

Picture credits: picture left: pumped-storage power plant Häusern, picture on the top right: pumped-storage power plant Wehr, both with kind permission of the Schluchseewerk AG. Picture at the bottom right: © PantherMedia / Scott Prokop.

# The World Market for Pumped-Storage Power Plants

**Extract**

Market volumes – projects – strategies – trends

Cologne, May 2013

## **The World Market for Pumped-Storage Power Plants**

In the next ten years to come, the worldwide market for pumped-storage power plants will grow stronger than ever before. More than 100 new plants with an installed capacity of about 74 Gigawatts will be developed by 2020 – which is around 50 per cent of the plants existing today and adds up to an investment volume of about 56 billion euros. When also considering the upcoming maintenance measures, the investment volume will even increase to over 73 billion euros.

The main reasons for the emerging boom are the globally increasing share of renewable energies of the total electricity production as well as the construction of new coal and nuclear power plants especially in Asian countries. New pumped-storage power plants will be constructed for the intermediate storage of electricity from these fossil power plants and for the fluctuating generation particularly of wind and solar power.

Asia is the largest growth market. Above all, the market will be characterised by what is happening in China – the country alone will account for about a third of the global market volume. Further strong markets can be found in Europe and the USA where the development of renewable energies will be the main market factor. Due to the comparatively old age of the American and, in some cases, European plants, maintenance measures will play an ever stronger role there.

In light of this development, ecoprogram GmbH has analysed the worldwide market for pumped-storage power plants in detail. We have not only included our own market knowledge in this study but also the expertise of public authorities, associations, operators and plant manufacturing companies.

This detailed research and up-to-date analysis of numbers, facts, estimations and trends of the worldwide market for pumped-storage power plants is of interest for manufacturers, suppliers, operators, disposal companies, business associations, research institutes and consultants.

### **The study “The World Market for Pumped-Storage Power Plants” includes:**

- A detailed analysis of the essential political, economic, managerial and technical trends for the construction and operation of pumped-storage power plants.
- A precise description of the present and the future market volumes by countries, up to and including 2020, based on a transparent and comprehensible methodology.
- A presentation of all existing (about 350) pumped-storage power plants active throughout the world with a total capacity of more than 152 GW, including essential technological data and contact addresses.
- A project list with more than 250 planned new construction projects, more than 30 of which are already under construction and over 200 of which are currently being planned or discussed. They have a total installed capacity of more than 170 GW.
- An analysis and description of the most important operators and plant manufacturers of pumped-storage power plants.

The study is available **in English and German from 3,900,- euros plus VAT.**

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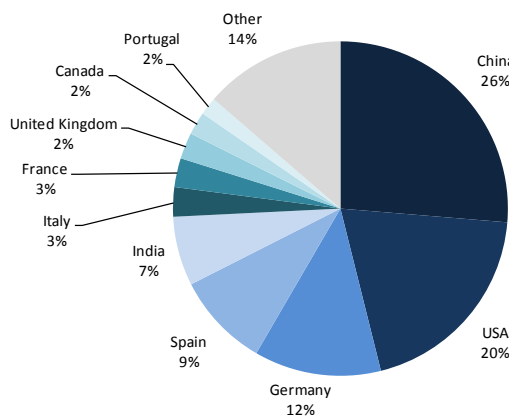
### 4.2 New pumped-storage power plants needed for development of renewable energies

In the past, the development of thermal base load power plants especially necessitated the construction of pumped-storage power plants. In the future, the development of renewable energies will have the same effect.

Renewable energies are being developed throughout the world. Wind power in particular should generate the main part of the electricity production from renewable energy sources in many countries. The problem of wind power is to generate electricity according to the demand. Electricity generation from wind power can vary significantly hourly, daily and seasonally. This is why new storage options are needed – most of these are planned to be pumped-storage power plants.

**Figure 16: Wind power plants as growth factor for pumped-storage power plants**

Allocation of the installed capacities from wind power 2011:



Source: World Wind Energy Association WWEA 2012.

