by 2050 will live in developing countries, with a majority of them in regions already experiencing water stress or without adequate access to potable water (PwC, 2012)
- **Globalisation and wealth growth** both increase water requirements and favour water-intensive products and services
- **Spatial and environmental pressures:** discharged waters on **coastal areas** are often insufficiently treated which affect downstream users and aquatic systems. 20% of European surface waters are seriously threatened by pollution. Coastal areas are also endangered by increasing urbanisation and tourism development
- **Climate change and the water-energy-agriculture nexus:** Following the European Commission (EC), the frequency of droughts and their environmental and economic damages appear to have increased over the past thirty years (EC, 2012) and will continue to increase. While water supplies will be reduced due to climate change, most current water technologies may participate in reinforcing climate change due to their intensive energy consumption. There is a strong correlation between energy and (waste) water collection, treatment and reuse (Angelakis & Gikas, 2014)
- **Water scarcities:** locally available water resources will not be able to meet the water needs in many regions. This leads to issues of water allocation and **competition** between the water users (domestic, industry, agriculture and environment).
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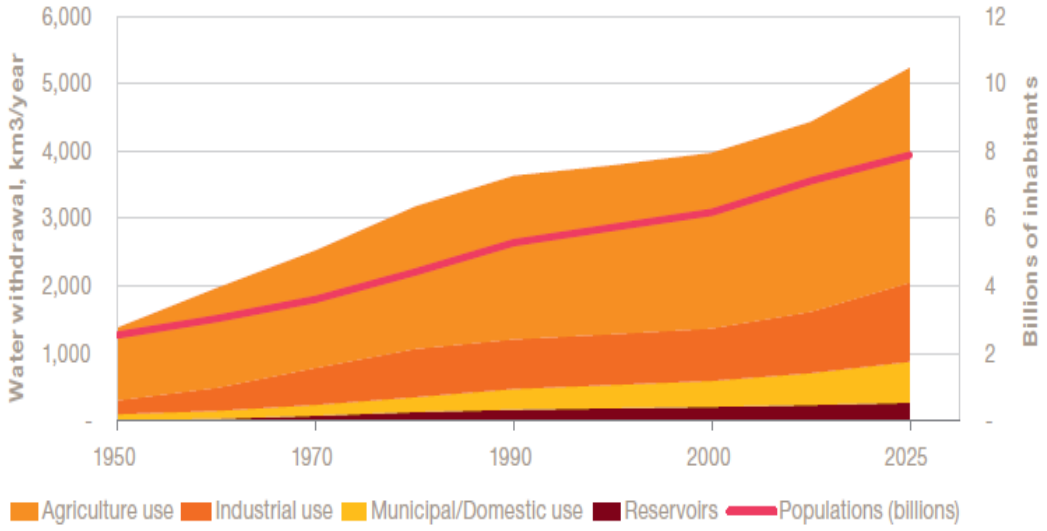

Figure 1: Change in water withdrawal and the global population, 1950-2025. PwC, 2012.

Main solutions against water scarcity

To address these issues and to maintain a sufficient quantity of supplied water, there exist different strategies (Bluetech, no date):

- **Water conservation and control** such as leak detection and repair, water efficient appliances, demand side management, smart monitoring and control and customer use awareness tools, water metering, new water tariff structures, and water injection in aquifers for storage and restoring (taking into account saltwater intrusion)
- **Water avoidance** such as vacuum sewers and toilets, waterless cooling and waterless laundry and dyeing
- **Alternative water sources** such as desalination, seawater toilet flushing, rain-water harvesting, storm-water capture and effluents from municipal wastewater treatment plants
- **Treated grey- and wastewater reuse** consisting of decentralised wastewater treatment and reuse such as sewage mining, source separation of urine, source separation of greywater, direct potable reuse, in-direct potable reuse and on-potable reuse.

Desalination is problematic

Currently, **desalination is a fast growing technology**. Desalination meets 0.5% of water needs worldwide and grows at a 10% annual rate (PwC, 2012). In the Mediterranean region (MEDA) region, desalination is also fast growing and benefits tourism, supply of desert areas and agricultural irrigation. About 18% of global desalinated water production is in MEDA.

Spain, Algeria, Israel and Libya have major desalination plants. In Malta, desalinated water makes 60% of the drinking water supply. In Cyprus, desalinated water is used for domestic uses in case of droughts and helps minimising the pressure on drinkable water resources.

