Energy Independence for Islands

How baseload renewable energy systems are outcompeting conventional diesel electricity generation systems

Authors

Mohamad Alameh and **Willem de Vries**

(Charged Islands)

In cooperation with **Floris van Dijk**

(Elestor)

Photo by Hamdhulla Shakeeb

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Abbreviations

BESS	Battery Energy Storage System
BRES	Baseload Renewable Energy Systems
CI-BRO model	Charged Islands BRES Optimization model
HFO	Heavy Fuel Oil
LCOE	Levelized Cost of Electricity
LCOS	Levelized Cost of Storage
LDES	Long Duration Energy Storage
LFP	Lithium Iron Phosphate
MW / MWh	Megawatt / Megawatt-hour
MWp	Megawatt-peak
PyPSA	Python for Power System Analysis
PV	Photovoltaic (solar generator)

1 Executive summary

Due to recent declines in the cost of photovoltaic solar generators (PV) and battery energy storage systems (BESS), baseload renewable energy systems (BRES) can now outcompete a grey generation mode (diesel electricity generation) on a 24/7 basis. BRES now promise a 30% reduction in electricity generation costs compared to diesel generators for a wide set of geographies, often reducing generation costs by 100 EUR/MWh. This gap is expected to grow with the introduction of cheaper long duration energy storage (LDES) systems in the future, potentially reducing cost of electricity supply by 50% compared to diesel generation.

With economic arguments in favour of BRES, a movement towards deployment of such systems can be expected and is also encouraged and supported by the writers of this white paper. Numerous islands will have to overcome various hurdles though trying to implement BRES. Examples of such hurdles are shortage of development & financing capabilities as well as the shortage of land and a lock-in of diesel generation assets.

2 Introduction

2.1 Commercial viability of Baseload Renewable Energy Systems (BRES)

In a recent publication[1] EMBER highlighted the stunningly low LCOE that photovoltaic solar generators (PV) combined with battery energy systems (BESS) can achieve today, whilst delivering baseload power (Baseload Renewable Energy Systems, or BRES). Working with a fixed ratio between PV & BESS and with no conventional generation as back-up, EMBER shows that coverage up to 99% of the time and LCOE's as low as 100 USD/MWh (86 EUR/MWh) are feasible. The driver behind these continuously declining LCOE's by BRES is mostly caused by recent declines in the cost of BESS. In this white paper we want to take things one step further; we want to prove that BRES are in fact the economically attractive method to generate electricity today for numerous geographies. In addition, we will show that upcoming BESS technologies will drive the LCOE of BRES-systems even further down.

2.2 Competing grey generation base

The economic attractiveness of BRES not only depends on its own LCOE, but also on generation cost of the competing grey generation base. Not all conventional power generation methods deliver equal electricity prices; the fuel utilized to produce electricity has a very large influence on the final price of the commodity. For electricity generation, frequently used grey fuels are natural gas, coal and oil (the latter largely in the form of diesel, but also heavy fuel oil, HFO). According to the IEA[2], electricity generated by diesel generators amounted to approximately 2.6% of total electricity production in 2023, representing approximately 780 TWh of electricity. Marginal production costs of electricity on basis of natural gas and coal are typically (well) below 100 EUR/MWh, and as a consequence do not incentivize the use of BRES yet. Electricity generation on basis of diesel is comparatively expensive though with marginal costs at 225 EUR/MWh[3]. Islands in particular are a victim of these economics, as can be read in a recent article by the IEA[4].

