Hydropower Solutions

HYPOSO

Hydropower solutions for developing and emerging countries

D6.3
Political recommendation papers
ECUADOR

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1 Introduction

HYPOSO is a multi-approach project to tackle several objectives; identification and mapping of the European hydropower industry, hydropower stakeholders in the HYPOSO target countries, education of new hydropower experts through capacity building activities and bringing together relevant actors from the EU hydropower sector with stakeholders in the target countries. Interaction with stakeholders is therefore an integral part of the activities, as workshops, capacity building activities and interviews with national/local stakeholders are envisaged in all target countries which are outside the European Union, namely workshops in Bolivia, Colombia and Ecuador in Latin America, and in Cameroon and Uganda in Africa. Additionally, capacity building courses will be carried out in Bolivia and Ecuador, and in Cameroon and Uganda.

2 Information about Deliverable

The policy recommendation papers developed within HYPOSO shall be seen as a perspective from the European side on the small hydropower sector in the HYPOSO target countries Bolivia, Colombia and Ecuador in Latin America, and in Cameroon and Uganda in Africa. The following recommendations are composed of findings during the HYPOSO project (reports on the framework conditions, discussions during HYPOSO events), as well as of trends that have developed in the recent years and should be considered when a sustainable development of the sector is planned. The following recommendations do not claim to be comprehensive or to propose any concrete legislative changes. This must always be done at national level.
The recommendations made here may however be taken into account in discussions on this matter.

3 General information about the electricity sector in Ecuador

According to the most recent official data from the Ecuadorian Government for 2022[1], the installed electrical capacity in Ecuador has shown an impressive growth in recent years. Between 2012 and 2022 the installed capacity grew by more than 60 % from 5,454 MW to 8,864 MW. Renewable sources accounted in 2022 for more than 61 % of the installed capacity (61.2 %, of which 58.6 % come from hydropower), leaving a little less than 39 % for non-renewable sources (38.8 %, internal combustion motors, gas and steam).
This resulted in an electricity supply in 2022 of 73.6 % from hydroelectricity, 23.6 % from thermal sources and 1.4 % from other sources.
Renewable energy capacity increased from 2,338.2 MW in 2011 to 5,424.8 MW in 2022, mainly due to new hydropower development. The total hydropower installed capacity went from 2,234.4 MW in 2011 to 5,194.3 MW in 2022. Hence, from 2011 to 2023, renewable energy capacity more than doubled, mainly due to growth in hydropower.

[1] https://www.recursosyenergia.gob.ec/5900-2/

The biggest hydropower plants which are Coca Codo Sinclair (1,500 MW) and Paute Molino (1,100 MW) account for already 50 % of the installed hydropower capacity (i.e., 5,194.3 MW). All this is surely an impressive development, but there is reason to believe that this development is far from an end.

4 Small hydropower in Ecuador

According to the latest available data, the World Small Hydropower Development Report (WSHDR) 2022[2], which has been published in August 2023, the remaining potential for additional small hydropower development in Ecuador until a capacity of 10 MW is additional more than 200 MW. Within the HYPOSO project, the so-called HYPOSO Map was developed, and with this online tool, **more than 475 potential sites for new hydropower plants have been identified**. This gives reason to believe that the potential for more hydropower in Ecuador is considerably larger than the approx. 200 MW mentioned in WSHDR 2022.

4.1 Why (small) hydropower at all?

To deliver on the UN Sustainable Development Goals[3], hydropower is crucial. For example, hydropower ensures availability and sustainable management of water and sanitation for all (SDG6), and it ensures access to affordable, reliable, sustainable and modern energy for all (SDG7). The implementation of hydropower plants contributes to SDG8, sustainable economic growth and jobs, and hydropower represents like few other technologies SDG9, to build resilient infrastructure, to promote inclusive and sustainable industrialisation, and to foster innovation. In addition, hydropower is a key solution for taking the urgent action to combat climate change and its impacts (SDG13).

4.2 Facts about small hydropower that are not known everywhere

Like many other countries, Ecuador, with the update of the generation expansion of its Electricity Master Plan (Plan Maestro de Electricidad - PME) until 2031, has set itself goals to increase the share of wind and solar energy, which makes absolutely sense given the opportunities Ecuador has for these RES. It is however often overlooked, that the volatile production of wind and solar energy can be a problem for the existing electricity grid which needs to be stable.