Desalination is still expensive and energy-intensive and there are also some environmental issues associated with the technology, such as the impact on the aquatic life. The process results in the discharge of concentrated brine into the receiving waters which may disturb the composition and distribution of species in the marine environment and changing the receiving ecosystem's function (UNEP, 2010).

Water treatment and reuse

In 2010, 2 million tons of sewage, industrial and agricultural waste were discharged into the world's waterways (UNEP, 2010). For the United Nations Environment Programme (UNEP), the world is facing a global water quality crisis. They call for a **wastewater management revolution.** The following list gives more detailed on these issues (Angelakis & Gikas, 2014):

- **Population and urban growth**: Sewage and drainage systems, in particular water recycling, will play a vital role in the future urban planning. These systems should be redesigned for giving a bigger place to decentralised wastewater treatment systems for efficient on-site water reuse (Gikas & Tchobanoglous, 2009)
- **Health issues:** Globally, up to 90% of wastewater flows untreated into the densely populated coastal zone are contributing to growing marine dead zones. Contaminated water from inadequate wastewater management provides one of the greatest health

challenges restricting development and increasing poverty through costs to health care and lost labour productivity

- **Water scarcity:** Wastewater reuse is one possible option to meet the challenge of increasing water demand and diminished quantities of available safe water for human activities.
- **Environmental issues,** due to water pollution.

Wastewater reuse can be an important tool to minimise the effect and the necessity of water in water scarcity areas.

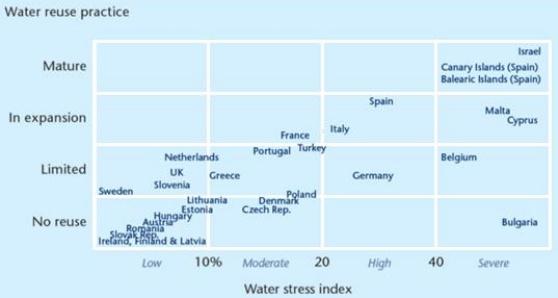

Figure 2: Water reuse, water scarcity remains the major driver. Lazarova, no date.

Figure shows that the **driver for treated wastewater reuse remains the status of water scarcity in the considered country**.

However, except in Kuwait and Israel, **water reuse is not sufficiently exploited**, even in countries with high water scarcity such as Australia, Egypt and Spain. Worldwide, the main uses for recycled wastewater are presented in Figure 3:

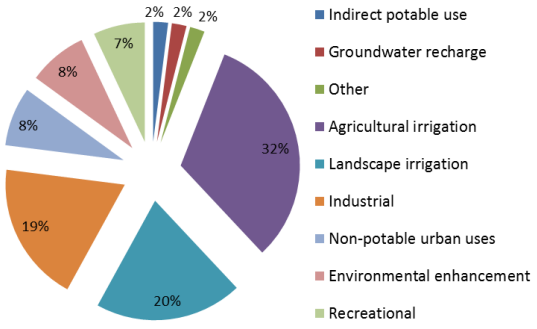

Figure 3: Types of treated wastewater reuse worldwide. Lazarova, no date

- In **Europe, only 2.4% of treated waste water (700Mm³/year) is reused**, mostly in Spain (BIO, 2015), with irrigation accounting for 75% of water reuse. The water reuse status is quite different between northern and southern Europe. In southern Europe, water is reused predominantly for agricultural irrigation and for urban or environmental applications, while in northern Europe water is reused mainly for urban, environmental or industrial application (Angelakis & Gikas, 2014)

Water reuse technologies

The following list presents some of the main technical solutions for the treatment and reuse markets and thus shows its fragmentation (adapted from Demoware, 2015):

- Conventional wastewater treatment techniques: coagulation, flocculation, activated sludge, sedimentation and filtration. In the markets for decades, well established technologies. Innovations to these traditional techniques are evolving (electrocoagulation flotation technology, etc.)
- Advanced biological treatment (e.g. enriched biomasses) and constructed wetlands.
- Membrane filtration including reverse osmosis, nanofiltration, ultrafiltration, microfiltration
- Membrane bioreactors (MBRs) combined biological treatment and membrane filtration
- Anaerobic MBR for waste management and water reclamation: 100% of the use is industrial. In the market since the 1980s **Forward Osmosis MBR**: not mature

technology. Compact wastewater treatment concept

- **Ion exchange** and capacitive deionization
- **UV and Ozone** treatments
- **Chemical treatment**, such as Advanced Oxidation Process (AOP): AOPs may be used in wastewater treatment for overall organic content reduction, specific pollutant destruction, sludge treatment, increasing bioavailability of recalcitrant organics and colour and smell reduction. However, AOP has not been widely applied so far because the chemical processes behind AOP require deeper research. AOP technology is an area with a high level of technology innovation and many start-ups seeking to commercialise a wide variety of processes that generate hydroxyl radicals. AOP can be applied also as disinfection technologies
- **Struvite crystallisation**
- **Soil Aquifer Treatment**: mature technology that has been used for many years at global level
- **Water injection** in aquifer for storage and restoring.

