Aquila Capital

THE INCREASING IMPORTANCE OF HYDROPOWER IN AN INVESTMENT PORTFOLIO

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Executive summary

- With investors increasingly adopting longer term investment goals and seeing climate change as a priority, investment in renewable energy is on the rise across the world. Solar and wind power are the most well-established renewable technologies in institutional investors' portfolios, in part due to falling costs. Hydropower on the other hand has only gained attention in recent years.
- However, hydropower is the leading renewable source for generating electricity worldwide, supplying around 71% of all renewable electricity.[1] The importance of the development of this technology has increased in recent years, and the number of investment opportunities across the world has grown. In addition to this, hydropower offers a number of advantages to investors, including stable, predictable returns and a significant diversification potential in a renewable energy portfolio. As a result, we believe hydropower is underweighted in the portfolio mix of most renewable energy focused institutional investors.
- Investments in this technology may be more complex to access than in other renewable energy sectors, due to reasons including technical expertise required and higher up-front investment per capacity unit. However, we believe that investors can overcome these challenges and benefit from the increasingly important hydropower sector, by pairing with an experienced asset manager with a strong network and good access to sourcing and securing attractive opportunities in the sector.

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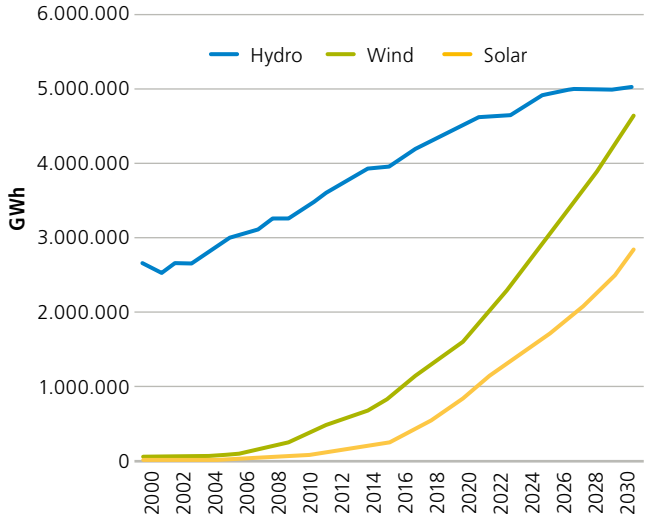
[1] *Source: https://www.worldenergy.org/data/resources/resource/hydropower/*

1. Introduction

Hydropower is one of the oldest and most established energy sources on the planet. Over 2,000 years ago the ancient Greeks began exercising the principle of using water to drive turbines, which generated energy for grinding grain. Today, hydropower continues to account for a significant share of the world's global energy production, and with the world facing an urgent challenge to reduce carbon emissions, the importance of this renewable energy technology is increasing (Figure 1). Hydropower is set to play a great role also in the future of power generation.

Figure 1: World power generation by renewable sources



Source: Bloomberg NEF, IEA, 2018

However, this technology has only gained the attention of institutional investors in recent years. The complexity of accessing investment opportunities in this asset class, versus other renewable energy sectors, is among a few factors that have made investors hesitant towards considering hydropower investments. Nevertheless, with the required technical know-how, hydropower offers investors excellent diversification possibilities, especially within a renewable energy portfolio. This paper discusses hydropower's pivotal role in achieving carbon reduction targets and offers insights into the importance of including hydropower investments in your portfolio. It also presents investment opportunities in three key markets – Scandinavia, Iberia and North America – and provides a close look at Aquila Capital's expertise in this sector.