The French study “Hydropower and the challenge of flexibility” (“L’hydroélectricité au défi de la flexibilité”[4]) has addressed the issue of flexibility services and has shown that hydroelectricity is essential for balancing the electricity system, especially in the low voltage system. According to the French study, one small hydropower plant is equivalent to ten domestic batteries (of each 10 kW), and can increase the capacity of a high-voltage line by 20 % to accommodate photovoltaics.

[2] https://www.unido.org/sites/default/files/files/2023-08/SOUTHERN_AMERICA_2022.pdf
[3] https://sdgs.un.org/es/goals
[4] https://www.france-hydro-electricite.fr/actualites/energie/etude-hydroelectricite-et-flexibilite-modeles-economiques/

According the German study ”Contribution of small hydropower plants hydropower plants to secure and cost-effective electricity supply in Germany” (“Netztechnischer Beitrag von kleinen Wasserkraftwerken zu einer sicheren und kostengünstigen Stromversorgung in Deutschland”), small hydropower plants have the capacity to considerably decrease the costs of electricity grid adaption if considerably more PV and wind energy are fed in. Small hydropower plants achieve high values of up to 5,500 full-load hours, and are also highly available and thus operate for an average of more than 8,000 hours per year and feed continuously into the grids. Hydropower plants are therefore reliable electricity producers and guarantee a steady supply of electricity.
If required, hydropower plants can also be operated as reliable control power plants: On the one hand, negative control power can be provided by reducing the very constant feed-in power on demand; on the other hand, additional feed-in power can also be provided by slightly throttling hydropower plants during normal operation. Especially with the use of dynamic reservoir management and associated storage capacities in the potential energy of the water, the control potential can be fully exploited.
These services bring a financial benefit with them. For example in Germany, the country where the study was carried out, a total of about 7,300 to 7,600 hydropower plants produce electricity. A distinction is made between large hydropower plants with an installed (electrical nominal) capacity of > 1 MW and small ones with an installed capacity of ≤ 1 MW. The large capacity class includes about 400 hydropower plants, whereas about 7,000 small hydropower plants are in operation. The share of large hydropower plants in the total amount of electricity is about 85 %, while small hydropower plants generate about 15 %. Although in Germany only about 4.1 GW of the 103 GW of installed renewable capacity is accounted for by hydropower (approx. 4%), they account for about 12% of electricity generation from renewable energy sources. This means that small hydropower plants are of great importance for the German electricity supply due to their grid-serving behaviour, as they feed in their output steadily and with high full-load utilisation hours without causing grid overloads, which significantly reduces the need for grid expansion in the distribution grids. This is another reason why it is important to maintain the existing capacities of small hydropower as well as to ensure their economic operation. If this were not successful, in Germany, the amount of energy provided by small hydropower plants (< 1 MW) would have to be substituted by wind power and photovoltaic plants, which would increase the additional grid expansion costs in the medium and low voltage grid alone in Germany to an amount of about 750 million € [5]. For Ecuador, given the considerably lower number of plants, the financial savings might be less but the information about the benefits of decentralised SHP should be considered, taking whatever financial savings as a welcome benefit.

[5] https://www.wasserkraft.org/wp-content/uploads/2021/12/Gutachten_Netztechnischer_Beitrag_Kleinwasserkraftwerke_Endversion.pdf

5 Recommendations for the small hydropower sector in Ecuador

As general recommendation it must be advised to use available tools and technologies that can bring the national hydropower sector forward. In the HYPOSO project for example, different tools that might be helpful for the Ecuadorian small hydropower sector have been developed; namely the **HYPOSO Map** (a useful online GIS tool to start the search for new hydropower sites from the desktop, providing more than 20 different layers with useful information for hydropower), the **HYPOSO Business Cases** (a replicable pre-feasibility study model and a financing model are publicly available via https://www.hyposo.eu/en/sector-information/), the **HYPOSO Meeting Platform** (an online meeting forum, free of cost, see more at https://www.hyposo.eu/en/hyposo-platform/), and the **HYPOSO OCW Platform** (the online platform of the **HYPOSO capacity building courses**, see more at HYPOSO (un-ihe.org)).
Furthermore, the **International Hydropower Association** (IHA) has developed some very useful material which should also be considered (see more under 5.3).