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[1] *https://ember-energy.org/app/uploads/2025/06/Ember-24-Hour-Solar-Electricity-June-2025-6.pdf*
[2] *https://www.iea.org/world/electricity*
[3] *Assuming 900 EUR/1000 liter for diesel, and a generation efficiency of ~ 40% (4 kWh/liter), a marginal generation price of 225 EUR/MWh is calculated. Other costs need to be added (as maintenance, depreciation etc.) to establish the total generation price.*
[4] *https://www.iea.org/commentaries/islands-need-resilient-power-systems-more-than-ever-clean-energy-can-deliver*

Photo by Willem de Vries

According to this IEA article, islands often incur electricity generation prices between 280 and 400 EUR/MWh. As a consequence, islands that generate their electricity by means of diesel generators typically spend between 10% and 15% of their GDP on electricity generation. Charged Islands estimates at least 20 GW of diesel generation capacity is in operation on islands alone. These generators are estimated to emit ~100Mton of CO_2 on a yearly basis[5].

3 Baseload Renewable Energy Systems in practice

As mentioned earlier, many island power systems still depend (almost entirely) on diesel generators to keep the lights on, with high and volatile fuel costs. BRES offer a cleaner and cheaper alternative. In this chapter, we quantify what such systems would look like in practice: we size PV + BESS portfolios that can meet baseload demand. We first outline the modelling methodology and key assumptions and subsequently present case-study results for selected near-equatorial islands.

3.1 Methodology & assumptions

Charged Islands utilizes an in-house developed PyPSA model to assess and model the BRES ('CI-BRO model'). The CI-BRO model optimizes for the total installed CAPEX and subsequently uses these outcomes to establish an LCOE under certain financing conditions. All cases are analysed with the same constant 10 MW baseload demand, sizing the BRES to meet this load continuously. To verify this 'continuous' capability, we have included all solar data of the last 18 years from the European Commission's JRC in our model. Our custom optimisation framework solves a linear least-cost problem to determine optimal capacities of PV, battery storage and, in hybrid cases, a small diesel generator. Because comparable long-term wind data is not available, the analysis focuses on solar-only BRES. For each island, we compare a Pure BRES (PV + BESS only) with a Hybrid BRES (PV + BESS + diesel) and compute the LCOE for each configuration. Further detailing of the CI-BRO modelling inputs have been incorporated in annex 2.

3.2 Case studies: Bonaire, Santiago & Guadalcanal

To illustrate how this methodology plays out in practice, Charged Islands has applied it to three real-world island cases: Bonaire in the Caribbean, Santiago (Cabo Verde) in the Atlantic Ocean and Guadalcanal (Solomon Islands) in the Pacific. Together, they span three continents and a variety of weather patterns. Output of the analysis is the required PV capacity, BESS capacity, diesel share of annual load (where applicable) and LCOE, which have been summarised in Table 1. For comparison's sake, we provide the contemporary grey generation costs here[6]:

- Bonaire, the contemporary grey production costs are: 277 EUR/MWh[7].
- On Santiago the variable electricity costs are approximately 290 EUR/MWh[8].
- On Guadalcanal, the marginal fuel cost component is 280 EUR/MWh[9], not including the operation, maintenance and depreciation of the diesel engines.

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[5] *Each MWh of diesel generated power is responsible for ~850 kilograms of CO2 emissions. A 70% utilization rate has been assumed for the estimated 20 GW of installed diesel generation capacity on islands.*
[6] *Generation prices are not always strictly separated from other grid related costs, we have provided the available numbers.*
[7] *https://www.webbonaire.com/2025/06/26/tarieven-2e-half-jaar-2025/ (Using 0.86 EUR/USD rate of 10-12-2025)*
[8] *https://caboverdeelectricitypsp.com/ (Using 0.86 EUR/USD rate of 10-12-2025)*
[9] *https://solomonpower.com.sb/wp-content/uploads/2024/12/January-Charges.pdf (Using 0.104 EUR/SBD rate of 10-12-2025)*

Table 1: Pure- & Hybrid sizing for a 10MW BRES, including the annual share of diesel and the resulting LCOE for three island case studies

Island case	Scenario	PV (MWp)	BESS (MWh)	Diesel share (% of annual load)	LCOE (€/MWh)
Bonaire	Pure BRES	85	477	–	285
	Hybrid BRES	69	244	0.45%	191
Santiago	Pure BRES	97	400	–	279
	Hybrid BRES	72	210	0.7%	186
Guadalcanal	Pure BRES	180	339	–	388
	Hybrid BRES	110	260	0.54%	259