2. Market overview

Hydropower is a widely used source for generating electricity worldwide, with stations built in approximately 100 countries around the world. In 2018, hydropower comprised a 16.4% share of the world's electricity generation.[2] This share varies significantly from city to city and country to country, and in some cases, hydropower can completely dominate energy sources – for example in Scandinavia, hydropower makes up 97% of the energy mix[3], and in 31 cities across the world, 100% of the electricity is generated from hydropower.[4]

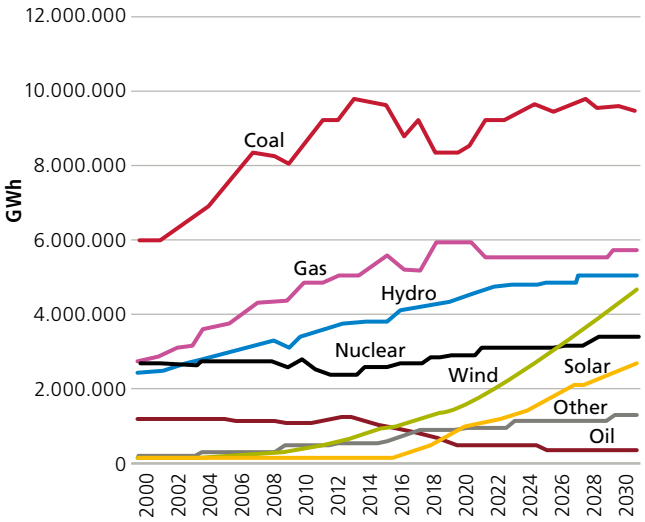
2.1 Hydropower plays a significant role in the renewable energy sector

Within the renewable energy sector, hydropower is the leading source for generating electricity worldwide, supplying around 71% of all renewable electricity.[5] The importance of the growth and development of the hydropower sector has increased in recent years in response to the promotion of renewable energy, in order to help fulfil sustainable development goals.

- Installed capacity and production quantities

In 2018, 7,159 TWh of renewable power was generated. Hydropower accounted for over two-thirds of the renewable energy generated at 4,311 TWh, despite a significant expansion in alternative energy sources including solar and wind.[6] Looking ahead to 2030, hydropower is forecast to hold on to its share in the world's total power generation, amid a rising contribution of power generation expected from solar and wind technologies (Figure 2).

Figure 2: Hydropower leads renewable energy generation



Source: Bloomberg NEF, IEA, 2018

[2] *REN21, 2018*
[3] *Bloomberg NEF, IEA, 2018*
[4] *CDP 2018*
[5] *https://www.worldenergy.org/data/resources/resource/hydropower/*
[6] *Bloomberg NEF, IEA, 2018*

- Renumeration and concessions

Around the world, the remuneration of hydropower plants is typically not subsidised, or even taxed beyond normal taxation. However small plants (with an output below 10 MW) are a frequent exception. Concession periods tend to be long and are normally extended on expiry (Table 1).

Table 1: Support schemes and concession periods in selected regions

Region	Remuneration scheme (mechanism)	Concession period in years
Scandinavia	Electricity market/certificates	60 to perpetuity
Germany/Austria	Electricity market/remuneration	30 to perpetuity
Switzerland	Electricity market/feed-in remuneration	60 to perpetuity
Italy	Electricity market/feed-in remuneration/certificates	30 to perpetuity
Iberia	Electricity market/feed-in remuneration	30 – extendable
North America	Electricity market/power purchase agreement	30 to perpetuity

The above is an illustrative example. Details may vary. Source: Aquila Capital Investmentgesellschaft mbH

3. The importance of incorporating hydropower in an investment portfolio

Investments in renewables have continued to increase each year, signalling investors' strong commitment to addressing climate change and reducing carbon emissions, along with providing long term stable cash flows. The majority of this can be attributed to the falling costs for solar and wind power, which are two renewable technologies that have already become well established in the asset allocations of institutional investors. Hydropower on the other hand, despite being the dominant renewable energy source, has only begun to be considered by institutional investors in the past few years. The following factors are key reasons why investors have been more cautious about this sector:

- Hydropower tends to require significantly higher up-front investment per capacity unit, making it less scalable than wind power or photovoltaic plants.
- The tailor-made nature of hydro power plants also make scalability more difficult.
- The technical know-how required for hydro power investments is more challenging since the success of a power plant depends not only on technical and structural components, but also on active management of the hydro plant and negotiations of power purchase agreements or understanding of merchant risk.
- Accessing investment opportunities is significantly more complex than in other renewable energy sectors.

