7. Produced water market analysis

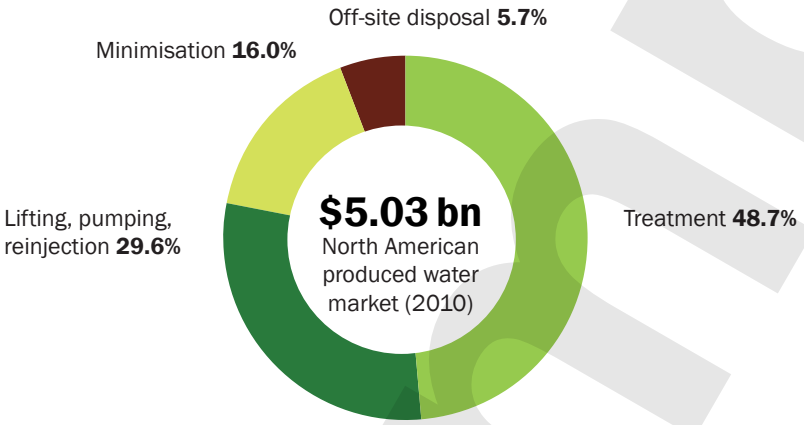
7.1 Market division/segmentation

Calculating the dollar value of the produced water market is a challenge because there are no clear divisions between the expenditures that go towards managing water in the oil field and the expenditures that go towards managing oil. In fact, until the two are separated managing water and managing oil is essentially one and the same. Perhaps the best way of analysing the market is to identify the oil field expenditures which are most directly associated with addressing produced water issues. These are as follows:

- Expenditures related to minimizing the volume of produced water.
- Expenditure related to lifting, pumping and reinjecting produced water.
- Expenditures related to treating produced water (and meeting process water requirements).
- Expenditures related to off-site disposal of produced water.

Although these categories inevitably involve some expenditure on managing oil rather than water on its own, it is probably not possible to reach a totally pure definition of the overall produced water market. At the same time many readers will find it useful to be able to put a rough figure to the overall size of the produced water management market. Our best estimate is shown below:

Figure 7.1 The produced water market by expenditure category, 2010



Source: GWI

These expenditures include both capital and operating costs. We would estimate the breakdown to be as follows:

Figure 7.2 The produced water market: Opex vs capex, 2010

Source: GWI

Total expenditure on produced water represents around [redacted]% of the total revenues of the oil and gas industry.

This report is primarily concerned with a subsector of this market – expenditure on treating produced water. This market can be divided into the following categories:

- **Primary and secondary separation**: reduces oil in produced water to 200-300ppm. Technologies include API Separators, heater treaters.
- **Secondary de-oiling**: reduces oil in water from 200-300ppm to 25-30ppm. Technologies include induced gas flotation, dissolved air flotation, compact flotation units.
- **Tertiary filtration**: reduces oil in water from 50-75ppm to below 10ppm. Technologies include nut-shell filters, ceramic filters, media filters, coalescers, adsorption technologies, biological treatment (including MBR).
- **Desalination technologies**: removes dissolved solids from produced water after oil and suspended solids has been removed. Technologies include reverse osmosis (including HERO™ and OPUS™), brine concentrators, crystallizers, filter presses.
- **Other equipment**: including monitoring systems, control systems.
- **Operating costs**: day-to-day expenditure including utilities, chemicals, labour, relating to the above categories of capital expenditure.

We estimate that this market divides up as follows:

Figure 7.3 The produced water treatment market by treatment category, 2010

Source: GWI

The size of project in the primary, secondary and tertiary categories is generally quite small – few are larger than a couple of million dollars. Projects involving desalination to zero liquid discharge can be much larger – up to $100 million. This makes desalination for oil and gas a lumpy market, and one which is difficult to forecast accurately. Some years there may be no large projects, others might have two.

This market divides between the main groups of resources as follows:

Figure 7.4 The produced water treatment equipment market by resource type, 2010

NB: Total does not include monitoring/other equipment.

Source: GWI

7.2 Key and emerging players

While this report focuses on the U.S. market for produced water, to give a broader view of the market and competitive landscape, we list the key global players in the following tables. Later in the chapter we focus on the breakdown of the U.S. market including market share estimates.