5.1 Accelerate the development of SHP through streamlined permitting and licensing

According to WSHDR 2022, there is no dedicated legislation for SHP in Ecuador. Hydropower plants until 10 MW thus fall under the general Ecuadorian electricity sector legislation and are considered according to article 3 of the LOSPEE as non-conventional renewable energy sources. Distributed generation is defined as plants that are installed close to consumption and which are connected to the grid. In May 2021, the Agency for Regulation and Control of Electricity issued a legal framework for distributed generation, for power plants with capacity between 100 kW and 10 MW, including hydropower. During the HYPOSO framework condition workshop, stakeholders have expressed their wish for an improved legislation for small hydropower (addressing amongst other a lack of legal clarity, certainty and decisiveness). Referring to the services which decentralised small hydropower can play for electricity grids (see under 4.2), it is therefore recommended that the policy makers start a process to set up a **sustainable legislation for small hydropower** in Ecuador, in best case together with national practitioners and making use of the exchange established during the HYPOSO project with stakeholders from Bolivia and Colombia. Once having established such legislation, the best form to allow a lot faster processes would be if permitting and licensing are facilitated in a **one-stop-shop** (i.e., all necessary steps needed for permissions and licenses can be found under one roof).

5.2 Install strict measures to ensure that only “good” hydropower projects are implemented

Regarding hydropower projects, we recommend that only “good” hydropower projects are provided with licenses and permissions.
Hydropower projects that are sited, planned and executed **in accordance with international good practice** in sustainability can have positive wider non-power impacts on local

communities, including but not limited to water supply, social investment, economic growth, livelihoods, irrigation, and flood and drought protection.

5.3 Embed hydropower sustainability practices in government regulation.

As mentioned, hydropower, be it large or small, will only be largely accepted if the realised plants will be really sustainable plants, taking care of people already living in and/or using the area, and of course taking care of the environment. The International Hydropower Association (IHA) has developed **sustainability guidelines** that should be embedded in national regulation. All different guidelines can be accessed via:
https://www.hydrosustainability.org/hydropower-sustainability-guidelines .
It is also worthy, checking the European approach on water related issues that shall lead to a more healthy status of the water environment, with the main element being the **Water Framework Directive** (WFD), which has the overall objective to achieve good environmental status for all waters, and which led to the request to EU Member States to draw up so-called river basin management plans based on natural geographical river basins, as well as specific programmes of measures to achieve the objectives. The WFD is supported by more targeted directives, i.e. the Groundwater Directive, the Drinking Water Directive, the Bathing Water Directive, the Nitrates Directive, the Urban Waste Water Treatment Directive, the Environmental Quality Standards Directive and the Floods Directive. These typical EU Directives might be interesting for political deciders, who could check, whether the topics that are dealt within the EU are already an actual national topic to be addressed. If so, of course the contact to European representatives is recommended to start discussions with experts from the EU.[6]

5.4 Incentivise sustainable hydropower development through financial and market mechanisms

We would recommend also to think about a **fair remuneration** of the services that hydropower (small and large) is providing for the electricity grids. As shown under 4.2, this service can save a lot of money when it comes to preparing the electricity grids for more volatile energy production from PV and wind energy.

5.5 Enable the national hydropower sector to grow for the better of the country

It is essential that the Ecuadorian hydropower sector will be able to further grow and thrive. It is recommended therefore that hydropower stakeholders, especially political deciders, get familiar with the latest updates about hydropower. As mentioned before, interested stakeholders from Ecuador are invited to enroll themselves in the **HYPOSO capacity building courses** (HYPOSO (un-ihe.org)). In addition, hydropower stakeholders from Ecuador are invited to **make contacts with European stakeholders**, on the one hand via the HYPOSO Platform, on the other hand via ETIP Hydropower (ETIP HYDROPOWER (etip-hydropower.eu)), currently a

[6] https://www.europarl.europa.eu/factsheets/en/sheet/74/water-protection-and-management

project funded by the European Commission, but already now and in future aiming to be a recognised interlocutor for the European Commission, Member States and Associated Countries about the hydropower's sector specific R&I needs, also open for making contacts to hydropower stakeholders from Latin America. It is further recommended that the stakeholders from Ecuador seek for **cooperation with the newly formed Colombian association CEERA** (CENTRO DE ESTUDIOS DE LA ENERGIA RENOVABLE Y EL AGUA - CEERA) which is interested to establish future contacts in Latin America to bring the sector forward.

