EWEA
THE EUROPEAN WIND ENERGY ASSOCIATION

Saving water with wind energy

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Saving water with wind energy

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Content

“Water is no longer the problem of a few regions, but now concerns all 500 million Europeans”
The European Commission[1]

Introduction

Water is a precondition for life, an indispensable resource for the economy, and it plays a fundamental role for the climate.

Each EU citizen consumes 4,815 litres of water per day on average, including direct water use (household consumption) and indirect water use (water required to produce industrial and agricultural products) (Vanham & Bidoglio, 2013). All these uses include energy production.

Water security is a major policy challenge: According to the OECD's report 'Water security for better lives' (2013), 40% of the world's population will face severe water stress conditions by 2050. Increasing water demand, water pollution and water stress will worsen water security in many regions worldwide. The OECD's report called on governments to speed up efforts to enhance efficiency and effectiveness in water management.

At least 11% of Europe's population had been affected by water scarcity by 2007, with the cost of droughts in Europe over the past thirty years at €100 billion, according to the European Commission.

The main overall objective of EU water policy is to ensure access to good quality water in sufficient quantity for all Europeans, and to ensure the good status of all water bodies across Europe[2]. The EU's Water Framework Directive aims to integrate more efficient use of water into broader European policies and strategies on energy, transport, agriculture, fisheries, tourism and others (Directive 2000/60/EC of the European Parliament and of the Council).

Of all the water used[3] directly and indirectly in the EU, the highest amount – 44% – is used in power production primarily to cool thermal or nuclear power plants (EEA, 2009). Such plants are contributing to Europe's water scarcity, and with more frequent droughts and the reduction of water resources in the south and east of Europe in the future, there will be an increasing need to minimise the European power sector's water consumption.

A new joint JRC/ University of Kassel report[4] (2014) confirmed that severe and persistent droughts are expected to appear more often and intensively in Europe, particularly the southern parts, due to climate change. The urgency of putting in place sustainable water resource management techniques and effective adaptation strategies is highlighted in the report.

Given the fact that water scarcity is pressing and will be exacerbated by climate change and population growth in the near future, it is vital to preserve water resources.

1 http://ec.europa.eu/environment/water/quantity/scarcity_en.htm
2 http://ec.europa.eu/environment/water/index_en.htm
3 With water used we mean water abstracted.
4 http://www.hydrol-earth-syst-sci.net/18/85/2014/hess-18-85-2014.html

Wind energy uses virtually no water. Replacing thermal and nuclear power stations with wind energy is therefore a key step in the fight to conserve and protect Europe's precious water resource and hedge against future power shortages due to water-dependent electricity production.

Key findings for Europe:

- Energy production (primarily cooling water) uses the highest amount of water in the EU (44%). The water used by thermal electricity generation and nuclear is equivalent to the average annual household water use of 82 million EU citizens or the population of Germany[5];
- Wind energy avoided the use of 387 million cubic metres (mn m^3) of water in 2012 - equivalent to the average annual household water use of almost 7 million EU citizens;
- The 387 mn m^3 of water use avoided by wind energy would avoid a cost of €743 mn;
- In 2030 wind energy will avoid between 1.22 bn m^3 and 1.57 bn m^3 of water according to calculations based on the EC 2050 Energy Roadmap's projections;
- In 2030, avoided costs of water use from increased wind energy deployment would amount to between €3.34 bn and €4.30 bn that year.

[5] This is based on an average annual water consumption of 55 m^3 per EU citizen only related to household use (various sources: [1], [10], [11] and [19]).

Policy recommendations

The EU could drastically reduce water consumption from the electricity sector in three ways:

Promote higher water efficiency standards and take water efficiency into account when designing future energy policies

The water efficiency of power plants should be taken into account in energy and climate policies. The European Commission should assess, when preparing proposals for a 2030 climate and energy framework, the impacts of energy policies on absolute and per kWh water use. Given the significant impacts of climate change on water resources in many EU Member States, water efficiency will become a key issue for the security of energy systems in the long term. Water availability, efficiency and use should therefore become a part of future assessments of electricity system security.

Set 2030 binding renewable energy targets. Move away from water-intensive technologies like thermal power plants to technologies such as wind energy which use virtually no water

Policy measures favouring water-intensive thermal plants, such as subsidies for fossil fuel or nuclear, should be ended immediately.

To maximise wind energy's water protection benefits – as well as its other benefits such as fossil fuel import reduction, job creation and CO_2 emission reduction – the EU must put in place an ambitious post-2020 EU climate and energy framework including an ambitious binding renewables target for 2030.

