Summary of Results
Foresight Observatory for International Markets

May 2011

The Future of Water

Key ideas

1. The demand for drinking water, industrial process water and irrigation water is expected to grow tremendously in the world. The most important growth area will be desalination, especially in China and the Middle East, but also in Spain, Australia and the United States.

2. The main opportunities for improving water efficiency in agriculture include exploitation of more water-efficient irrigation technologies.

3. The most significant needs of industry are the development of technological solutions for water recycling and reuse, as well as the development of more water efficient process technologies.

4. Closing water cycles, recycling industrial and municipal wastewaters, and the production of clean water from saline and brackish waters create new challenges.

5. Successful business opportunities may involve integrating different technology sectors such as biotechnologies, materials technologies, ICTs and water technologies.

6. Monitoring, control and knowledge-management technologies are one of the most promising development areas. The main drivers of innovation in water-measurement technology are the need for onsite and easy-to-use measurements in order to make timely decisions and take action.

Introduction

At present the world is facing a number of challenges affecting our present lifestyle and quality of life. One of these is a lack of clean water due to the ever-growing consumption of water, uneven distribution of the world's water resources and the poor quality of water. The fast growth of the world's population means that there will be increased competition for water. The United Nations has calculated that the minimum daily amount of water needed is 20 litres per person. Twenty percent of the current 6.5 billion inhabitants of the plant have to manage with less water. In industrial countries water consumption per person may be ten-fold compared to the estimated minimum amount. The growth of people's welfare means that water consumption per person will grow significantly. For example, the growing Asian population is rapidly adapting to the Western world's way of utilising water and raw materials.

Compared to oil and mineral resources, water is the one essential resource for which there is no substitute. The main part of the earth's total water, 97%, is in the oceans (salt water). The percentage of fresh water is only 3%, of which one third is groundwater and only 0.3 percent is surface water. The rest is in glaciers and ice caps.

The global water and waste water market is expected to grow significantly by the year 2020. Helmut Kaiser Consultancy (2007) estimates that 2020

market demand for water will have increased threefold compared to the year 2006. North America, Japan and Europe have been the most significant demand areas, but the largest growth potential is in developing countries, such as China and other Asian countries, South America and Africa and non-European Union countries of the Eastern Bloc.

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Key Applications

Agriculture

The most significant water consumer is agriculture, which accounts for over 70% of the world's water consumption. Lux Research (2009) states that the water demand in agriculture is growing and will be greater than sustainable resources in several areas. The consumption of meat and other animal products is growing due to the growing population and changing lifestyles in developing countries, as well as use of biofuels based on corn, sugar and soy. Lux Research finds that, without changes in technology, world agricultural water consumption in the next 50 years will grow to 5000 cubic kilometres (km3) instead of today's 2800 km3. The over-exploitation of aquifers may cause saline water to enter them and thus further decrease the quality and availability of water.

The main opportunities for improving the water efficiency of agriculture include exploitation of more water-efficient irrigation technologies (drip and subsurface applications and the use of non-conventional water resources, such as treated wastewater. If recycled water is used for food production, monitoring and quality control will be an extremely important issue. In general, improved methods and technologies for the monitoring and assessment of water resources are needed. New desalination plants may be needed to treat saline aquifers. Water productivity may be increased by changing crops and cultivation practices. Along with these measures, more profound change in our lifestyle is needed to decrease water consumption for irrigation and thus ensure availability of water for drinking and food production.

Industry

Water usage by industry accounts for about 20% of withdrawals globally, and a much greater share in many developed countries. In Finland, industrial water use is almost twenty times that of municipal water use. Most potential clients for water equipment providers and technology developers are industries, which use large volumes of water, have high treatment costs and are willing to pay for new technologies. Depending on the industrial sector, the cost of water may be considerably higher than the production cost. The pulp and paper industry, iron and steel industry, mining industry, energy production and medical sector are among the industrial sectors that the E.U. water platform (WSSTP) has identified as high water consumers and potential polluters facing significant challenges for diminishing consumption and emissions into the environment.