CEERA has in addition ambitious plans to **set up a study programme on hydropower** in Latin America and seeks for collaboration on this issue with, among others, stakeholders from the Latin American HYPOSO partner countries Bolivia and Ecuador. It is thus recommended to establish contacts with CEERA.

The set-up of a **national open table** for all actors involved in the Ecuadorian hydropower sector is recommended further, as such exchange of positions and ideas can benefit the sector and lead to an improved situation for more hydropower in Ecuador.

It needs to be mentioned finally, that a **lack of gauging stations** is not only impeding good decision making for future hydropower opportunities, but also causing an unneeded risk for downstream communities (flood forecasts) and should therefore be **addressed wherever needed**.

5.6 Enable public involvement in SHP projects, making them Social hydropower projects

We recommend, if possible, that **public involvement** is facilitated, encouraged, and supported by regulative means to be taken by political deciders. Research[7] has shown that, based on the degree of citizens' involvement in small hydropower projects, inclusive relationships between their involvement and awareness were revealed. The acceptance of future plants could be improved if such involvement would see support.

5.7 Use available finance sources

Regarding finance for hydropower projects, national stakeholders like project developers are often lacking enough money and are not well informed where to get access to finance possibilities. We recommend that a dedicated office (in best case part of the one-stop-shop, see under 5.1) will be established and promoted in the national hydropower sector, to act as information hub for local developers who are seeking financial support and have no information where that could be done best. As first source of information a look into report D5.4 of the HYPOSO project is advised, in which it was revealed that if the needed finance for a project would be in the context of medium-term debt (i.e., 10 years including grace period), funding from commercial banks or crowdfunding sources (HYPOSO project partner and finance expert 1to3 Capital is linked to crowdfunding site 'CrowdPartners') is possible. In case a project would

[7] https://www.researchgate.net/publication/343234722_Effect_of_Residents'_Involvement_with_Small_Hydropower_Projects_on_Environmental_Awareness

not be pre-feasible within that context the assessment was performed (i.e., to yield a minimum DSCR (debt service coverage ratio) of 1.3x), it is recommended to take long-term finance (20 years including grace period) into account to come from covered debt - for political and commercial risks - from commercial banks plus an export credit agency coverage or from development banks who often also need governmental guarantees (in future for example through coverage from the EFSD+[8]).