Country	2011 [MW]	Growth rate 2011 [%]
China	62,364	39
USA	46,919	17
Germany	29,075	7
Spain	21,673	5
India	15,880	22
Italy	6,737	16
France	6,640	17
UK	6,018	16
Canada	5,265	31
Portugal	4,083	10
Other	32,359	20

The problem that countries with a large share of wind power plants can in some cases not utilise the generated electricity already occurs today. Storage opportunities are especially missing in times with a low electricity demand and strong wind (during the night, for instance). Forced switch-offs of wind power plants already happen in some countries in order to compensate the load curve and relieve the grids.

However, the share of electricity from wind power plants of the total electricity generation will increase significantly throughout the world by 2020. Besides onshore wind power plants, new renewable electricity generation sources should especially be developed through offshore wind parks. Ambitious forecasts expect the installed capacities in China and the USA to amount to up to 150 GW in 2020. According to the German Federal Government, 10,000 MW should be installed in the country in offshore projects by 2020 and the total installed capacity should increase to about 46 GW. The United Kingdom even wants to install more than 15,000 MW in offshore plants and increase its total capacity to almost 28 GW in 2020. The installed capacity will furthermore increase through the so-called repowering (modernisation and replacement respectively) of old plants.

[...]

### 7.22 Portugal

Inhabitants [million]	10.8	Area [km <sup>2</sup> ]	92,345
Number pumped-storage power plants (PSPP)	7	Capacity existing plants [MW <sub>el</sub> ]	1,190
Number PSPP projects	10	Capacity projects [MW <sub>el</sub> ]	4,540
Share of wind and solar power of total electricity generation *	15%	Share of coal and nuclear power of total electricity generation *	26%
Growth wind and solar power by 2020**	++	Growth coal and nuclear power by 2020**	0

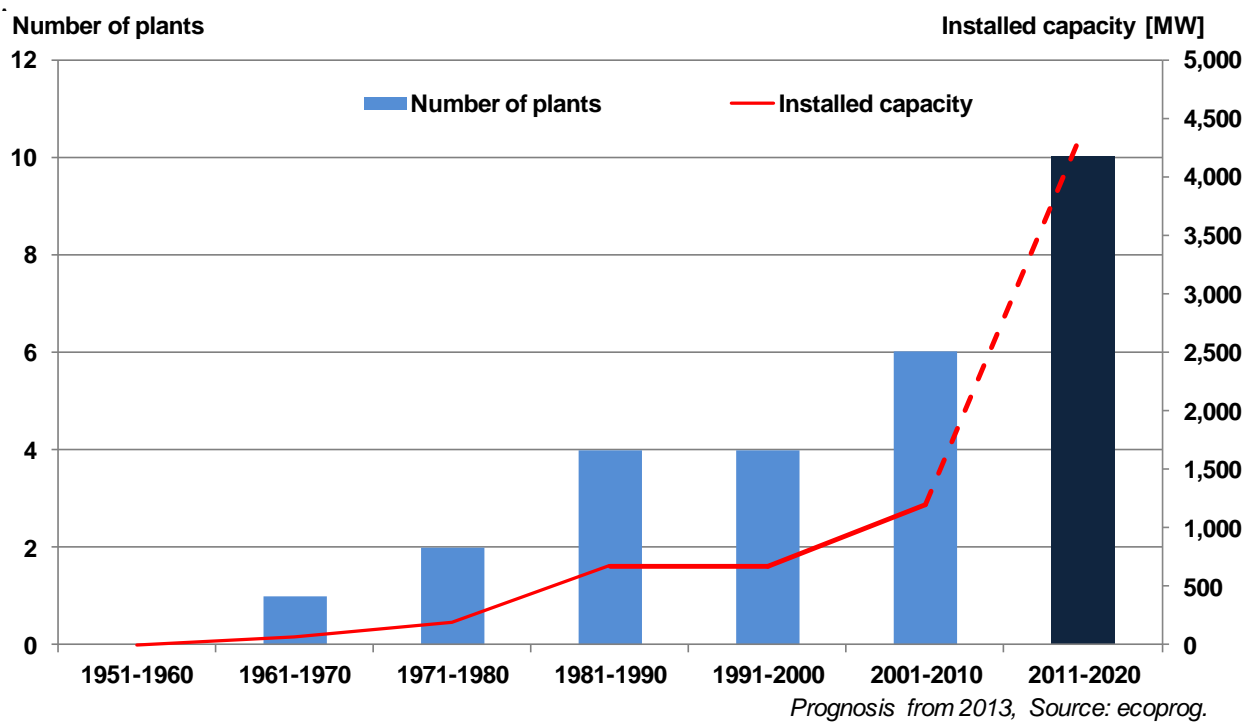
\* According to IEA (as of 2009)