Promote adequate pricing of water usage and consumption

Water withdrawal for power plant cooling constitutes a service provided by a given ecosystem – e.g. a river. This service is not always properly priced and therefore is a subsidy, despite the potential negative impacts on that ecosystem (warmer water, alterations to fauna/flora, physical modification of riverbeds etc). It also disregards use of that service for other purposes, such as agriculture/irrigation, leisure and fishing.

This service constitutes an environmental cost that needs to be taken into account by power plant operators. EWEA recommends that an appropriate pricing system for water usage and water consumption be introduced in countries that do not already have one. This will help finance the preservation of ecosystems and level the cost playing field with technologies that do not require water services. The pricing should be proportional to the per-kWh use/consumption of water and take into account regional differences, especially risks of drought.

Water consumption per energy technology

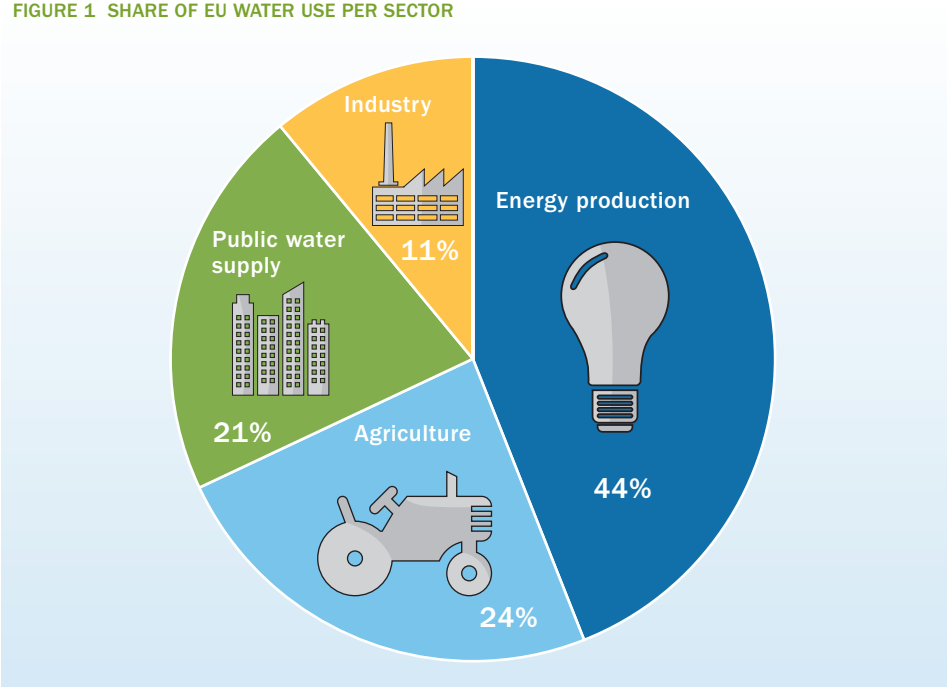
Power production uses water in two main ways: 1. Water ‘consumption’: water is taken permanently from a source, typically to be evaporated or transported to another location. 2. Water ‘withdrawal’: water is withdrawn temporarily from the ground or diverting a surface source like a river or lake, and then returned to its origin. Water withdrawal is generally associated with technologies such as hydropower.

Power production is the activity which uses the highest amount of water in the EU (44%), primarily for cooling purposes, followed by agriculture (24%). Public water supply and industry have lower shares. In energy production almost all cooling water is restored to a water body at a higher temperature while in agriculture the amount is just a third.

Surface water is the predominant freshwater[6] resource across Europe since it can be easily used in large volumes and at a reasonably low cost. Of the total water used, 81% comes from surface water supply. All use for energy production as well as more than 75% for industry and agriculture comes from surface sources while public water supply is from groundwater resources due to higher quality standards.

Electricity generation is expected to be affected by future decreased rainfalls and higher temperatures. It has been already impacted in the past in various locations across Europe during very warm summers (EEA, 2009).

FIGURE 1 SHARE OF EU WATER USE PER SECTOR



Source: EEA, 2009

[6] Sources of freshwater include surface water (lakes, rivers) and groundwater, desalinated water, collected rainwater and re-used water.