Several of the players in primary and secondary treatment are also involved in the tertiary and advanced treatment market. However, some companies have technologies only for tertiary or advanced treatment. A produced water expert from Siemens believes there is an opportunity for several players in the produced water market, noting:

> *Look at all [the] competitors - everyone matches up a little differently in terms of what in-house technologies they bring to the table.*
>
> **Produced water expert, Siemens**

The main players that provide the chemicals and the engineering & design services are shown below:

Figure 7.5 Key players for the primary and secondary global market

Company	Expertise

Company	Expertise

Source: GWI

Globally, and are two of the largest players. and are also significant. Globally, is one of the largest players offshore for compact flotation, though one expert believes that has lost a significant portion of the global market share over the past two years. However, as noted, market share can shift significantly year-to-year based on projects awarded.

The market has become very competitive over the past few years, especially since the science behind the equipment is not too advanced. This allows the smaller players to enter the market. For instance, in Brazil, local suppliers are taking over the market.

Many companies that have global presence have no share of the U.S. market. Some are trying to break into the U.S. market. Globally, has one of the largest market shares with their technology, but they are having difficulty breaking into the U.S. market, especially shale. Similarly , which is viewed by other players as a credible, viable player, has faced challenges breaking into the U.S. market. This is mainly because they are not considered to provide undifferentiated offerings.

There are also many companies entering into advanced treatment. There is no clear leader and many companies are exploring produced water treatment within shale operations. Many companies are also running pilot projects, helping them enter the market.

Many players entering the advanced treatment market have different in-house technologies and are trying to align their expertise with operations where appropriate. A water treatment company executive commented:

> *It is an emerging market. Right now there are so many configurations that people are talking about. And a lot of companies involved. All the major treatment companies are involved.*
>
> **Water treatment company executive**

For the **Marcellus shale**:

> *is involved, is involved, is involved. Everybody who is in the water arena because of the size of the reserve and the growth potential and the investment which is going in. Most of the people who are major players in the water industry are focused on that market. And then several small companies who have traditionally done treatment for fresh water using the same unit operations. They are also trying to get into that market.*
>
> **Water treatment company executive**

Figure 7.6 Key and emerging players for tertiary treatment and desalination

Company	Expertise

Source: GWI

Figure 7.7 Key players for chemicals

Market division	Main players

Source: GWI

Looking at the monitoring sector, [redacted] holds approximately 50% of the global market. Most of the opportunity for monitoring equipment is at the end of the treatment process, but there are also opportunities between stages and we are seeing an increase in multi-stage monitoring.

Figure 7.8 Key players for monitoring

Company	Expertise

Sources: GWI; Company Websites

7.3 Consolidation

Many of the larger companies have acquired smaller companies over the years. The following figure gives examples of company consolidation over the past several years. If small players are working on large contracts or interesting technologies, there is a chance they will be acquired by larger companies. For example, [redacted] wasn't considered a player, but a few years ago started winning onshore and offshore projects. In 2007, they were acquired by [redacted].

Figure 7.9 Significant company acquisitions, mergers and joint ventures

Company	Acquisitions	Month, Year	Deal value

Company	Acquisitions	Month, Year	Deal value

Source: GWI

7.4 Navigating the supply chain

Navigating the supply chain and breaking into the market is one of the biggest challenges companies face in the industry. Most technology companies offer a piece of the puzzle, but a complete solutions package still seems elusive. Part of "the reason the market isn't developed fully is because while the market has been clear, the way to penetrate the market hasn't". Additionally, as with every aspect of produced water, the supply chain varies based on geography, local conditions and regulation.

> *, and others need a steady, consistent supply of water. And that consistency is fresh water. If you're not delivering them fresh water, then that changes their additive packages and the way they have to add their stimulation chemicals... The important factor is the different processes that yield water that can be reused... It's a bit of a moving target. That creates problems for companies. It also complicates the supply chain.*
>
> **Produced water expert, Siemens**

For an emerging technology company, breaking into the market requires a partnership with a services company and buy-in from the engineering/design firms. As from noted:

> *The company that really has the best shot at solving that piece is going to be a company with the capital resources that can implement a system that will let you reuse the water. There is a big water demand for all these fractures that are required to produce the gas and a big water problem with all the produced water. Whoever can figure out how to treat and transport produced water for frac'ing supply and solve the water balance equation will succeed.*

A company aiming to break into the market with a technology solution can't go directly to the end user. Oilfield services companies (such as , and) and engineering firms (such as and) generally separate the solutions providers from the end-users. Both are key decision makers in technology adoption and application. As a result, while technology companies can develop improved technologies and solutions, there is no easy method (and sometimes no method) for accessing the end user.