WATER & TOURISM

Mass tourism is a **global phenomenon** and **is one of the largest and fastest-growing economic sectors in the world**. **International tourist arrivals worldwide are expected to increase by 3.3% a year between 2010 and 2030** to reach 1.8 billion by 2030 (UNWTO, 2015a).

Tourism impacts water resources in several ways. First of all, tourists generally use about 30% more water than locals (Dinares and Sauri, 2015). Intense water usages in tourism include those in swimming pools and aquatic centres, spas and wellness centres and golfs and green areas irrigation. In addition, a major part of touristic areas are situated on coasts, which are fragile landscapes and important economic and ecological zones (WssTP, 2010). Another issue is that water resources are either scarce or expensive in coastal areas and on islands.

Regarding the MEDA region, tourism accounts for 20% of total domestic water demand in Cyprus, 5% in Tunisia and 5% in Malta (GWP, 2012). Water consumption is expected to rise quickly due to higher touristic flows, higher comfort expectations and the diversification of touristic equipment. The water issues linked to tourism in the MEDA region include:

- Seasonal water consumption, with the consumption peaks during times when resources are at their lowest and used for irrigation (Eurostat, 2009). The period from May to September accounts for 80% of the touristic flow (WssTP, 2010). This can trigger conflicts between touristic and local water usages.
- In some areas, the water consumption can reach a five-fold increase (GWP, 2012).
- Much touristic equipment that excessively consume water such as golfs, swimming pools and aquatic centres.

Green and sustainable tourisms

In order to prevent and manage the impact of tourism on natural and social resources, a number of "green and/or responsible tourism" initiatives. The overall idea is to respect the environment and the culture in which the touristic resort is located. There are different labels for green and responsible tourism such as Green Key Global, Ecolabel and Green Globe (UNEP and UNWTO, 2005).

According to CREST (2015), many **leading hoteliers** have created **senior management positions in sustainability**, recognising the importance of sustainable practices to their business. Examples include Marriott, Hilton, IHG, Fairmont, Wyndham, Accor, and Kimpton. In more details, The Accor hotel chain has developed the 'Earth Guest Programme' in 2005, which was renamed 'Charter 21' in 2011 (Accor, no date). The charter was divided in five sections: Management, Energy, Water, Waste and Products. **For the water section, rainwater use, wastewater treatment and grey water reuse were promoted. As a result of this programme, from 2005 to 2007, water consumption had fallen by nearly 20% (GWP, 2012).**

With regards to tourists' preferences, many reports conclude that most tourists are now concerned by their environmental impacts while travelling, and think that tourist accommodations should play their part so as to limit their environmental footprint. However, the green and responsible tourism remains a niche market globally, although it develops in certain areas that benefit from an exceptional natural and socio-cultural environment such as the Pacific islands.

Water supply sources in MEDA tourism sector

The water supply sources for tourism accommodations in the MEDA region are:

- Connection to the municipal or similar water distribution system
- Private wells and drillings
- Uses of non-conventional resources (still rare but becoming more common) according to Eurostat, 2009 and GWP, 2012:
    - Desalination in Malta, Baleares islands, Djerba, Cyprus, Tunisia, some Greek islands and Morocco
    - Treated wastewaters reuse especially on islands, coastal towns and in areas with high water scarcity and potential water-use influenced conflicts
    - Water imports for islands and as short term solution in periods of extreme drought
    - Rain water harvesting

Water use optimisation

Figure 4 presents the water-savings measures of Barcelona hotels only but it includes at the same time the main ones that hotels worldwide implement. Grey-and wastewater reuse solutions, not shown in the Figure, are currently rather uncommon in hotels and tourism accommodations. It is important to note that tap water-saving systems/devices were implemented in more than 80% of Barcelona hotels in 2008, as these solutions could represent a threat to water reuse solutions uptake.