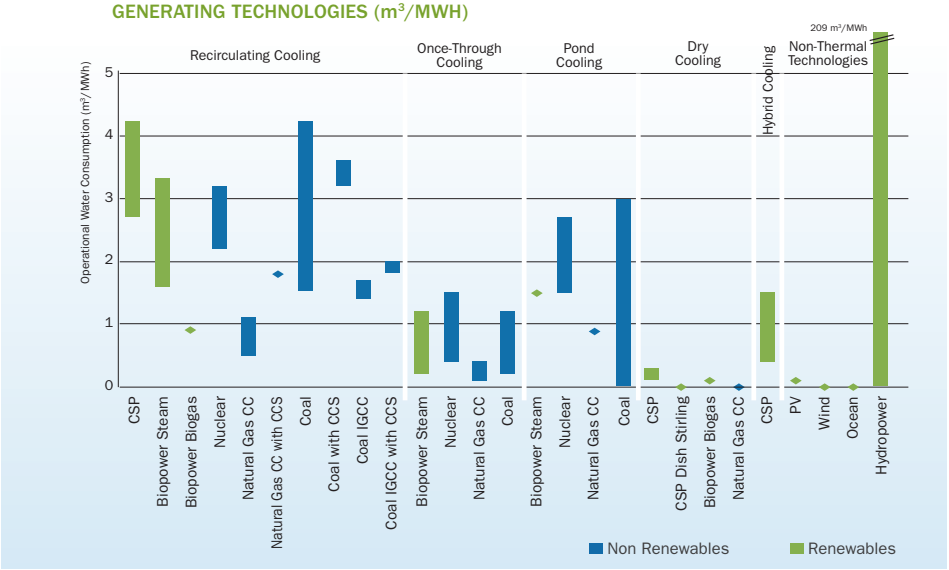
Water consumption for cooling in power generation varies according to the type of system and generation technology. The choice of the cooling system is often site-specific and depends on water availability, local environmental regulations and other factors. Non-thermal technologies (such as wind or PV) have the lowest operational and lifecycle water consumption of water per unit of electricity generated. Wind turbines, for instance, might only need water for cooling purposes (generator, transformer, inverter) and occasional blade washing (US DOE, 2006) – and even then, the blades are already washed by the rain.

On the other hand, estimates of water use for gas power plants are around 0.7 m^3/ MWh, for coal estimates range between 1.7 to 2 m^3/ MWh and for nuclear 2.7 m^3/ MWh[7].

The average water consumption rates from SRREN are also in line with analysis conducted by Vestas in 2009[8] (0.7 m^3/MWh for natural gas combined cycle plants, 2.7 m^3/MWh for nuclear power plants and 1.7 m^3/MWh for supercritical pulverised coal power plants).

Consequently, it is possible to estimate that the average water consumption of coal power plants is 1.9m^3/MWh, water consumption of gas plants is 0.7m^3/MWh and of nuclear is 2.7 m^3/MWh.

FIGURE 2 OPERATIONAL WATER CONSUMPTION BY THERMAL AND NON-THERMAL ELECTRICITY GENERATING TECHNOLOGIES (m^3/MWH)