If technology companies want to break into the market, they need to align with the necessary partners, in order to offer oil and gas companies a comprehensive solution. This is the major challenge for emerging players. For instance, many small companies that provide membranes have partnered with engineering firms to provide turn-key solutions.

> *A successful service company has to be recognized by local, regional and national groups. It has to have the acumen to look at the problem clearly, be large enough to be reputable, small and agile enough to move fast and have the infrastructure necessary to promulgate the product. There hasn't been a company with the attributes necessary to do that... They will hire a company they feel comfortable with – not necessarily one of the big players.*
>
> **Industry expert**

And there is sometimes resistance to foreign companies, "that's what the big guys are finding".

may be currently best-positioned as a complete solutions provider with access to the end-user. , and , while leading integrated suppliers, are still removed from

the end-user. For frac'ing, currently no one seems to have figured out how to navigate the supply chain. As one source noted, "If [redacted] had a tie-in with a services company that were doing well fracturing, they could certainly solve the equation". Or perhaps [redacted], with its recently-debuted [redacted], if successful, could be playing this difficult-to-navigate supply chain the right way. "Now service companies are looking – is this a market? Is this a product that we can offer a service?"

Several experts believe that engineering is trending toward a more environmentally conscious approach. Although the core drivers of new technology adoption are still regulation and demand from oil services companies, cozying up to the engineering firms is certainly a critical piece of the puzzle.

7.5 Market share estimates

[redacted], [redacted] and [redacted] hold the majority of the market share for produced water treatment in the U.S., with serial-acquirer, [redacted], by far the dominant player. The tertiary/desalination sector is less concentrated than the primary/secondary treatment sector. This reflects the fact that both oil sands and tight gas have opened up the market to smaller companies offering recycling solutions.

Obtaining reliable market share data is difficult. The best we can do is to ask different market participants of their impression of the share of different suppliers and to collate this information to obtain a best estimate of the situation. It is complicated by the fact that the market is lumpy – a company may do a $40 million project one year, then nothing for two years. We have tried to deal with this problem by taking a notional average market share over a three year period.

Figure 7.10 Estimated market share of primary and secondary treatment equipment in North America

Source: GWI

Figure 7.11 Estimated market share of tertiary treatment equipment in North America

Source: GWI

7.6 Future market growth

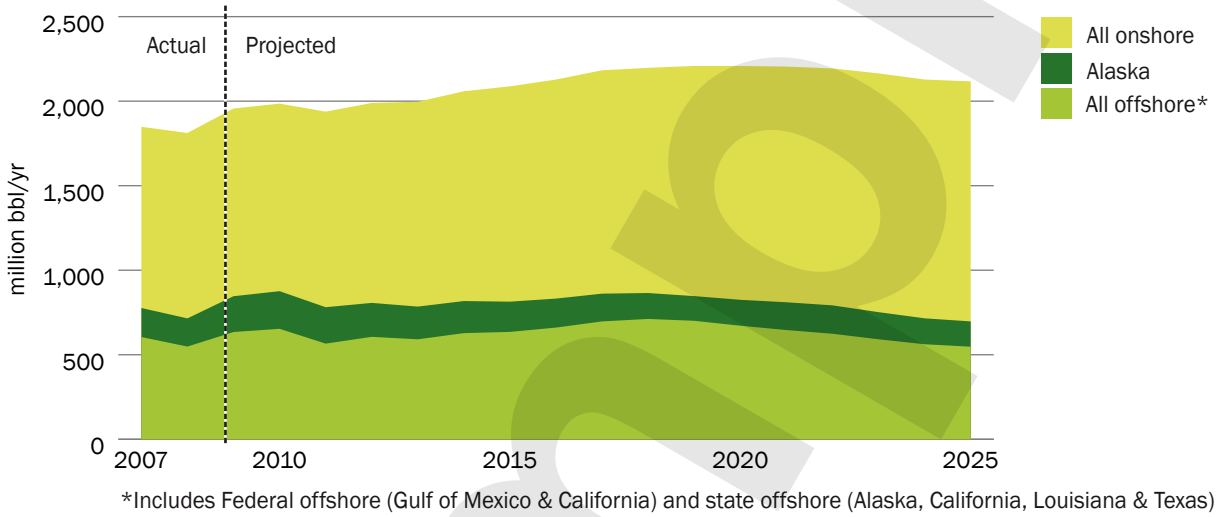
The market for produced water treatment is a function of the following drivers:

- Future oil and gas production
- The oil to water and gas to water ratio in the formation
- The additional process water requirement required by unconventional oil and gas production
- The economics of reusing produced water in comparison to the alternatives