3.1 Benefitting from diversification

Despite these challenges, hydropower offers many advantages, leading to it securing a significant role in the global renewable energy mix. Key benefits include reliability, proven technology, large storage capacity, and very low operating and maintenance costs. In addition to this, a low correlation with other renewable energies (hydropower exhibits a typical correlation coefficient of below 0.3 to wind and photovoltaic investments), showcases the diversification potential of hydropower. Table 2 illustrates the characteristics and complementary elements of photovoltaic and wind power versus hydropower investments. Given the strong potential for diversification, we believe hydropower is underweighted in the portfolio mix of most renewable energy focused institutional investors.

Table 2: Comparison of renewable energy systems

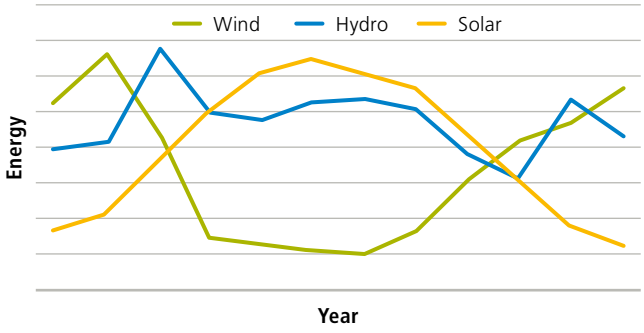
	Photovoltaics	Wind power	Hydropower
Feed-in remuneration	Yes	Yes	Rarely
Concession duration	Up to 20 years	Up to 20 years	50 years to perpetuity
Base load capacity	No	No	Yes*
Residual value	Very low	Low	Generally higher than purchase price
Correlation with other renewable energies	Low	Low	Low
Market price risk	No	Low	High**
Debt financing (average)	60–75%	50–65%	Approx. 50%
Inflation protection through price of electricity	No	Low	High
In industrial use for	Approx. 15 years	Approx. 20 years	Approx. 120 years
Expected return (IRR)	6–7% p.a.	5–8% p.a.	6–9% p.a.

The above is an illustrative representation of core markets in Europe. Details may vary.
** Particularly reservoir power plants and pumped-storage power plants. ** In the absence of power purchase agreements.*

Source: Aquila Capital Investmentgesellschaft mbH

Further, a key advantage of hydropower is that it is a stable and predictable renewable energy source – its energy production is less reliant than solar and wind energy on what time of day or season of the year it is (Figure 3).

Figure 3: Low seasonal fluctuations of hydropower over the year



Source: Aquila Capital Investmentgesellschaft mbH. For illustrative purposes.

We believe that by combining photovoltaic, wind and hydropower investments in a portfolio, there is potential for diversification advantages (Table 3), namely a decrease in overall portfolio volatility and an increase in overall portfolio returns. This belief is supported by a study from Vienna University of Technology, which suggests that diversifying across the three asset classes and across geographies results in distinct stabilisation effects at the portfolio level.[7]

[7] *Technische Universität Wien (2011), Untersuchung der Standardabweichung österreichischer Niederschlagsabfluss-Ist-Daten im Zeitraum von 1994 – 2008 im Kontext von Wind und Solar (Analysing the Standard Deviation of Actual Austrian Precipitation Run-off Data Between 1994 and 2008 in the Context of Wind and Solar)*

Table 3: Diversification effects at the portfolio level

	Hydropower	Wind power	Photovoltaics
Seasonal dependency (highest revenues)	Spring, autumn, winter	Spring, autumn, winter	Spring, summer, autumn
Dependency on the time of day	Very low	Low	Very high
Annual production (full load hours)	4,700 – 5,200	1,300 – 1,700	700 – 1,000
Generation volatility	Moderate	Moderate	Low
Predictability	Moderate	Moderate	High
Operational complexity	Low	Moderate	Low
Regulatability	Moderate to high	Low	Low
Dependence on subsidies	Low	High	Very high

Source: Aquila Capital Investmentgesellschaft mbH.