\*\* Estimation of ecoprolog on a scale of - - to + + (interim values: -, 0, +) based on different sources.

#### Management summary

Today, the Portuguese market for pumped-storage power plants is one of the world’s most dynamic ones. The capacity in PSPPs will quadruple by 2020. The main reason for this is the growth of renewable energies and especially of wind and solar power.

Figure 101: Market forecast Portugal



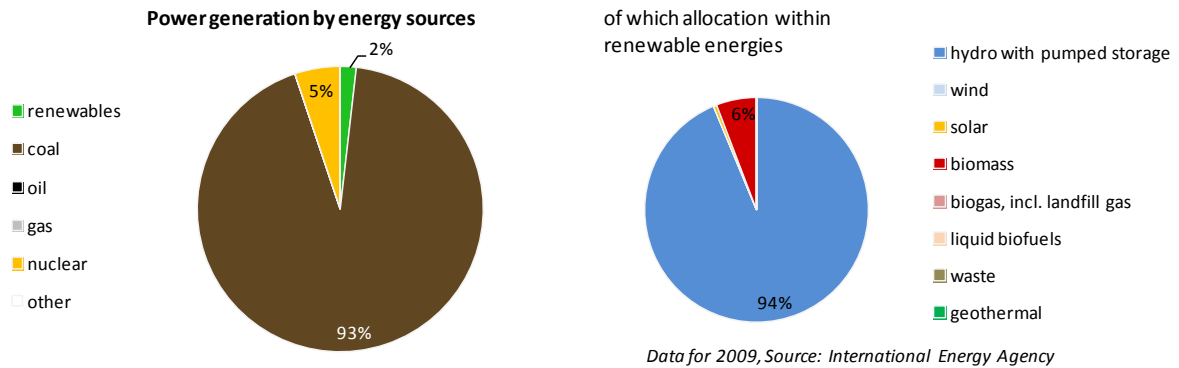
#### Background / market factors / framework conditions

The electricity generation in Portugal significantly depends on imports. The country imports gas, coal and oil. Renewable energies account for almost 40 per cent of the total electricity generation. Water power and wind power are, due to the natural preconditions, the most important renewables.

[...]

[...]

**Figure 151: Power generation by energy sources in South Africa**



Plants

In early 2013, three pumped-storage power plants with a total installed capacity of 1,580 MW were operational in South Africa. All of the plants were build and commissioned in the 1970s and the 1980s.

Drakensberg, the pumped-storage power plant with the the largest installed capacity, started operation in 1981 between Johannesburg and Durban. The two smaller pumped-storage power plants are located in the mountains close to Cape Town. They were mainly constructed to compensate the load of the country’s only nuclear power plant Koeberg.

**Figure 152: Pumped-storage power plants in South Africa**

Plant	Capacity [MW]	Operator	Start of operation
Langkloof (Drakensberg)	1,000	Eskom	1970
Palmiet	400	Eskom	1989
Steenbras	180	Cape Town Electricity Services	1979

Market development

After the pumped-storage power plant Ingula with an installed capacity of 1,300 MW is completed in 2014, no further plants of this type will be developed by 2020. Ingula will be the country’s largest PSPP. The costs of the project have tripled since the planning phase. Today, the total investment is estimated to amount to about 2.2 billion euros.