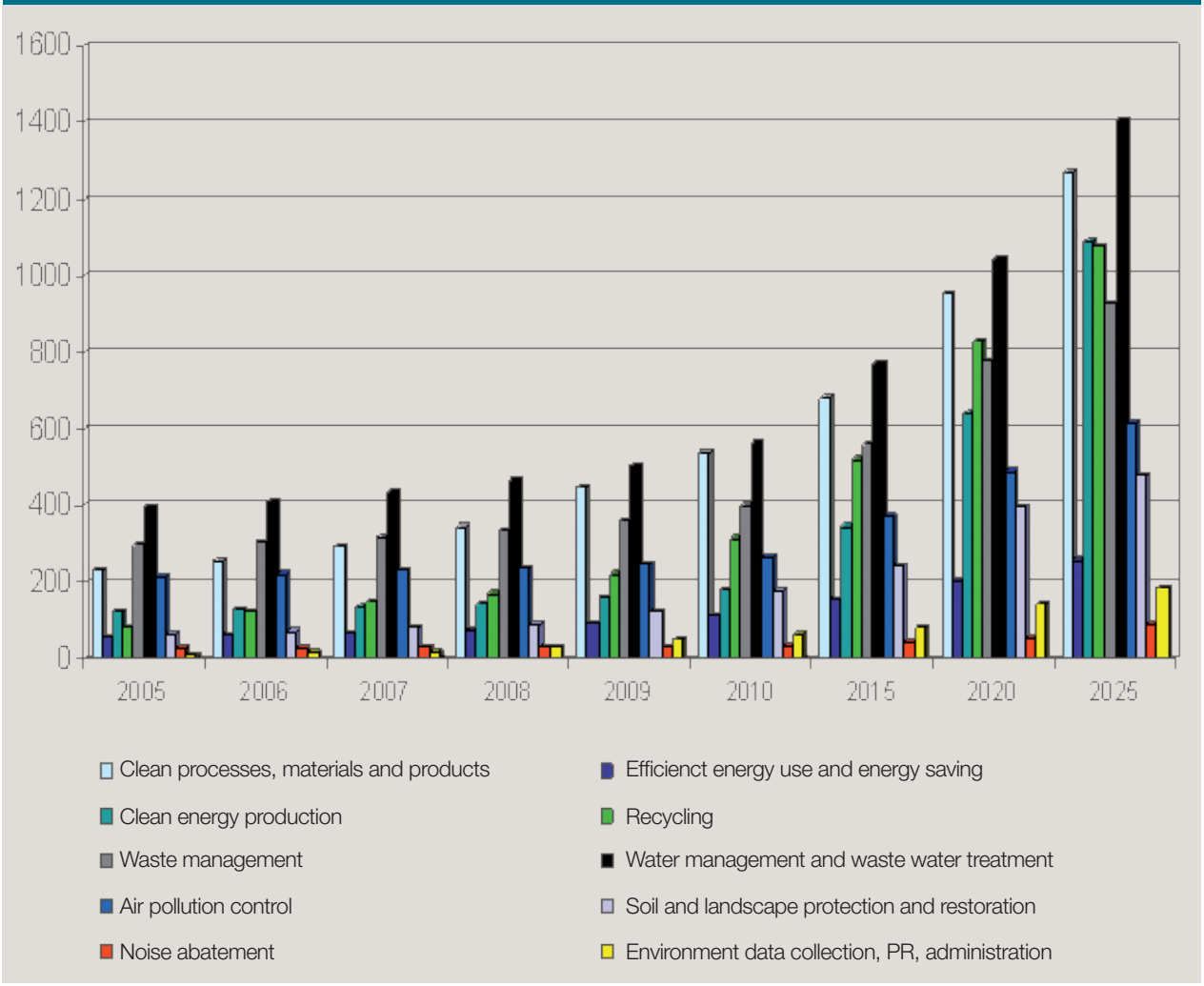
The most significant needs of industry are the development of technological solutions for water recycling and reuse, as well as the development of more water efficient process technologies. Depending on the industry and application, the quality requirements of recycled water may vary. The problem is that in many cases there is not enough knowledge on the effects of water quality on process and product quality. Therefore, industries may be using better water quality than is needed (http://www.aquafit4use.eu). In addition to recycling used water back into the process, there may be opportunities for integrated recycling between industries and for the use of treated water in irrigation, etc.

The industrial need for ultraclean water is also increasing worldwide. Besides the food and biotechnology industries, the high-tech sector (production of semiconductors and the like) and power plants consume a large amount of ultrapure water in their processes.

Municipal Consumption

Municipal water consumption accounts for about 10% of total water consumption. In developing

Figure 1: Markets for Sustainable and Environmental Technology, 2005-2025, in billion USD. In the total worldwide value chain (1 USD = 0.75 EUR)



Market Survey Commissioned by Sitar, Helmut Kaiser Consultancy, Tubingen 2007

countries the lack of clean water and sanitation systems is creating the need for reasonably priced technologies that enable utilisation of new water sources. This may involve desalination and rainwater recycling solutions. Water scarcity is, however, a problem in several developed countries, such as South European countries and parts of the United States. In China the lack of clean water is one the greatest challenges.

The potential threat of emerging micro-pollutants (pharmaceuticals, pesticides, hormones, biocides, detergents, industrial chemicals) has generated much discussion in recent years. Due to the wide spectrum of these anthropogenic and natural pollutants, it has been difficult to attain scientific consensus on their health effects. Although there has not been any powerful driving force, such as legislation, for the development of technologies for micro-pollutant treatment, the technologies have developed. To reduce potential impacts, the reduction of critical chemicals and more efficient and cost-effective treatment solutions are needed.