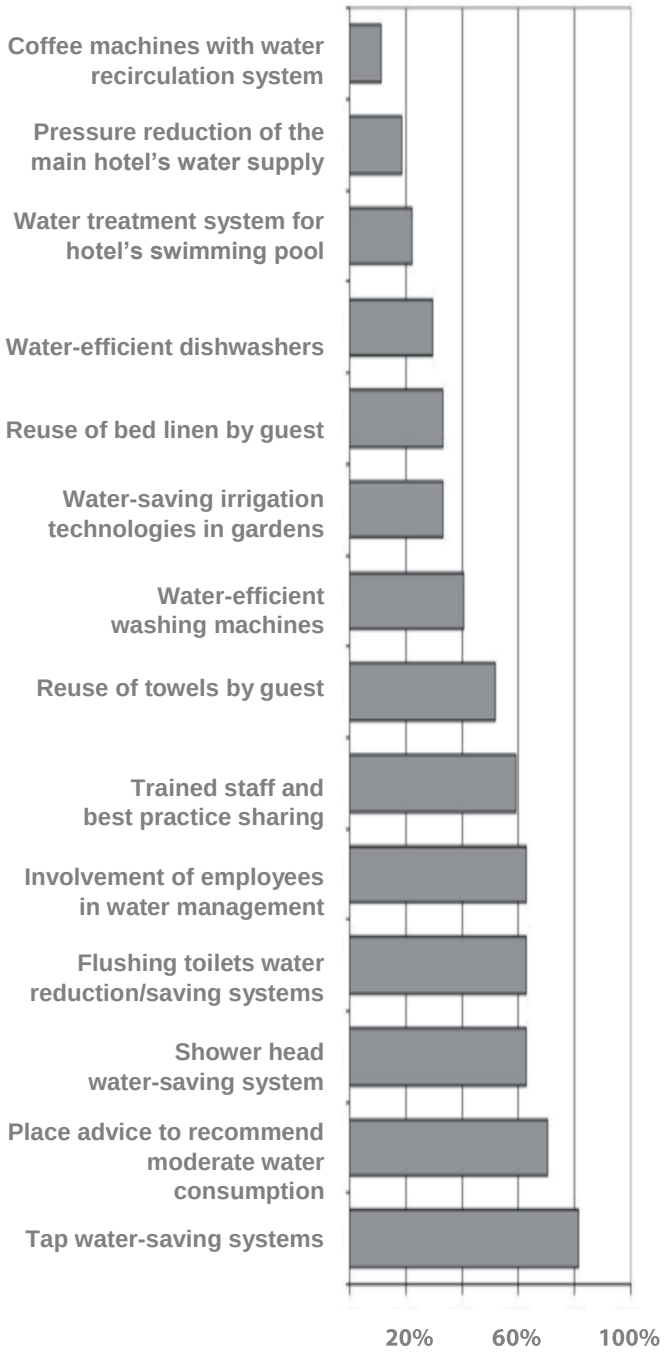

Figure 4: Water-saving practices/measures and adoption rates in Barcelona hotels in 2008. Dinares and Sauri, 2015.

MARKET CHALLENGES

The uptake of water reuse solutions is rather low compared to their potential. There are several reasons for that:

- Public acceptance
- Market failure and information failure: high financial cost and lack of economic attractiveness
- Regulatory failure: lack of EU wide environmental and health standards for reused water
- Poor coordination of water professionals between those who design water supply infrastructures and the operating ones.
- Technical and health/environmental challenges

The table presented in Figure 5 summaries the main constraints to be overcome per type of water application.

In its report 'Optimising water reuse in the EU', the consulting company BIO by Deloitte (BIO, 2015) detailed the reasons for this issues and **their analyses are in line with the results of the conclusions based on a number of interviews with water professionals conducted by LGI Consulting throughout 2014/2015** and presented in the table below.

Market failure issue

Water reuse solutions face economic barriers due to their costs and insufficient incentives for a strong uptake. This is partly due to the fact that there is no much price difference between reused water and conventional supplied water. In addition, some EU countries subsidise conventional water supply and most EU water supply markets suffer from a lack of full cost recovery. Indeed, current freshwater prices usually fail to take into account the complete range of costs associated with the different phases of the water supply chain. Another problem arises from the lack of integration within the products existing in the water supply and water treatment markets. Usually, there is a separation of water supply and wastewater treatment equipment, which can increase the costs of reuse and make more difficult the identification and distribution of costs and benefits associated with water reuse.