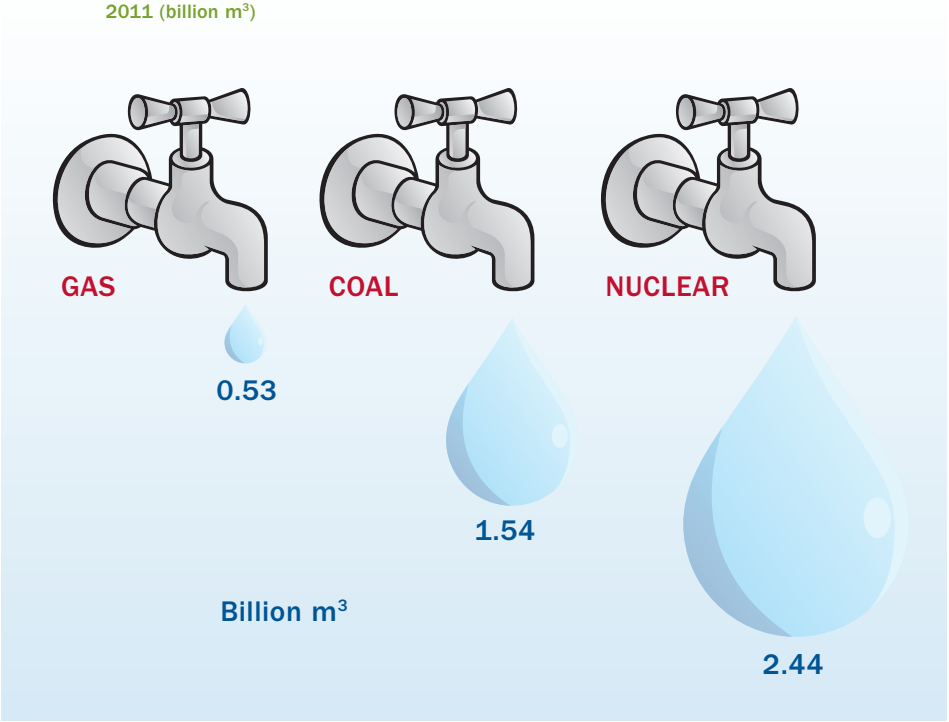
Source: IPCC, SRREN 2011

[7] As outlined in the Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) in 2011

[8] http://www.vestas.com/en/about-vestas/strategy/political-affairs/water-energy-climate-nexus.aspx

Based on data from Eurostat and the European Environment Agency[9], we estimate that 830 TWh of electricity was produced from coal power plants, 758 TWh from gas and 902 TWh from nuclear in 2011. With the average water consumption rates of the three technologies, gas generation used 531 million m^3 of water, coal generation used 1.5 bn m^3 of water and nuclear generation 2.4 bn m^3 in 2011, a total of 4.5bn m^3. This is equivalent to the average annual household water use of 82 million EU citizens.

FIGURE 3 FOSSIL FUEL AND NUCLEAR ENERGY ANNUAL WATER CONSUMPTION IN THE EU 27, 2011 (billion m^3)



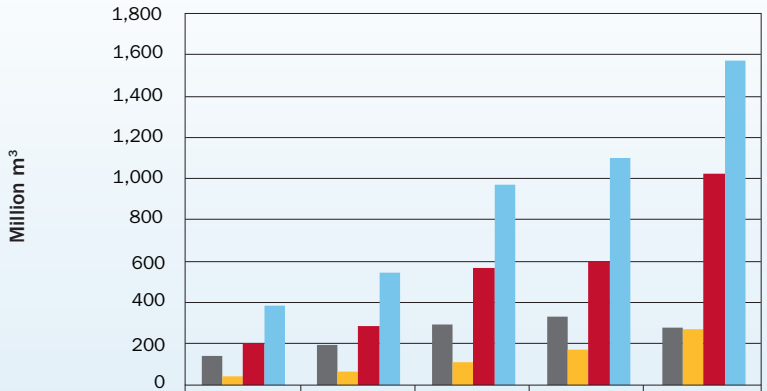
Source: Eurostat, 2013

[9] Gross electricity production in the EU-27 was 3,280 TWh in 2011 according to Eurostat. The European Environment Agency, in a 2012 report, calculates that nuclear has a 27.5% share of gross electricity production in the EU, coal a 25.3% share and gas a 23.1% share. http://www.eea.europa.eu/data-and-maps/indicators/electricity-production-by-fuel-1/electricity-production-by-fuel-assessment-3#toc-1

Avoided water use and water cost by wind energy

Wind energy avoided the use of 387 mn m^3 of water in 2012[10], equivalent to the average annual household water use of 7 million EU citizens. The European Commission's Roadmap 2050 forecasts that wind energy will produce between 313 TWh of electricity (Current Policy Initiatives 'CPI' scenario) and 331 TWh (High Renewables scenario) in 2015. By 2030, wind energy will produce between 807 TWh and 1,198 TWh. Assuming that wind energy replaces a mix of fossil fuel and nuclear generation, it will avoid the consumption of 514 mn m^3 to 543 mn m^3 of water per year by 2015, and between 1.22 bn m^3 and 1.57 bn m^3 per year by 2030.

FIGURE 4 WATER USE AVOIDED BY WIND ENERGY (HIGH RENEWABLES SCENARIO)