**Figure 153: Project outlook South Africa**

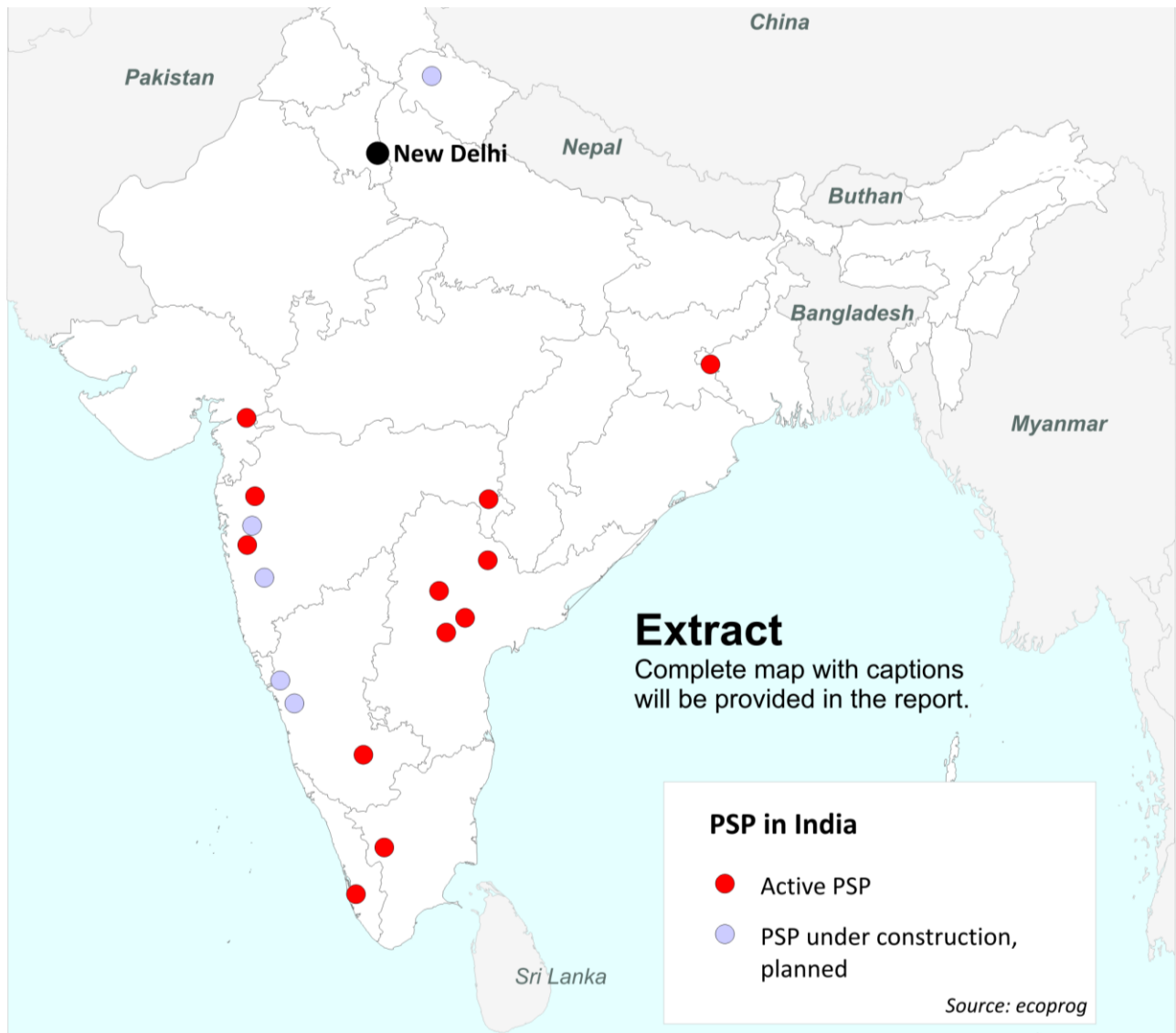
Plant	Capacity [MW]	Status	Start of operation
Ingula	1,332	under construction	2014

[...]