Application	Major constrains
Irrigation (agriculture & landscape)	Seasonal demand
	Usually away from the point of water reclamation
Industrial use	Constant demand but site specific
Non-potable urban use	Limit demand
	Requirement for dual piping systems
Recreational/environmental use	Site specific
Indirect potable use (ground water recharge)	Require suitable aquifer
Indirect potable use (surface water)	Requires available reservoir between the points of water reclamation and reuse
Direct potable use	Public perception issues

Figure 5: Major water reuse applications and related issues. Angelakis & Gikas, 2014.

Regulation and market failures

Policy-makers are constrained in their legislation power due to the public opposition towards direct water reuse. The WssTP commented that 'a lack of clear regulation which covers a wide range of reuse scheme forms also makes commercial actors and investors nervous of operating in an area with poor legal clarity and legitimacy' (WssTP, 2013). The main consequence of the defiance towards treated waters, in this context, is that water reuse standards are often stringent, such as in France, Italy and Greece, adding another complexity layer and delaying the potential development of water reuse projects. The consequences of stringent standards are typically high administrative burdens and additional costs.

Technical and environmental challenge

The major problem, regarding WWTP effluents is the increased salt level. Salinity problems are more frequent in WWTPs located in coastal areas, most likely due to seawater intrusion, or intrusion from shallow saline aquifers into the municipal sewerage systems (Ilias and al, 2014). Water with high salt concentrations may result to reduced agricultural productivity and to deterioration of agricultural land quality (Angelakis & Gikas, 2014).

MARKET POTENTIAL

Globally, **the market for wastewater treatment and reuse is growing** (Figure 6). In particular, the global market for wastewater-recycling and reuse technologies increased from nearly $6.7 billion to $9.5 billion during the period from 2009 to 2012, equivalent to a compound annual growth rate (CAGR) of 12.6%.

This market is expected to **increase from $9.5 billion in 2012 to $23.4 billion in 2017, reflecting a five-year CAGR of 19.7**% (BCC research, 2013). Another source estimates similarly that in terms of volume of water recycled the **global water recycle and reuse market is to grow at a CAGR of 22.39% from 2014 to 2020** (Research and markets, 2015). The key driver for the water reuse market is water scarcity.

While wastewater reuse is likely to grow strongly in the next years at a global scale, **there will be differences between regions: it should be very strong in areas subject to severe water stress (such as Spain, Australia) and/or with intensive urbanisation (such as China), and less strong in industrialised countries that do not suffer as much in terms of water resources scarcity (PwC, 2012). The agricultural (including landscape irrigation) and industrial sectors are projected to be the main users of recycled wastewater.**

However, in the industry sector, the growth might be slowed by the quality requirements for industrial purposes which are getting closer to that of urban and domestic uses (PwC, 2012). Another source indicates however, that reuse in the industrial sector is a key trend of the water reuse market (Research and markets, 2015).

A key challenge is the recycling of the residues created by water reuse since they should be disposed of or managed properly (Research and markets, 2015).

For the European market, **the potential for water reuse in Europe is very high**. More than 200 water reuse projects have been implemented in the EU and a significant number of water reuse projects are in an advanced planning phase (Angelakis & Gikas, 2014). Water reuse volume at the EU level in