3.3 Pure vs hybrid BRES

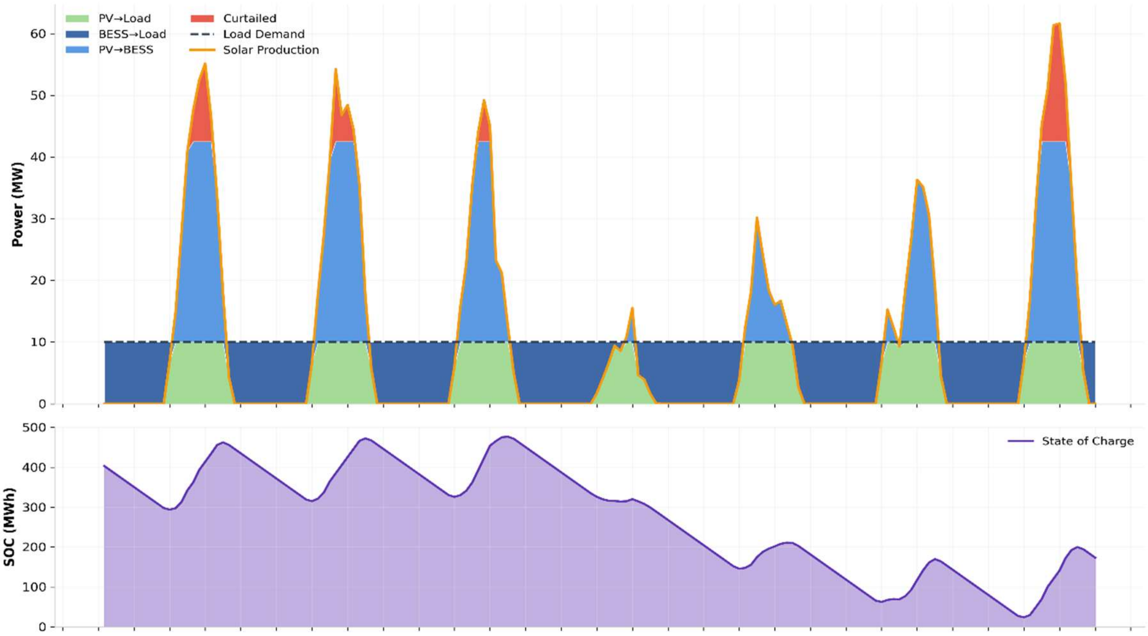
Both configurations in Table 1 are designed for the same strict standard: each system must cover the full 10 MW baseload in every single hour of eighteen years of hourly JRC solar data. The CI-BRO model first builds a PV–battery system that reliably covers "normal" operation on sunny days, subsequent nights and the regular cloudy spells. In the Pure BRES scenario, the model subsequently adds extra PV and storage as long as necessary to fulfil the mentioned delivery requirement. In the Hybrid-BRES scenario, the model does this as long as it remains economical. The last hours of storage capacity, which are needed only for very rare multi-day events, are used so infrequently that they become extremely expensive per MWh. Beyond that point, it is cheaper to cover those few critical hours with a small amount of diesel than to keep increasing battery size.

The mentioned trade-off is clear in all cases. On Bonaire for example, a Pure BRES solution requires 85 MWp of PV and 477 MWh of storage to meet a 10MW demand in every hour of the eighteen-year record, resulting in an LCOE of about 285 €/MWh. Complementing the BRES with a small diesel backup reduces the optimal design to 69 MWp of PV and 244 MWh of storage, while still achieving the same 100% reliability with the inclusion small amounts of diesel energy. In the Hybrid BRES scenario, the LCOE falls to roughly 190 €/MWh with diesel supplying only around 0.45% of annual energy. Figures 1 illustrates how a Pure BRES and a Hybrid BRES scenario handle relatively dark days: in the Pure BRES scenario the battery must ride through the full event on its own, whereas in the Hybrid BRES scenario a small diesel unit steps in pre-emptively, preventing deep depletion of the battery and making a smaller storage volume sufficient. The pattern is clear: a minimal amount of diesel, used only in the most extreme weather event(s) of the year, avoids a large block of rarely used storage.