[...]

**Figure 92: Map of pumped-storage power plants in India**



Competition

The pumped-storage power plants are operated by the energy supply companies of the respective federal states. The Andhra Pradesh Power Generation Corporation Limited (APGenco) is the largest operator of PSPPs. The company runs two pumped-storage power plants with a total installed capacity of 1,700 MW. The remaining operators only have one plant in their power plant portfolio. The largest among them is Sardar Sarovar Narmada Nigam Ltd. with the pumped-storage power plant Sardar Sarovar with an installed capacity of 1,450 MW.

Japanese plant manufacturer HMI Hydro is the largest turbine producer in India. They equipped Sardar Sarovar in 2006 and Purulia in 2007 with a total installed capacity of 2,350 MW with Francis pump turbines.

[...]

## Pumped-storage power plants in Germany

[...]

### **Reisach**

Other name: Kraftwerksgruppe Pfreimd  
 Status: active  
 Start: 1955  
 Capacity [MW]: 123  
 Number of turbines: 4  
 Technology: Francis  
 Head [m]: 150

GDF-Suez Kraftwerksgruppe Pfreimd GmbH  
 Seestraße 6  
 92555 Trausnitz  
 Tel: +49 965 57 41  
 Fax: +49 965 58 364  
 kommunikation-pfreimd@gdfsuez-energie.de  
 www.gdfsuez-energie.de

Remarks: The plant has been modernized between 1993-1998: Regulatory zone: E.ON

### **Reschwitz**

Other name: Silbersee  
 Status: discussed  
 Capacity [MW]: 540

Thüringer Energie- und Greentech-Agentur (Thega)  
 Mainzerhofstr. 12  
 99084 Erfurt  
 Tel: +49 361 56 03 220  
 Fax: +49 361 56 03 327  
 info@leg-thueringen.de  
 www.thega.de

### **Riedl**

Other name: Passau  
 Status: planned  
 Start: 2018  
 Capacity [MW]: 300  
 Number of turbines: 2  
 Head [m]: 350  
 Investment costs [Euro]: 350.000.000

Verbund AG (50%); Rhein-Main-Donau AG und E.ON  
 Wasserkraft (50%)

### **Ringingen**

Other name: Ringinger Heufeld  
 Status: refused

### **Rönkhausen**

Status: active  
 Start: 1969  
 Capacity [MW]: 140  
 Capacity pump [MW]: 140  
 Number of turbines: 2  
 Technology: Francis  
 Turbine manufacturer: Andritz Hydro (Sulzer Escher Wyss)  
 Generator manufacturer: Voith Hydro (Siemens Hydro)  
 Head [m]: 270

Mark-E Aktiengesellschaft  
 Körnerstraße 40  
 58095 Hagen  
 Tel: +49 233 11 230  
 Fax: +49 233 11 23 22 222  
 info@mark-e.de  
 www.mark-e.de

Remarks: It is planned (12/2011) to connect the plant to wind power stations. The towers of these wind power stations could be used as additional storage for water.

### **Säckingen**

Other name: Schluchseewerk, Bad Säckingen  
 Status: active  
 Start: 1966  
 Capacity [MW]: 360  
 Capacity pump [MW]: 300  
 Number of turbines: 4  
 Technology: Francis  
 Turbine manufacturer: Andritz Hydro (Sulzer Escher Wyss)  
 Generator manufacturer: AEG  
 Upper basin [km2]: 0  
 Head [m]: 400

Schluchseewerk AG  
 Säckinger Straße 67  
 79725 Laufenburg  
 Tel: +49 776 392 780  
 Fax: +49 776 39 27 87 02 99  
 info@schluchseewerke.de  
 http://www.schluchseewerk.de

Remarks: Regulatory zone: EnBW

### **Sauerland**

Status: planned  
 Capacity [MW]: 400

[....]

## Pumped-storage power plants in in China

[...]