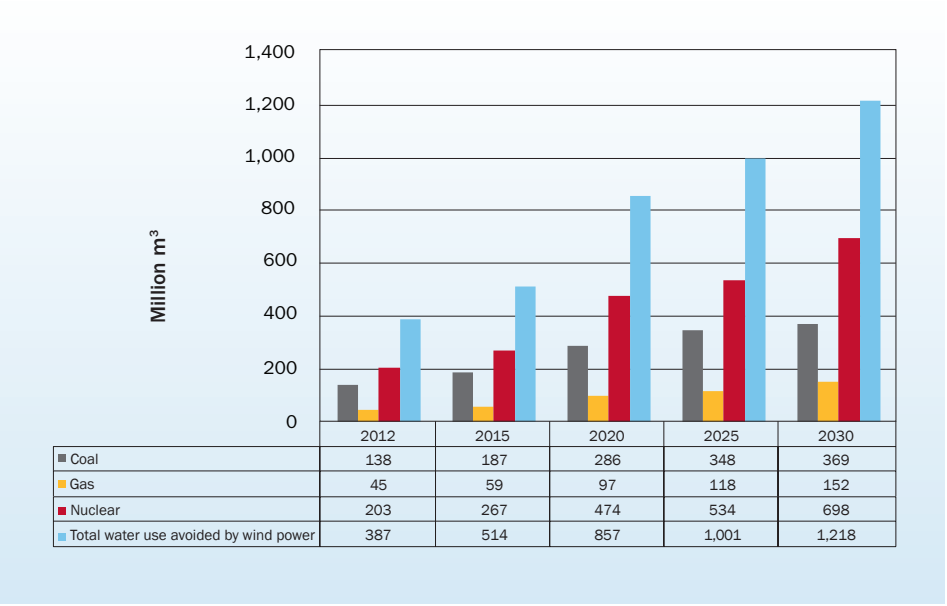


	2012	2015	2020	2025	2030
Coal	138	197	295	335	278
Gas	45	62	112	169	269
Nuclear	203	285	565	598	1,024
Total water use avoided by wind power	387	543	973	1,101	1,571

Source: EWEA based on European Commission Energy Roadmap 2050

[10] More information on the calculation, see annexe.

FIGURE 5 WATER USE AVOIDED BY WIND ENERGY (CURRENT POLICY INITIATIVES SCENARIO)

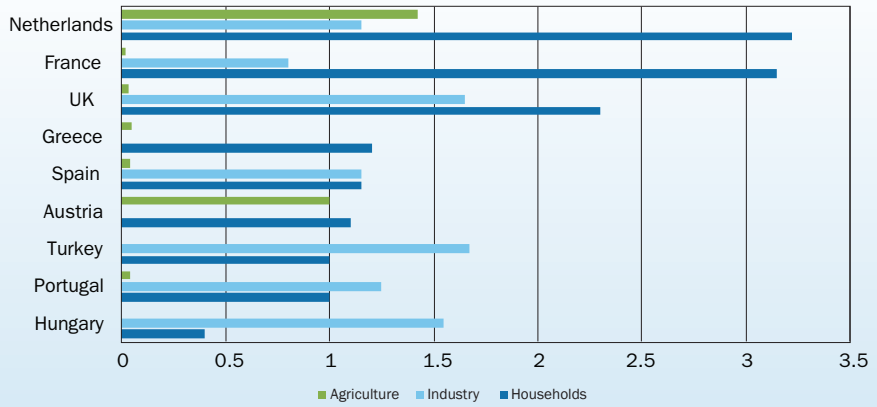


	2012	2015	2020	2025	2030
Coal	138	187	286	348	369
Gas	45	59	97	118	152
Nuclear	203	267	474	534	698
Total water use avoided by wind power	387	514	857	1,001	1,218

Source: EWEA based on European Commission Energy Roadmap 2050

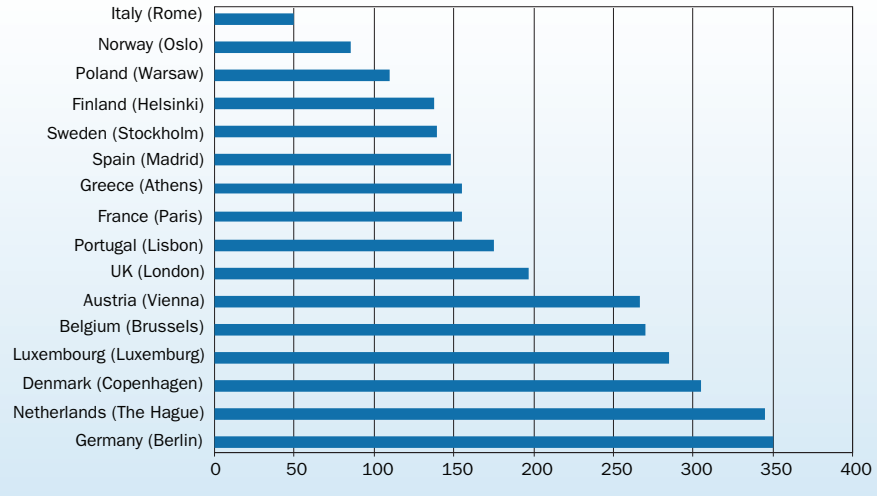
The European Environment Agency publishes water prices in different economic sectors (agricultural, industrial and households). However, determining an average cost for water consumption across the EU is complex due to the lack of comparable information. Based on Fig. 6, we averaged a water price for industrial use of €1.4 per m^3 in the late 1990s. Assuming a 2% annual index, a reasonable estimate for today is €1.92 per m^3.