3.2 Overcoming yield challenges

Hydropower also differs from wind and solar technologies in terms of the yields on offer. The residual value of a hydropower plant tends to be higher than photovoltaic and wind plants, due to the long service life of the technology and the very long or perpetual operating licence periods. This results in a lower yield for hydropower investments.

However, there are a number of ways to overcome this challenge:

- One method to increase the yield is to add assets from a portfolio where there is no or little residual value of the hydropower plant. Such an asset might be a hydro plant that must be sold or given back to the government for free or at a very low price. In our Portuguese investment portfolio, which currently comprises 21 operational small-scale hydropower plants located in northern and central Portugal with a total capacity of approximately 100 MW, the hydro plants will be given back to the Portuguese government at the end of the concession rights. Therefore, there is no residual value, which increases the yield in this investment by moving the investment returns to the front.
- Another option is to issue a bond with a bullet structure on the asset, in order to reduce early debt re-payments. In our Norwegian portfolio in 2018, we issued our first green bond through Småkraft AS, a Norwegian hydropower operator. Proceeds from the EUR 50 million 5-year bond were used to finance the company's growth, however it also had the desired effect of increasing the yield upfront. (Please refer to section 5.1 for the case study of Smakraft AS.)

4. Investment opportunities

Although hydropower is the most mature renewable energy technology, it continues to evolve. There are several investment opportunities for hydropower growth and development around the world. This section takes a look at the investment opportunities available in three key regions – Scandinavia, Iberia and North America.

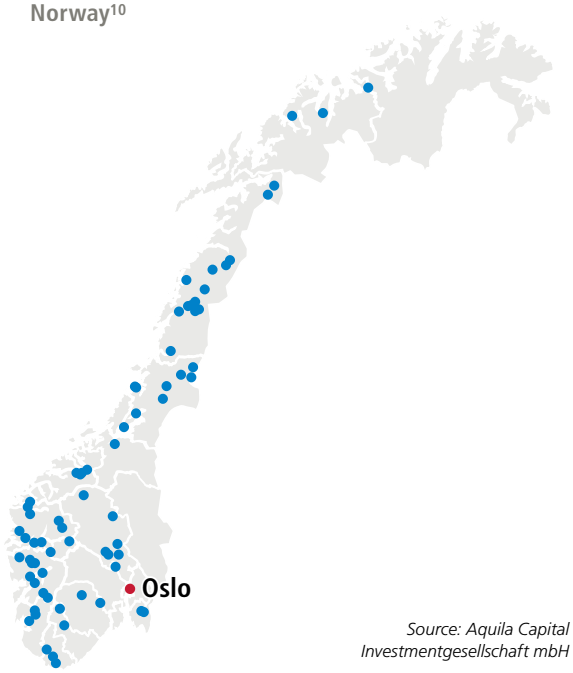
4.1 Scandinavia: a highly attractive market for hydropower investments

Substantial clean energy sources, in particular hydropower and wind, has made the Nordic region a significant exporter of renewable energy. In 2017 net Nordic exports were 11 TWh, with Norway exporting 15 TWh and Sweden 20 TWh.[8] There is a large share of cost-effective hydropower in the region, as well as the ability to store energy in hydro reservoirs. As a result, the region has a high proportion of low-cost base load power generation, in comparison to Germany.

Based on the political goals of reduced carbon emissions and on the cost development of wind and solar technologies, further integration of renewables is planned in the region. The new capacity of wind and solar installations is set to lead to higher volatility of production, however the Nordics' natural storage capabilities (in terms of stored or pumped hydropower) will be able to minimise the effect of this. In addition, planned new interconnectors are expected to further integrate the Nordic market and double the region's trading capacity by 2030.[9]

The Nordic region is a highly attractive market for hydropower investments with a large number of existing run-of-river power plants, Europe's largest fleet of stored hydro plants and a mature renewable energy sector with a stable legal framework. There are a growing number of opportunities for institutional investors to increase their exposure to this market, as local energy suppliers are divesting assets in order to develop increasingly specialised strategies. Aquila Capital has been active in the region for several years, during which time we have established an extensive local network and a strong pipeline of target investments. Currently, we have a portfolio of around 120 operational small-scale hydropower plants in Norway, some of them with storage capabilities.