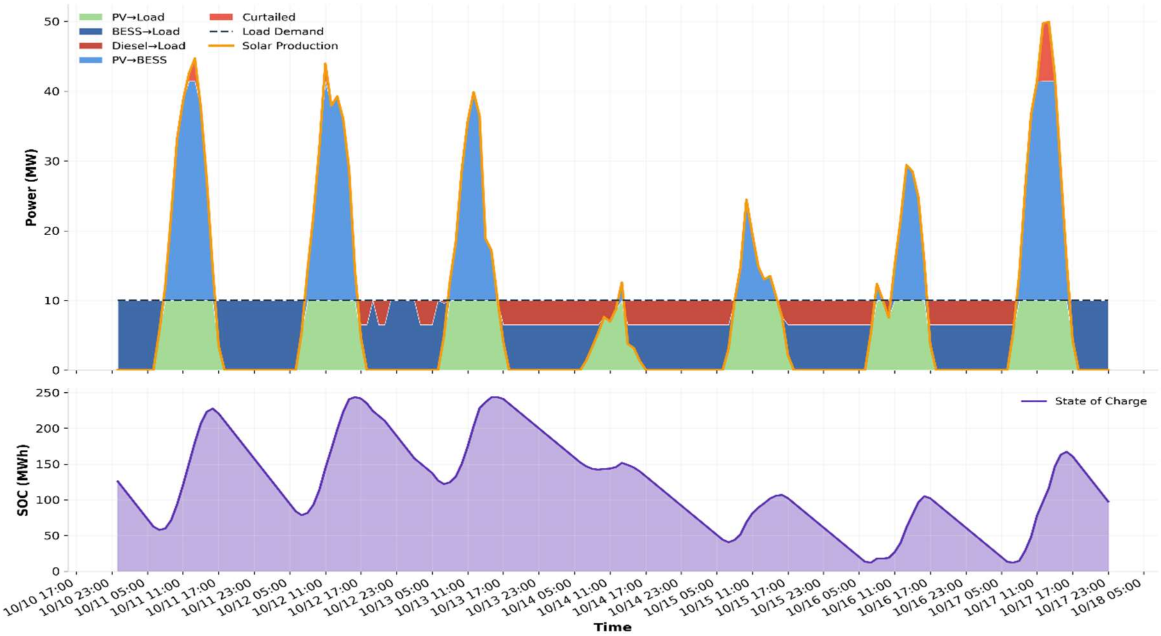
In the Guadalcanal case, the effect of longer cloudy spells becomes apparent. Either the PV needs to be sized such that it generates a hard-needed minimal quota during the day, or the batteries need to be able to ride out the cloudy spells. This also illustrates that competitiveness of BRES is also dependent on local weather patterns, not only the distance to the equator.

Figure 1: Dispatch of BRES on Bonaire during a multi-day cloudy period (October 2008)

(a) Pure BRES dispatch on Bonaire during a multi-day cloudy period: *Power flows between solar, battery and the 10 MW baseload (top), and the corresponding battery state of charge (bottom). The system rides through the entire sequence using only PV and storage, which drives the battery close to its energy limits and requires a relatively large storage volume to maintain 100% reliability over the 18-year record.*



(b) Hybrid BRES dispatch on Bonaire for the same event: *With a small diesel generator available, part of the load is supplied by diesel as the battery approaches a low state of charge. This pre-emptive "kick-in" prevents deep depletion of the battery, therewith requiring significantly less total storage capacity whilst serving the same load criterion.*



4 Next-generation storage

4.1 Inclusion of long duration energy storage systems

The simulations presented so far rely entirely on today's proven technologies: standard silicon photovoltaic (PV) modules combined with Lithium-Iron-Phosphate (LFP) batteries. This combination is currently the cheapest and most bankable option for large-scale BRES projects. Bankability is essential: projects of this size rely on project finance, which in turn requires mature, well-understood technologies to enable deployment at scale.