FIGURE 6 COMPARISON OF AGRICULTURAL, INDUSTRIAL AND HOUSEHOLD WATER PRICES IN LATE 1990s (€/m³)



Source: EEA

FIGURE 7 COST OF WATER FOR TYPICAL HOUSEHOLD (200 m³ PER YEAR) IN A SELECTION OF EU MEMBER STATES IN 1998 (€)



Source: EEA

Assuming that water price will not increase significantly beyond indexation (2% annually) it is estimated that it will be €2.74 per m³ by 2030.

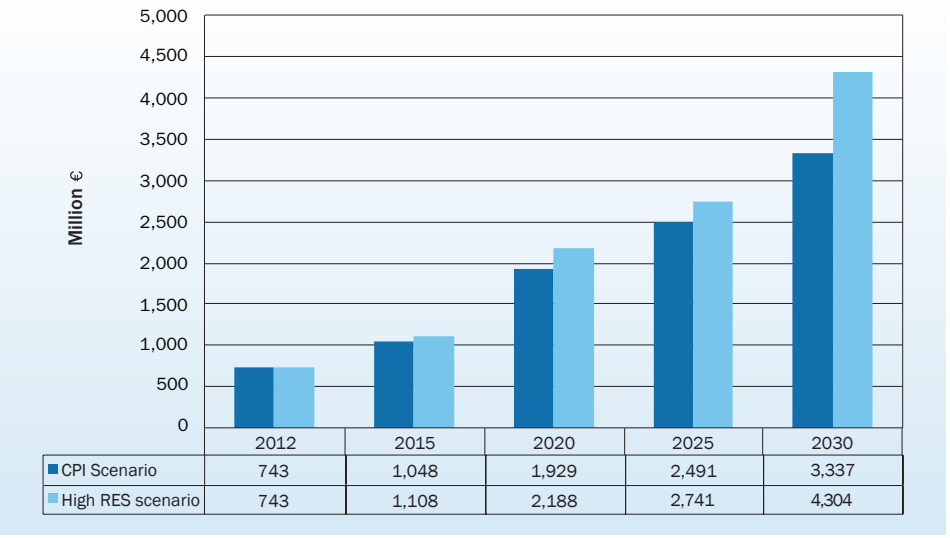
TABLE 1 ASSUMPTIONS ON FUTURE WATER PRICE (€/m³)

Year	Water price (€/m³)
2012	1.92
2015	2.04
2020	2.25
2025	2.49
2030	2.74

Source: EWEA based on EEA

Taking wind energy production figures from the Roadmap 2050 and the cost estimates for water in Table 1, wind energy will avoid between €1.05 bn and €1.11 bn in water costs a year by 2015, €1.93 bn and €2.2 bn a year in 2020 and between €3.34 bn and €4.30 bn a year in 2030.

FIGURE 8 TOTAL COST OF WATER AVOIDED BY WIND POWER (HIGH RES/CPI SCENARIOS, EC ROADMAP)



Source: EWEA based on European Commission Energy Roadmap 2050, EEA

Annex
Calculating avoided water use

m^3 of water consumed per MWh produced	
Nuclear	2.7
Coal	1.9
Gas	0.7

Wind generation (MWh)	2012	2015	2020	2025	2030
High RES	230,810,000	331,000,000	613,000,000	785,000,000	1,198,000,000
CPI	230,810,000	313,661,100	539,317,990	633,590,770	807,354,600

Source: 2012 EWEA, 2015 to 2030 European Commission Roadmap to 2050

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EWEA is the voice of the wind industry, actively promoting wind power in Europe and worldwide. It has over 600 members from almost 60 countries, including wind turbine manufacturers with a leading share of the world wind power market, plus component suppliers, research institutes, national wind and renewables associations, developers, contractors, electricity providers, finance and insurance companies, and consultants. This combined strength makes EWEA the world's largest and most powerful wind energy network.

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