Figure 4: Aquila Capital's hydropower plant locations in Norway[10]



Source: Aquila Capital Investmentgesellschaft mbH

4.2 Iberia: diversifying by region and asset class

The Iberian Peninsula is resource rich in terms of renewable energy potential. However the climate, in particular annual average precipitation, varies significantly across the region. Spain for example is the most climatically diverse country in Europe, having five main climatic zones. The highest annual rainfall occurs in north-eastern Portugal and in northern Spain, reaching over 2,200 mm, while south-eastern Spain receives the lowest average annual precipitation of less than 200 mm.[11]

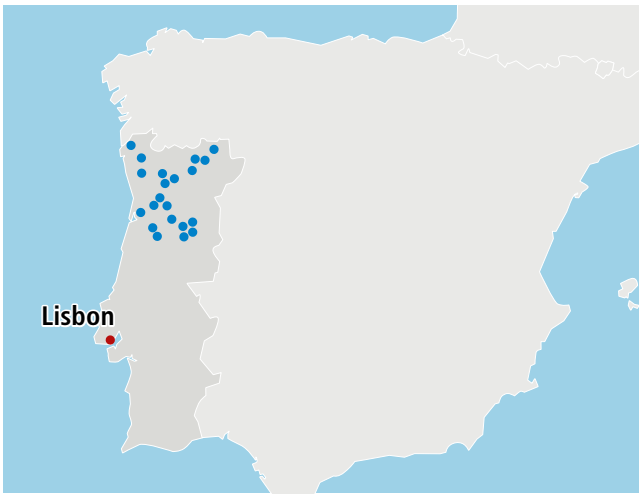
In northern Portugal in particular, the climate is cool and rainy. A stable trend can be observed that the average precipitation level is notably higher than in Germany: annual precipitation amounts to 1,450 mm in Braga and 1,100 millimetres in Porto for example, compared to an average of 775 millimetres of rain or snow fall per year in Hamburg.[12]

[8] *https://www.nordicenergy.org/figure/the-nordic-energy-systems-role-in-europe/*
[9] *THEMA: Nordic power price forecast Spring 2017 edition*
[10] *As of 31.12.2018*
[11] *AEMET; retrieved at 11.03.2019*
[12] *https://www.climatestotravel.com/climate*

There are growing investment opportunities in the region. Portugal for example was one of the top five countries to see the largest individual increases in hydropower capacity (1.1 GW) in 2017. Portugal commissioned two pumped storage projects in 2017, including Frades II (780 MW), which is one of the largest variable speed projects in Europe.[13]

Aquila Capital is active in the Iberian Peninsula's integrated energy market. Our investment approach is to focus only on the attractive rainier regions of northern and central Portugal and northern and central Spain. We believe that these investments offer diversification both regionally and by asset class. In order to minimise risks, we obtain a technical report at the time of purchase of the asset, which looks at the historical hydrology (typically covering the last 20 years), as well as any potential effects of climate change. A climate study forecasts a slight increase in annual precipitation in northern Portugal, while a decrease is expected for the southern part.[14] We also take into account the volatility of production into the capital structure, limiting to a maximum 50% leverage level and building up an adequate cash buffer. Additionally, insurance instruments, such as weather derivates, can be utilised.