7.6.1 Future oil and gas production

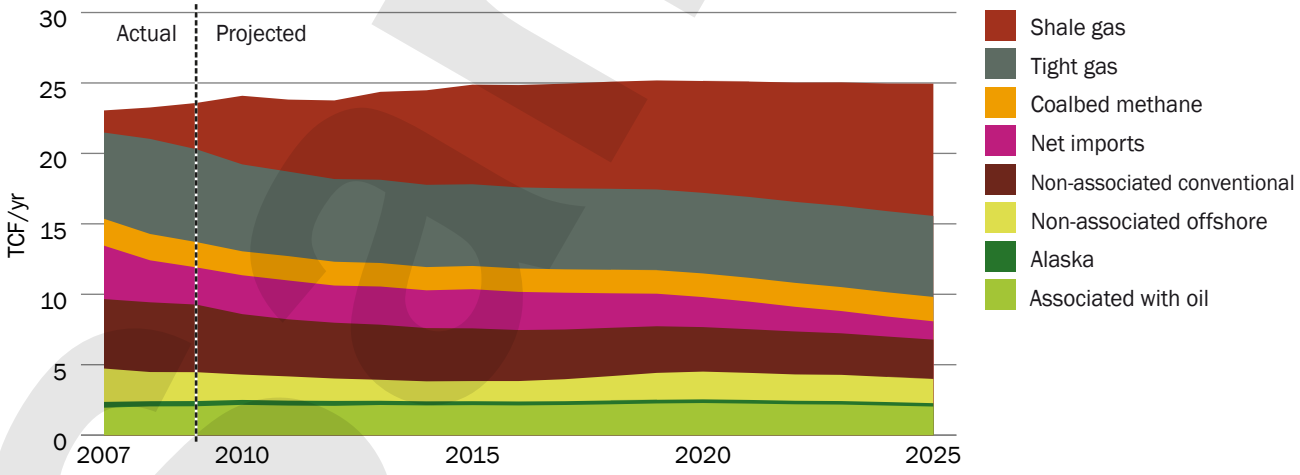
The U.S. Energy Information Agency and the Canadian National Energy Board publishes forecasts of expected energy production going forward. The data for the period 2007 to 2025 is shown below:

Figure 7.12 U.S. crude oil production forecast, 2007-2025



Source: Annual Energy Outlook 2011, Reference case, U.S. Energy Information Agency, 2011

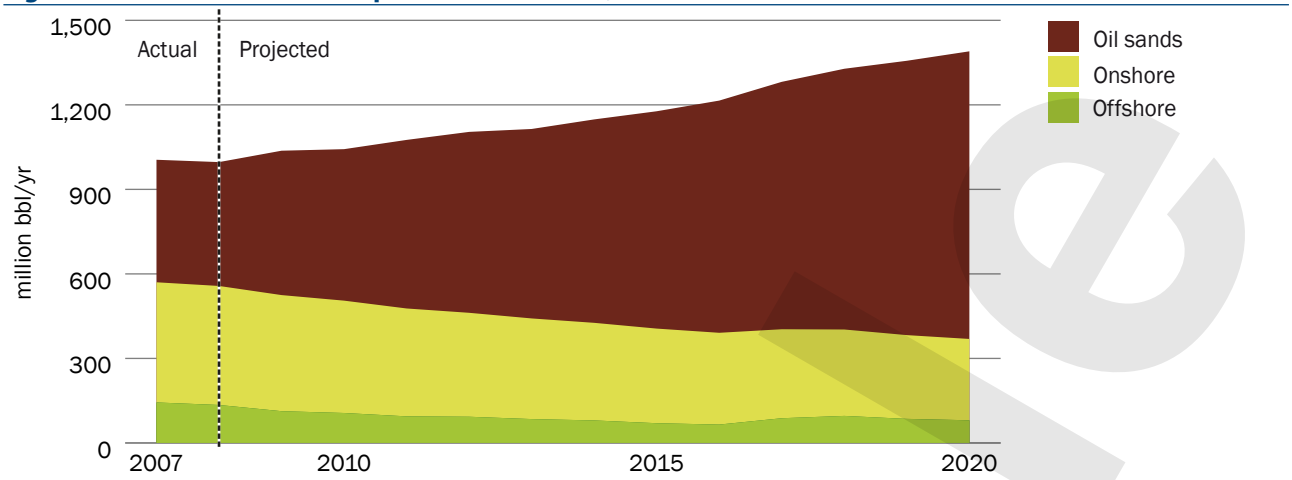
Figure 7.13 U.S. gas production forecast, 2007-2025