PV modules and LFP batteries are expected to become ever cheaper still in the coming years, which will further strengthen the economic case for BRES. However, both technologies have already seen dramatic cost reductions over the past decades. It is therefore reasonable to assume that the potential for further price declines is gradually shrinking. Because storage costs are a dominant driver of BRES LCOE, any step-change improvement in the economics of BRES is likely to come from new storage technologies, rather than from incremental improvements in PV or LFP.

One of the most promising candidates in this regard are flow batteries. They are well suited as long-duration energy storage (LDES) because their cost structure differs from LFP as power (stacks and inverters, MW) is relatively expensive, while adding energy capacity (storage volume, MWh) is comparatively cheap. In LFP systems, power and energy tend to scale together, which makes them ideal for fast cycling and short-term balancing, but less attractive for very long storage durations. This contrast makes LFP and LDES naturally complementary in a BRES portfolio: LFP handles high-power, short-duration flexibility, while LDES covers deep, multi-day energy deficits at lower cost per stored MWh.

Using cost and performance data provided by Elestor, Charged Islands has simulated future BRES configurations in which LFP batteries are complemented by Elestor's flow-battery-based LDES. The analysis was repeated for the same set of island cases and the same 10 MW baseload requirement as before. The resulting system sizes and LCOE values are summarised in Table 2.

Compared with PV-plus-LFP systems, these LDES-enabled BRES configurations reduce LCOE by with an impressive 25% in the Pure BRES cases. On Bonaire, the LCOE of a pure BRES system falls from roughly 285 to 211 €/MWh when LDES is added; in Santiago it drops from about 280 to 208 €/MWh. The key reason is that a large part of the long-duration storage duty is shifted from relatively expensive LFP energy capacity to cheaper flow-battery energy capacity, while LFP remains responsible for short-term cycling and fast balancing.

Photo by Jim Plaum

Table 2: Pure- & Hybrid sizing for a 10MW BRES with the option to store electricity in LDES, including the annual share of diesel and the resulting LCOE for three island case studies

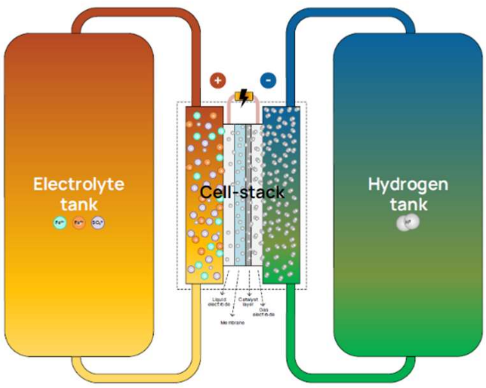
Island	Scenario	PV (MWp)	BESS LFP (MWh)	BESS LDES (MWh[10])	Diesel share (% of annual load)	LCOE (€/MWh)
Bonaire	Pure BRES (+LDES)	84	146	361	–	212
	Hybrid BRES (+LDES)	69	151	103	0.6%	167
Santiago	Pure BRES (+LDES)	79	150	424	–	209
	Hybrid BRES (+LDES)	70	160	62	0.85%	171
Guadalcanal	Pure BRES (+LDES)	103	58	1292	–	292
	Hybrid BRES (+LDES)	88	135	390	0.7%	216

In the Hybrid BRES (+LDES) cases, LDES adds a new degree of freedom to the optimisation. On Bonaire, a combination of 69 MWp PV, 151 MWh LFP and 103 MWh LDES delivers an LCOE of about 167 €/MWh, with diesel supplying only 0.6% of annual energy. For Santiago, the hybrid system settles at 70 MWp PV, 160 MWh LFP and 62 MWh LDES, with an LCOE of 171 €/MWh and a diesel share of 0.85%. On both islands, diesel remains a marginal “last resort” resource, while most of the flexibility is provided by the combined LFP–LDES storage portfolio. This role separation is illustrated in Figure 3, which shows how short-duration storage handles daily balancing while long-duration storage sustains longer deficit periods.