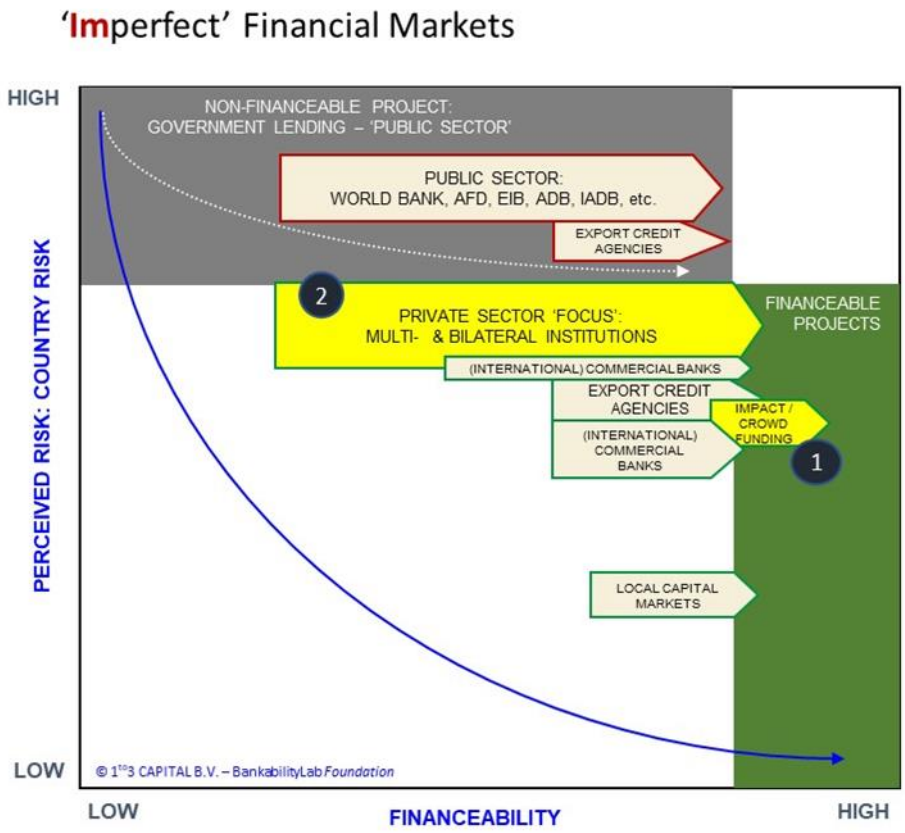

Figure 1: Financeability Matrix and Imperfect Financial Markets (Source: Marc J.M. Buiting)

In addition, it is recommended that available offers for financial capacity development are used. Prospective developers could apply for these courses. Most development banks have capacity development facilities.

5.8 Start today with planning future scenarios

Predictions of precipitation patterns for Ecuador give reason to expect **a changed precipitation in the future** (see below the result from the HYPOSO Map, available via https://www.hyposo.eu/en/hyposo-platform/). It is recommended to **think already now about addressing this issue to secure future water supply** (for the public and for agriculture). Multipurpose hydropower plants with reservoirs might be an answer for irregular precipitation scenarios in the future.

[8] https://international-partnerships.ec.europa.eu/funding-and-technical-assistance/funding-instruments/european-fund-sustainable-development-plus-efsd_es

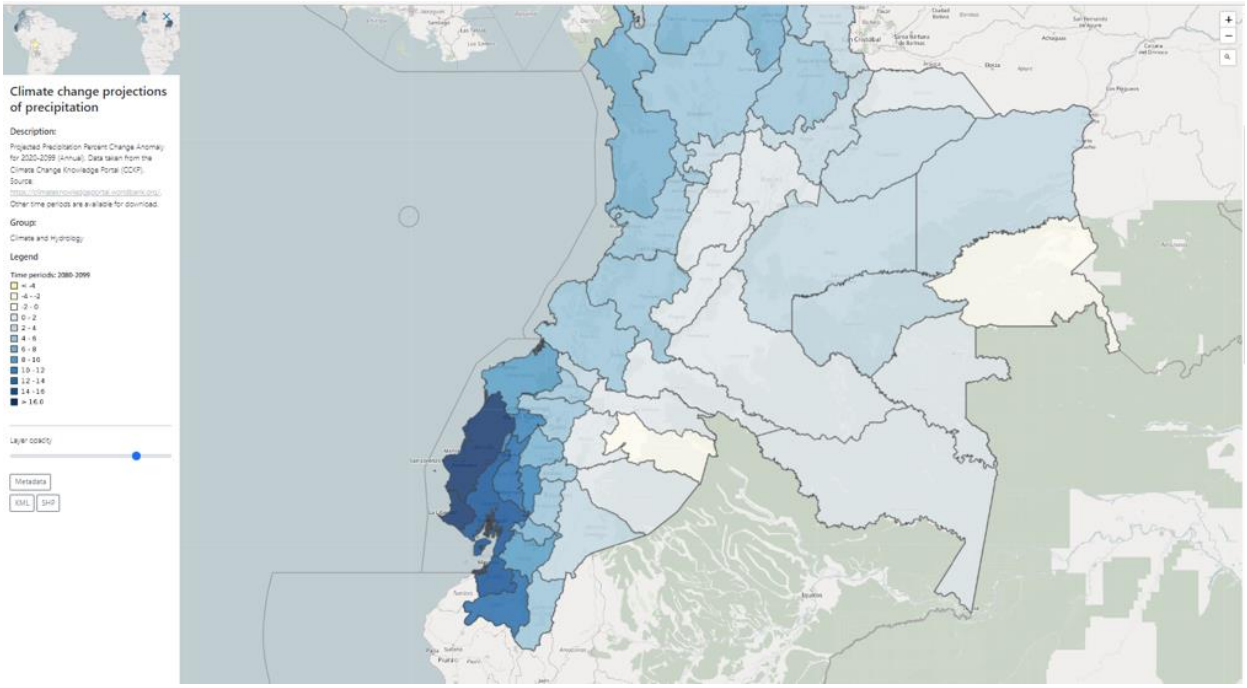

Figure 2: Screenshot of the HYPOSO Map, showing an increase of precipitation mainly in Ecuador's pacific coastal area

Given the **favourable geographical conditions** in Ecuador, although that might result in plants with a capacity beyond the limit of small hydropower, we recommend that **Pumped Storage Hydropower** (PSH or PSP) is considered for accelerating even more the expansion of renewable energies. There is no other proven renewable technology that matches its long lifetime and its ability to support reliable grids.