Source: Annual Energy Outlook 2011, Reference case, U.S. Energy Information Agency, 2011

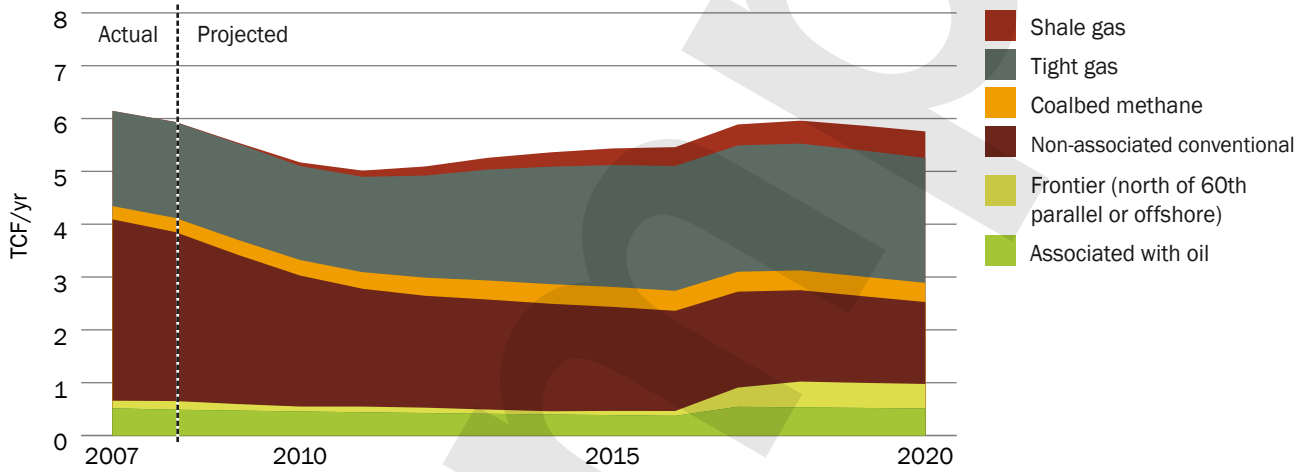
The Canadian National Energy Board provides the following forecasts for oil and gas production:

Figure 7.14 Canadian crude oil production forecast, 2007-2020



Source: Canadian energy demand and supply to 2020, Reference case, Canadian National Energy Board, 2009

Figure 7.15 Canadian gas production forecast, 2007-2020



Source: Canadian energy demand and supply to 2020, Reference case, Canadian National Energy Board, 2009

Combining the two forecasts, together with information from the Canadian Association of Petroleum Producers (CAPP) for the period 2005-2025 and some GWI estimates, gives the following forecasts for North American oil and gas production:

Figure 7.16 North American oil production forecast, 2007-2025

Sources: Canadian energy demand and supply to 2020, Reference case, Canadian National Energy Board; Annual Energy Outlook 2011, Reference case, U.S. Energy Information Agency; CAPP Canadian crude oil production forecast 2010 - 2025, published May 2010 by the Canadian Association of Petroleum Producers

Figure 7.17 North American gas production forecast, 2007-2025

Sources: Canadian energy demand and supply to 2020, Reference case, Canadian National Energy Board; Annual Energy Outlook 2011, Reference case, U.S. Energy Information Agency; GWI

7.6.2 Produced water volumes

The relationship between the volumes of oil and gas brought to the surface and the amount of produced water lifted at the same time is complicated. There will be a different ratio for each well, depending on the geological conditions and the age of the well, and this ratio will change over time. The most complete survey of the matter was carried out by John Veil of the Argonne National Laboratory in 2009. Some states do not collect complete data on produced water which makes it difficult to reach a definitive figure. The report suggests that the total volume of produced water from the U.S. was 20.995 billion barrels a year in 2007, with the national average Water to Oil Ratio (WOR) of 7.6 barrels of produced water per barrel of crude for onshore production. If off-shore production is also included, the ratio falls to 5.3:1.

We have used this as the starting point for estimating the volume of produced water brought to the surface. We have then projected growing WORs going forwards (to take account of aging wells) and used typical WGRs for different resources, to reach a forecast for total produced water. For shale gas (where frac water is proportional to the number of wells drilled), we analysed individual well production databases from the major shale plays to come up with functions that described both the number of wells drilled each year, and the quantity of shale gas produced by older wells.