The broader conclusion is that LDES does not fully replace either LFP batteries or diesel; it reshapes their roles. LFP continues to do what it is best at: frequent cycling and short-duration balancing. LDES takes over the rare, deep energy def9icits that would otherwise require expensive LFP battery banks, and diesel is pushed even further into the background as a tail-risk insurance option. The result is a fully reliable, largely renewable baseload system with substantially lower LCOE and a very small residual fossil footprint.

Figure 2: Visualisation of Elestor’s redox flow battery, on basis of hydrogen & iron. The storage solution is chemically stable, can respond as quick as LFP batteries and does not require any rare materials.

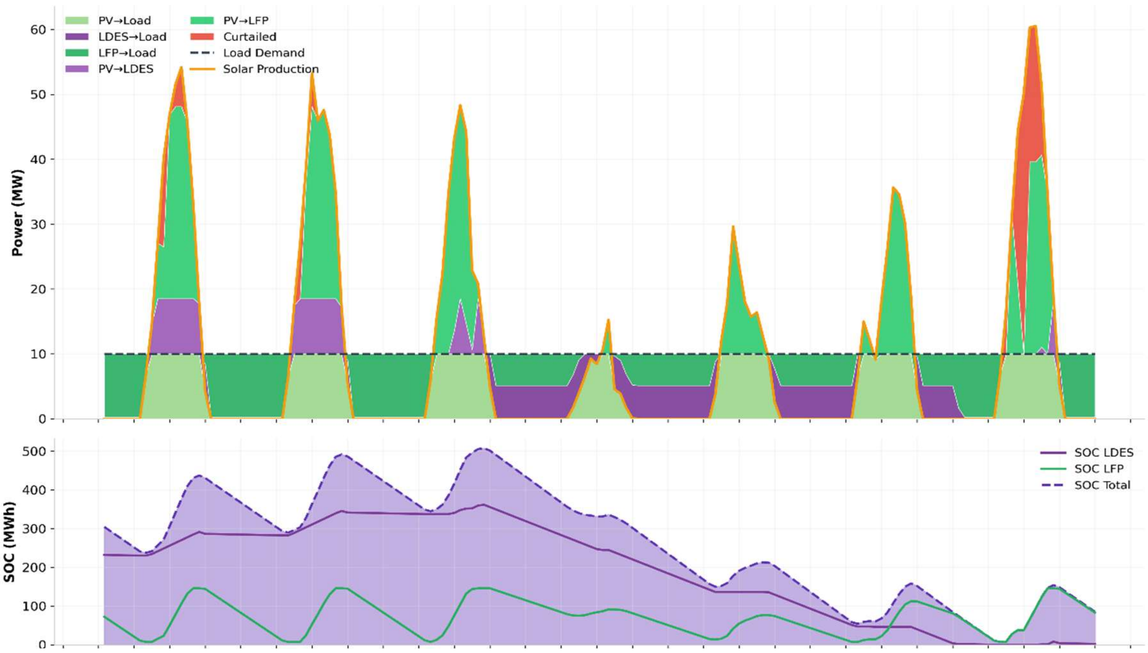
$$H_2(g) + 2\,Fe^{3+} + 3\,SO_4^{\;2-} \underset{discharge}{\overset{charg}{\rightleftharpoons}} 2H^+ + 2Fe^{2+} + 3\,SO_4^{\;2-} + electric\ energy$$