For Ecuador, the Global Greenfield Pumped Hydro Energy Storage Atlas, developed by the Australian National University (ANU), might be a perfect tool to start the journey for PSH/PSP development in the country. The atlas can be accessed via: https://re100.anu.edu.au/ .

The screenshot below of this tool is giving an impression of the potential that Ecuador is having.

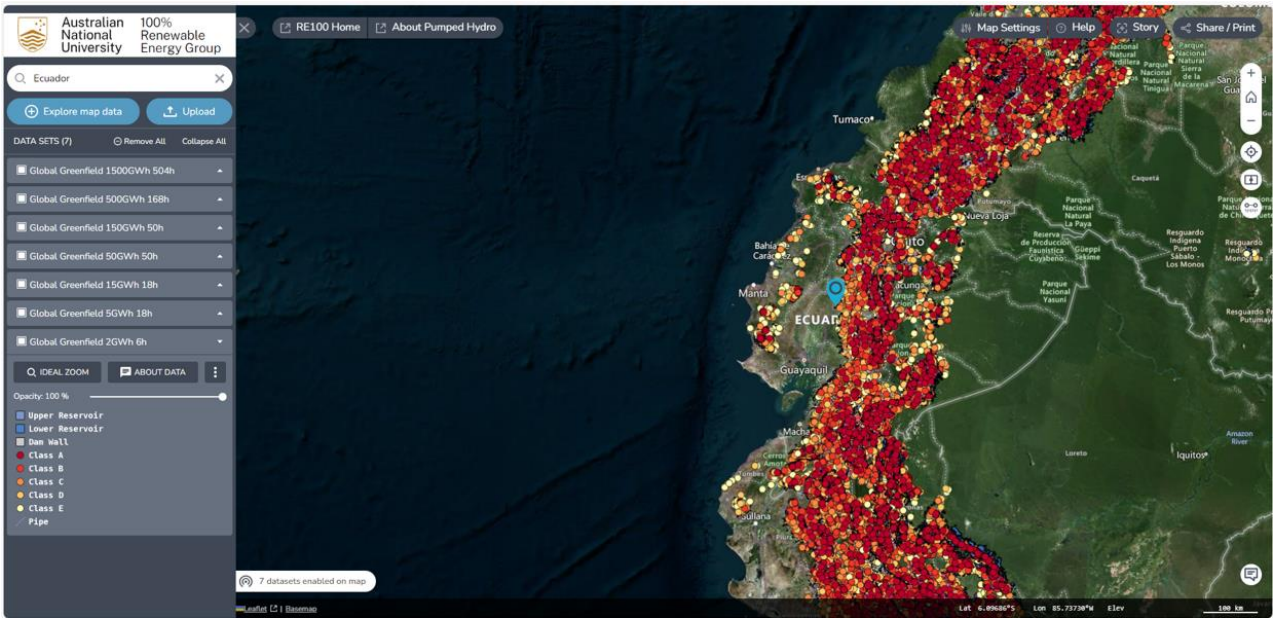

Figure 3: Screenshot of the Global Greenfield Pumped Hydro Energy Storage Atlas, showing parts of the PSP potential in Ecuador

6 Conclusion

The HYPOSO consortium is convinced that **small hydropower plants (SHP) are a viable solution** as a contribution to achieving the **decarbonisation of the energy sector**, which, if implemented well, will enable the further expansion of other renewable energies. At the same time, the value of small hydropower plants for a **stable electricity grid** cannot be underestimated, especially in the mid– and low-voltage grid. In our view, measures should therefore be taken that will lead to more SHP projects being implemented in the near future.

Ecuador should **not only look into SHP**, but should also make use of the favourable geographical characteristics which it has, and explore **the potential of PSH/PSP** in the country.