Figure 5: Aquila Capital's hydropower plant locations in Portugal



Source: Aquila Capital Investmentgesellschaft mbH

4.3 North America: a well-developed market with growing opportunities

The US and Canada benefit from an abundance of resources, making them among the top producers of hydropower in the world, both small and large scale. In the US, all 50 states have hydroelectric stations, while Canada is one of the few countries in the world to generate the majority of its electricity from hydroelectricity.[15] Both countries have well-developed and functioning power markets, but with the opportunity for new players to enter – in 2017, the region was among the top five fastest growing regions by new installed hydropower capacity.[16]

Hydropower is critical to the renewable energy agendas of the US and Canada, and as a result is supported by political schemes. In the US, this includes a comprehensive energy bill to modify the definition of renewable energy to include hydropower and a licensing reform bill, in order to promote the development of pumped storage projects and add hydroelectric capacity to existing nonpowered dams. The Department of Energy in the US is supporting the advancement of 50 GW of hydropower development by 2050, via retrofitting 13 GW of new generation capacity (including upgrades to existing plants, adding power at existing dams and canals, and limited development of new stream-reaches), and 36 GW of new pumped storage capacity.[17]

The US and Canadian markets both offer investors a variety of power purchase agreements, while there is a trend of growing private ownership in the generation sector. The region also demonstrates a lively pipeline of hydropower projects. In Canada for example, 139 MW of new hydropower, comprised of several run-of-river projects, came online in 2017. In the US, planned projects includes Absaroka Energy, which received a 5-year operating licence from the US Federal Energy Regulatory Commission in December 2016 for the 400 MW Gordon Butte pumped storage project, and plans for an energy storage facility from the San Diego County Water Authority and the City of San Diego.[18]

[13] *https://www.hydropower.org/sites/default/files/publications-docs/iha_2018_hydropower_status_report_4.pdf*
[14] *„Technical due diligence analysis of a small hydropower plant portfolio", Aqualogus, Aug 2018*
[15] *https://www.enbridge.com/energy-matters/energy-school/hydroelectric-power-in-north-america*
[16] *https://www.hydropower.org/sites/default/files/publications-docs/iha_2018_hydropower_status_report_4.pdf*
[17] *https://www.hydropower.org/sites/default/files/publications-docs/iha_2018_hydropower_status_report_4.pdf*
[18] *https://www.hydropower.org/sites/default/files/publications-docs/iha_2018_hydropower_status_report_4.pdf*

5. Aquila Capital's expertise in hydropower

Aquila Capital's dedicated hydro team has been investing in hydropower assets since 2011. Since then, we have acquired numerous plants across Norway, Portugal and Turkey. Aquila Capital has 143 hydropower plants with a transaction volume of EUR 1.1 billion as of end 2018. The following section provides two case studies of recent projects in Norway and Portgual.

5.1 Merger of Smakraft and Norsk Gronnkraft

Norsk Grønnkraft AS ("NGK") was the second-largest small-scale hydropower plant operator in Norway. When Aquila Capital acquired NGK in December 2014, it had 21 hydropower plants, which produced over 210 GWh of electricity annually. In addition, NGK entered into exclusive framework agreements with established hydropower project developers (such as Norsk Grønnkraft Utbygging and Tinfos). Småkraft AS ("SK") meanwhile was founded in 2002 and is the largest operator of small-scale hydropower plants in Norway. When Aquila Capital acquired SK in December 2015, it had developed and commissioned 44 run-of-river hydropower plants, which produced about 455 GWh of electricity annually.

In September 2017, Aquila Capital integrated NGK and SK into one operational organisation, thereby creating a single entity, fully focused on efficient operations of small-scale hydropower plants in Norway, SK. The merger resulted in an efficient and low-cost operation as well as in stable returns. In parallel, SK spun off its construction business into Småkraft Utbygging AS ("SK-U"). Today, SK consists of 106 power plants with an installed capacity of ca 330 MW and a total annual generation of over 1.1 TWh.

Reasons for the investment

Norway is one of the few countries in Europe that does not depend on nuclear or coal power plants for its energy production: 99% of all energy in Norway is generated from environmentally friendly hydropower.[19] In fact for centuries, hydropower has been the main part of the energy mix in the country. For this reason, the technology is well-developed and is generally independent of subsidies in Norway. Further, Norway has a stable economic and political system.