### **Hongping**

Status: under construction

Start: 2015

Capacity [MW]: 1.200

Number of turbines: 4

Turbine manufacturer: Voith Hydro

Generator manufacturer: Voith Hydro

Investment costs [Euro]: 700.000.000

State Grid Corporation of China

No. 86, West Chang'an Street

100031 Xicheng District, Beijing City

sgcc-info@sgcc.com.cn

www.sgcc.com.cn

Remarks: Voith says the initial development phase will be completed in 2015 and bring the plants generating capacity to 1,200 MW, though future development will increase Hongping's capacity to 2,400 MW.

### **Huanggou**

Status: planned

Capacity [MW]: 1.200

Number of turbines: 4

### **Huanren**

Status: planned

Capacity [MW]: 800

Number of turbines: 4

### **Huilong**

Status: active

Start: 2005

Capacity [MW]: 120

Number of turbines: 2

Head [m]: 379

### **Huizhou**

Status: active

Start: 2007

Capacity [MW]: 2.400

Number of turbines: 8

Turbine manufacturer: Alstom Hydro

Generator manufacturer: Alstom Hydro

Head [m]: 532

China Southern Power Grid Co., Ltd

No 6 Huasui Road, Zhujiang Xincheng

510623 Guangzhou, Tianhe District

Tel: +86 203 81 21 080

Fax: +86 203 81 20 189

www.csg.cn

Remarks: Initial units went online between 2007 and 2008. By 2011, the plant was fully operational.

### **Jixi**

Other name: Tongkeng village

Status: under construction

Start: 2016

Capacity [MW]: 1.800

Number of turbines: 6

Technology: Francis

Head [m]: 599

Investment costs [Euro]: 904.000.000

Remarks: Studies were carried out in 2008 and construction began in December 2010. It is expected to last 6 years. The project was financed by State Grid, East China Grid, Jiangsu Electric Power, Shanghai Electric Power, Xuangcheng municipal government and the local government.

### **Jurong**

Status: planned

Capacity [MW]: 1.350

Number of turbines: 6

### **Langyashan**

Status: active

Start: 2007

Capacity [MW]: 1.000

Number of turbines: 4

Head [m]: 363

### **Liaoning**

Other name: Liaoning Kuandian Manchu

Status: active

Start: 2012

Capacity [MW]: 1.200

Capacity pump [MW]: 300

Number of turbines: 4

Technology: Alstom turbine

Remarks: US\$ 712 million project; only one generator online now, the other three are expected to operate by the end of the year

### **Liyang**

Status: under construction

Start: 2015

Capacity [MW]: 1.500

[...]

## Register pumped-storage power plants

Adler Canyon	328	Bargi	173
Aguayo	280	Bath County	328
Agueira	233	Bear Swamp	329
Aldeadávila II	280	Belesar II	280
Alderney	311	Belesar III	280
Alqueva	233	Bellwood	329
Alqueva II	233	Belmeken	99
Altendorf	256	Bendeela	86
Altenfeld	124	Bergwerk August Victoria	124
Alto Rabagão	233	Bheema	160
Ananaigawa	185	Bhira	160
Anapo - Priolo Gargallo	173	Biasca II	256
Andong	295	Bison Peak	329
Apache	328	Bistrica	266
Årdal	206	Bistrica	266
Arolla	256	Bjelimici	95
Atdorf	124	Black Canyon	329
Aurland IV	206	Black Mountain	330
Avce	274	Blaubeuren	124
Azumi	185	Blautal	124
Bad Creek	328	Blechhammer	125
Bad Grund	124	Blenheim-Gilboa	330
Bad Reichenhall	124	Blue Diamond	330
Bailianhe	107	Bolarque II	280
Baishan	107	Bon Air	330
Baixo Sabor	233	Bowydd	311
Bajina Bašta	266	Bragado	234
Balmacaan	311	Brattingfoss	206
Banks Lake	328	Bryant Mountain	330
Banqiaoyu	107	Busko Blato	95
Baoquan I	107	Cabin Creek	331
Baoquan II	107	[...]	[...]

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