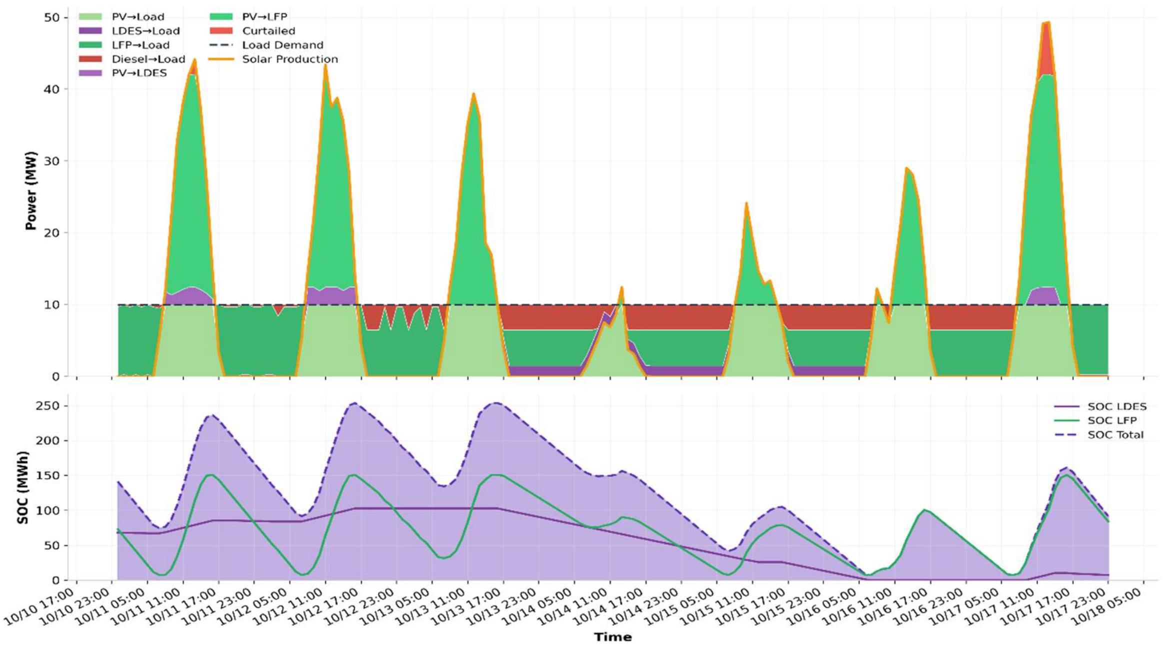
[10]In reality, we expect the sizing of LDES to be (significantly) higher. Motivation behind this is the fact that diesel has been included in this analysis at a fixed rate of 300 EUR/MWh which is unrealistic once the full load hours drop significantly. As the diesel will only be used for a limited set of hours in the year, the real costs per MWh will be different. In a next analysis, diesel will be included on a marginal + standby cost basis.

Figure 3: Dispatch of BRES with LDES on Bonaire during a multi-day cloudy period (October 2008)

(a) Pure BRES (+LDES) scenario: *Power flows from PV, LFP and LDES to the 10 MW baseload (top), and the states of charge of LFP and LDES (bottom). LDES slowly charges and discharges over the event, covering the deep energy deficit, while LFP handles the faster cycling.*