Centralised municipal wastewater treatment is mainly based on conventional technologies with partial modifications to improve such things as energy efficiency at treatment plants. Investments in this area are significant in countries like China and several other developing countries. The public sector has been cautious and not motivated to invest in new innovations.

There are, however, several challenges that may lead to a new-technology development boom.

In Western Europe and the United States, water infrastructure (clean water and wastewater) is ageing and needs renovation. New systems that can be more easily replaced are also needed. The character and quantity of contaminants has changed and new potential threats have been identified. The growth of urban areas and the need in some areas to utilise rain water and urban runoff bring new efficiency improvement challenges and the need for separated collection systems. Especially in areas lacking water and decentralised areas systems for grey water, recycling, reuse, the separation of grey water and sanitation systems are needed.

Technologies are needed that enable energy- and material-efficient use of sludge as one of the significant drivers of wastewater treatment technology.

The market for small, decentralised wastewater treatment plants is growing as well. Although there are many solutions on the market, reliable, low-maintenance systems that are easy to care for are still needed.

Use of Water Treatment Residues

Closing water cycles, recycling industrial and municipal wastewater and producing clean water from saline or brackish waters create new challenges. All these processes produce some kind of treatment residue: sludge, concentrates or brines. For example, the amount of municipal wastewater treatment sludge is growing substantially due to the construction of new plants in developing countries.

Production of brines is one of the major disadvantages of membrane desalination techniques, which are widely used and growing. The concentrate may be as much as 25% of the feed. The brines are mainly disposed of into the ocean and inland facilities and discharged into sanitary sewers. Other potential ways are evaporation ponds, deep-well injection and land application. The environmental sustainability of these applications has been questioned.

The most sustainable and cost-efficient way is to use these residues for material or energy production. One of the challenges is their high water content. More efficient dewatering and drying technologies that also use less energy are needed. Increasing use and finding effective utilisation concepts for municipal and industrial sludge are other challenges. Optimal utilisation concepts combine the use of the nutrient and energy resources of sludge. Sludge components may also be used as raw materials. This requires thorough development of the whole wastewater and sludge treatment chain.

Key Trends and Prospects

Sustainable, energy- and cost-efficient technologies and processes need to be developed to decrease the overall need for water by industry and to clean the water released so it is of drinkable quality. This requires a new kind of holistic thinking and ideas that involve players and technologies. The shift to material- and energy-efficient zero-emission technologies and closed cycles is gradually continuing and will lead to the need to develop systems that enable the efficient recovery of sludge, brines and concentrates. This may be done by modifying the treatment process to produce more easily exploitable solid products or by developing new technologies for the treatment of residues.

Climate-change policies will increase the demand for energy-efficient water treatment solutions and environmental challenges also demand environmentally friendly water-treatment technologies that do not involve hazardous chemicals. Improving energy efficiency and finding new energy sources for plants are two challenges of membrane technologies. Prominent technologies can also emerge from lower energy consuming dialyse solutions and advanced osmosis technologies. The other challenges of membrane technology involve improving the development of functional, non-clogging membranes and the use of desalination brines in chemical production.

Wastewater and sewage sludge is no longer perceived simply as difficult waste. Now it is seen as a resource that can be recycled and reused. It will be an opportunity to extract energy, phosphorus and other nutrients and materials to offset oper-

ating costs and minimise the volume of sludge requiring disposal. There may be also be new opportunities by combining wastewater treatment and energy production, such as microbial fuel cells and growing energy-producing vegetation in wastewater.

The economical use of water and eco-efficient technologies are the most promising options for the future. New nano-technology applications are also expected within 10 years, and module-based water processing units look promising. Successful business opportunities may involve integrating different technology sectors together, such as bio, material and ICTs with water technologies. These new technologies may be the key to entering growing international markets where big companies dominate.

Tightened legislation and the move towards increasing recycled wastewater so it can be used as drinking water are driving the water sector to produce more efficient water-purification methods. Innovations for the disinfection of storm water and personal drinking-water purification kits reflect the growing need for solutions on conventional technology markets to combat droughts, hurricanes and other extreme weather conditions relating to climate change.

Monitoring, control and knowledge-management technologies make up another promising area for development. The general drivers of innovation in water measurement technology are the need for onsite and easy-to-use measurements in order to make timely decisions and take action. Information technology can save money and make water management more efficient.

The need for a quick analysis response is especially critical concerning drinking-water safety and water-works process control. Increasing demand for purified water and/or verification of purification results has created a new need for rapid measurement technology. For industries using ultrapure water, such as the high-tech industry and power plants, analytical testing of water purity is of great importance.

This has created a need for very precise measurements that are able to identify very low contaminant concentrations. New sensor technology based on such things as biotechnical innovations attempts to respond to these needs.

Integrating information from a large number of distributed sensors can provide early indications of issues such as leakage and early flood warnings. New wireless hydrometeorological monitoring and software supports these needs.