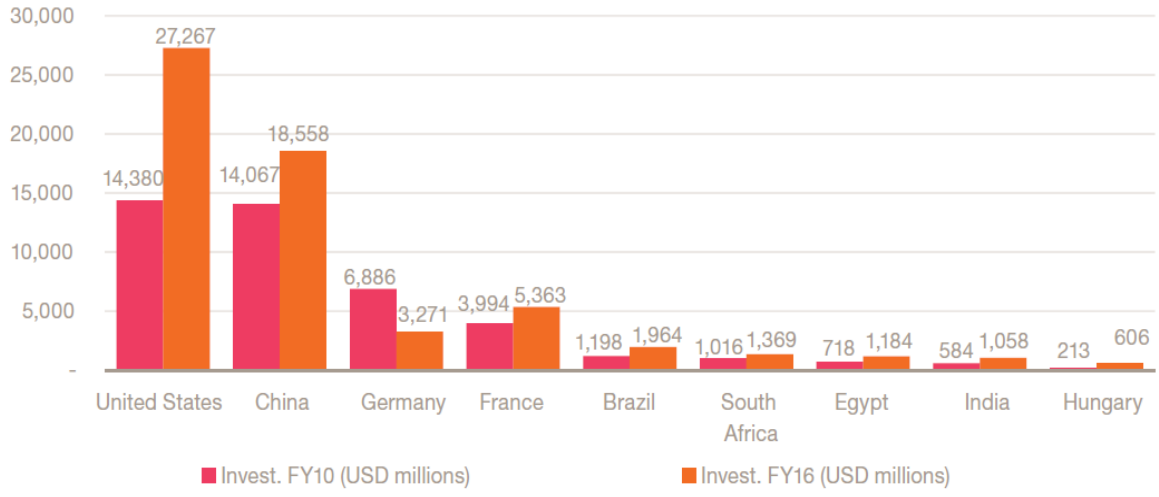

Figure 6: Investment in wastewater sanitation, 2010 vs. 2016. PwC, 2012.

2025 is estimated to save 0.9% of the total water abstraction in 2015; in MEDA states (e.g., Malta, Cyprus, Greece and Spain) reused water may cover up to 26%, 7.6%, 5% and 3% respectively of their future water demand (*Ibid.*).

Space constraints

Therefore, the market for demEAUmed solutions is reduced by the space available in hotels and shall be divided between new and existing hotels. Indeed, hotel retrofitting is expensive, and according to JRC (2013), it is unlikely that the hotel would undertake water pipeline works only; the most important possibility for water reuse solutions installation in existing hotels is when they are being deeply retrofitted. However, **the installation of rainwater and greywater recycling systems is easily applicable to all new hotels**, when the installation is planned sufficiently ahead of time.

Hotel segmentation

The following paragraph presents arguments to determine which category(ies) and sub-category(ies) could be the most interesting with regards to demEAUmed's uptake:

- The **"leisure, recreation, holidays"** sub-category would be the most interesting of the type of hotel's use because it is the one most likely to include water-intensive facilities and large scale hotels.
- **"Green hotels"**, while potentially interested in demEAUmed solutions, only represent a niche market at the moment and their investment budget is rather low. They would therefore be one-off buyers of demEAUmed solutions.
- The **"brand" category** is to be analysed well because the market penetration of brands indicates tourism market maturity (HA, 2015). A mature tourism market, i.e. a market that generates a lot of revenues with past, current and future sustained growth is rather populated by hotels brands/chains rather than independent hotels. **The branded hotel market is estimated to account from 53% to 68% (so more than half the market) of the total hotel market according to different sources (HNN, 2015a).** Five of the leading branded hotel companies (IHG, Accor, Hilton, Marriott and Starwood) account for approximately 30% of total branded hotel market in terms of open rooms (HA, 2015). That concerns demEAUmed in the sense that chains (and their brands), as important water consumers, are likely and have the capacity to invest in sustainable programmes.
- In the "class" category, corresponding to hotels' star, the most promising sub-categories for demEAUmed would be **luxury, upper-upscale and upscale**, for they correspond approximately to 3, 4 and 5 stars hotels, which consume the most water. In addition, their investment capacity is likely to be more important than for the lower class sub-categories.

Other sectors

Small and remote communities, particularly in water-stressed areas, often face acute problems concerning water supply and treatment. Small communities often lack the size and financial resources to build and operate full-scale wastewater treatment plants. Additionally, small communities are too large or densely populated to rely entirely on septic tanks. If they are remote, they do not have the possibility of being connected to a larger wastewater treatment system. This is why remote communities often face a conundrum that can be dealt with efficient and affordable technologies (Herczeg 2013).

When natural water resources are scarce, the same problem occurs with water supply. **Water reuse solutions then become particularly relevant for these small, remote communities dealing with water shortages**.

Stathatou et al. (2014) found that water reuse in remote islands of the Aegean sea can have several advantages over solutions used so far, such as desalination, groundwater (over-) exploitation, and water shipment. **The main advantages relate to cost and energy savings, increased environmental protection, but also social benefits such as perception of self-sufficiency**, a critical issue among island communities.

A short analysis of other sectors that could be promising was also conducted. The result of these analyses was that **the market potential for demEAUmed water reuse solution is particularly high in the commercial buildings market** and in specific water stressed areas.

The most interesting countries and regions for these particular applications are:

- Islands with high water stress, little/no access to water, high environmental preservation criteria: Greece, Sardinia, Pacific islands
- Remote areas, especially in developing countries: North Africa, India, China and South America to a smaller extent
- Highly urbanised cities and countries that seek a "green" image: UK, United Arab Emirates, USA, Asia-Pacific and Singapore

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