Figure 7.18 North American produced water volumes 2007-2025

Source: GWI

Figure 7.19 North American produced water volumes, 2010-2020

Produced water volume (billion bbl/yr)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
On-shore crude											
Off-shore crude											
Oil sands											
Natural gas											
Shale gas											
Coal bed methane											
Total											

Source: GWI

7.7 Forecasting produced water expenditure

The produced water volume figures are most useful in forecasting the level of operating expenditure associated with produced water management. This is not least because much the cost is related directly to the energy consumed lifting, pumping and reinjecting the water.

Figure 7.20 Produced water management market forecast, 2007-2025: Operating costs versus capital costs

Source: GWI

Figure 7.21 Produced water management market forecast, 2007-2025: Breakdown by activity

Source: GWI

Figure 7.22 Produced water management market forecast, 2010-2020: Data table

Produced water market ($bn)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Minimisation											
Lifting, pumping, reinjection											
Treatment											
Off-site disposal											
Total											

Source: GWI

Capital expenditure on treatment equipment is not directly associated with the volume of produced water coming to the surface. It is primarily a function of additional capacity brought on line as well as regulation, and the alternatives for disposal. At some point in future it may also be a function of the value of potable water to other users as well, although this is not yet a driver of expenditure. These issues are covered in detail in other chapters of this report.

Figure 7.23 The produced water treatment equipment market, 2007-2025: Conventional oil including EOR

Source: GWI

Figure 7.24 The produced water treatment equipment market, 2007-2025: Conventional and tight gas

Source: GWI

Figure 7.25 The produced water treatment equipment market, 2007-2025: Oil sands processing

Source: GWI

Figure 7.26 The produced water treatment equipment market, 2007-2025: Shale gas

Source: GWI

Expenditure on desalination equipment for the coal bed methane market is likely to be lumpy. Although there may be a steady sale of reverse osmosis systems and equipment, occasionally there will be larger projects possibly involving high recovery desalination projects. This explains why the curve for desalination equipment is so irregular.

Figure 7.27 The produced water treatment equipment market, 2007-2025: Coal bed methane

Source: GWI

Consolidating these forecasts gives the following breakdown according to the different resources:

Figure 7.28 The produced water treatment equipment market, 2007-2025: By resource type

Source: GWI

Consolidating these forecasts gives the following breakdown according to the different treatment types:

Figure 7.29 The produced water treatment equipment market, 2007-2025: By treatment type

Source: GWI

Figure 7.30 The produced water treatment equipment market, 2010-2020: Data table

Conventional oil ($m)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Primary and secondary											
Tertiary											
Desalination (general)											
Desalination (EOR)											
Conventional and tight gas ($m)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Primary and secondary											
Tertiary											
Desalination											
Oil sands ($m)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Primary and secondary											
Tertiary											
Desalination											
Shale gas ($m)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Primary and secondary											
Tertiary											
Desalination											
Coal bed methane ($m)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Primary and secondary											
Tertiary											
Desalination											
Other equipment including monitoring and control											
Total ($m)											
Summary by resource ($m)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Conventional oil											
Oil sands											
Conventional and tight gas											
Shale gas											
Coal bed methane											
Total (excluding monitoring and control)											

Summary by treatment type ($m)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Primary and secondary											
Tertiary											
Desalination											
Other equipment including monitoring and control											
Total ($m)											

Source: GWI

The operating costs by treatment type are as follows:

Figure 7.31 Produced water treatment operating costs, 2007-2025: By treatment type

Source: GWI

7.8 Operating services

Although energy consumption is the largest operating expense in terms of the overall produced water management market, chemicals and outsourced operating services are also significant items.

Chemicals services represent around 13% of total operating costs. Typically chemical suppliers (such as) have staff on site to manage and monitor chemical use. Supply contracts include the cost of this service as well as the cost of the chemicals themselves. Managing produced water treatment chemical supplies is likely to be a subset of a larger contract to manage chemical supplies for a production location.

Figure 7.32 The produced water chemicals market, 2007-2025

Source: GWI

Increasingly specialist water outsourcing companies are emerging on the market. This is particularly true of the **shale** market where temporary treatment facilities are required. As the desalination market grows it is likely that this market will grow too. Desalination facilities require specialist expertise, and it is likely that there will be demand for third party owned and managed desalination plants, possibly with the responsibility for environmental compliance outsourced as well.

We would estimate that the current annual value of produced water treatment plants is currently in the region of $ million.

Figure 7.33 The produced water outsourced treatment operations market, 2007-2025

Source: GWI