SK and NGK were among the largest small-scale hydropower operators in Norway. Pro-active asset management and analysis revealed that a merger of both assets had the potential to enhance the value of the two portfolios. The portfolio additionally has an indefinite lifespan, with a high resale value and high operating efficiency. It is operated by a team with long-term experience in the small-scale hydropower market in Norway.

Increasing annual production since merger

The merger has resulted in the several benefits below.

1. GROWTH POTENTIAL: Framework agreements with the established construction partners and SK-U, as well as opportunities in the market, enabled production to grow by over 40% in recent years. The future growth potential is forecast to be approximately 1 TWh of annual production until 2022 (Table 4).

2. ECONOMIES OF SCALE: The merged SK entity has the potential to grow further without an increase of headcount, leading to a continuous reduction of fixed cost per GWh and a further diversification of hydrological risks.

3. STRINGENT OPERATION: NGK's monitoring system was also implemented for SK's plants, leading to a reduction of downtime and an increase of production. The portfolio is continuously monitored, which subsequently led to a sale of three underperforming plants and optimization of others.

4. SYNERGY EFFECTS: The merger enhanced negotiation and procurement power with respect to services (including insurance, spare parts and other services).

Table 4: Increased growth potential of merged portfolio

Key figures	NGK at acquisition in Dec 2014	SK at acquisition in Dec 2015	Merged SK in June 2018	Growth since acquisition	SK target in 2022
Total installed base capacity	~ 69 MW	~ 152 MW	~ 334 MW	+ 51%	~ 2 TWh annual production
Average annual production	~ 221 GWh	~ 455 GWh	~ 1 TWh	+ 51%	
Number of operating hydropower plants	31	44	100	+ 33%	
Average age of the power plants (volume weighted)	13 years	8 years	7 years		

Source: Aquila Capital Investmentgesellschaft mbH

[19] *https://www.statkraft.de/stromerzeugung/wasserkraft/ as at 25.09.2018*

5.2 Acquisition of Aguia Enlica

Aguia Enlica is Aquila Capital's platform company in Iberia. It was acquired by Aquila Capital in December 2018. It is a regionally diversified portfolio of 14 run-of-river plants and seven reservoir plants in Portugal, with an estimated annual production of 312 GWh. The portfolio represents about 25% of the Portuguese small-scale hydropower market. It is diversified across 10 river systems and all plants have been in operation for several years. Approximately half of the portfolio's annual energy production stems from plants with reservoirs, whose importance and economic potential is increasing as the share of intermittent renewable energy grows steadily.

The assets also benefit from attractive feed-in tariffs – 75% of the production is covered by a long-term feed-in tariff, which is gradually phased out for the individual power plants with an average weighted remaining lifetime of seven years for the portfolio. This improves the predictability of investors' returns.

The wind and solar technologies being built out in Iberia are set to further increase the value of hydropower over time, given its more stable production profile due to its storage capabilities. Aguia Enlica also offers the possibility of further optimisation, as we implement best practices learned from projects in Norway – Aguia Enlica allows us to scale up and build an efficient small-scale hydro portfolio like we did in Norway, as well as look at more efficient operational management and concession extension.

6. Conclusion

Hydropower has secured a pivotal role in achieving the world's carbon reduction targets. It is not only one of the oldest and most proven energy sources on the planet, it is also reliable, has a large storage capacity and very low operating and maintenance costs. Further, its energy production is less reliant than solar and wind energy on what time of day or season of the year it is.

Hydropower investments also provide long-term stable cash flows and have a low correlation with other renewable energies, giving it strong potential for diversification in a portfolio. However, investment opportunities in this technology are more complex than in other renewable energy sectors, and require technical know-how. Hydropower also tends to require significantly higher up-front investment per capacity unit, making it less scalable than wind power or photovoltaic plants. Aquila Capital has a dedicated hydro team and has been investing in hydropower since 2011, acquiring numerous plants across Norway, Portugal and Turkey. Our technical expertise and strong network enable us to provide attractive opportunities within a robust portfolio and investment pipeline of operational European hydropower assets.

Watch our video – click below

https://www.aquila-capital.de/en/insights/ninetynine-seconds/#c1123

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