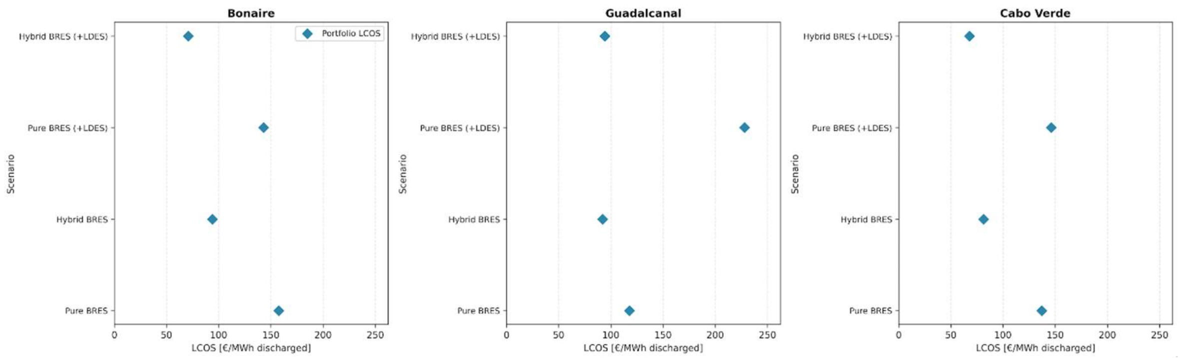
(b) Hybrid BRES (+LDES) scenario: *Same weather event with a small diesel unit available. Diesel supplies only a small share of the load but prevents extreme depletion of the storage stack, allowing a smaller overall storage volume while still meeting the 100% reliability requirement.*



4.2 Storage economics: Levelized Cost of Storage (LCOS)

In the previous sections, the main economic metric has been the LCOE of the entire BRES system: total discounted costs divided by all MWh supplied to the 10 MW baseload. For storage technologies, however, it is often useful to look separately at the Levelized Cost of Storage (LCOS) the effective cost per MWh of electricity delivered from storage to the load. Therefore, LCOS depends not only on a technology's €/kW and €/kWh, but also very strongly on how often it is used (cycles, throughput).

Figure 4: LCOS of portfolio storage (LFP and LDES combined) for Bonaire, Guadalcanal and Cabo Capo Verde (Praia)



As can be seen in Figure 4, adding battery storage capacity generally reduces portfolio LCOS because it reduces the intensity of use each separate MWh of storage. In the Pure BRES configuration, storage must cover both daily balancing and extended low-solar periods and therefore requires large capacities. Adding LDES can change the cycling pattern by shifting the rarer, deeper events away from short-duration storage, while the short-duration battery continues to cycle frequently for daily balancing. Allowing a small contribution from a generator reduces the need for storage to discharge during the most extreme shortfall hours, which typically lowers the cost per MWh discharged from storage because the storage portfolio can operate in a more regular and efficient way. In many cases, the Hybrid BRES (+LDES) configuration achieves the lowest portfolio LCOS because the generator handles the hardest shortfalls, short-duration storage provides frequent balancing, and LDES is used mainly when longer gaps occur.

The differences between the island cases reflect how much storage is needed and how often it needs to account for extended low-solar events. Bonaire and Cabo Verde show lower and more stable portfolio LCOS values, consistent with shorter and less frequent low-solar periods that allow storage to be used more regularly. Guadalcanal shows higher values, especially in configurations without a diesel generator, because longer low-solar periods require more long-duration capacity that may be used less frequently, raising LCOS even if installed capacities are high.

Finally, portfolio LCOS and system LCOE do not always move in the same direction. Adding LDES can increase portfolio LCOS if it is used rarely, because the denominator in LCOS (MWh discharged) grows slowly. Nevertheless, it is very much possible that in such events the system LCOE decreases since LDES helps to reduce the overall CAPEX of the BESS.

5 Hurdles for BRES implementation

Baseload Renewable Energy Systems offer clear advantages over diesel generation. 20 GW of diesel generation systems utilized on islands can be replaced by BRES today, whilst lowering the price of electricity by at least 30%! At the same time, it is also clear that there are several hurdles that prevent deployment of BRES on islands worldwide, despite the economic argument. To name a couple:

1. Capacity and capability to develop a BRES project is typically missing on islands.
2. Access to financing, related to the previous point, is also often missing.
3. Sufficient space to develop sufficient solar capacity; we acknowledge that a solar-only BRES requires a significant surface.
4. Locked in generation assets, be it diesel or otherwise.

All hurdles mentioned above can be overcome though, albeit not all at the desired speed perhaps. Charged Islands has been founded to provide a solution for the first two restraints, bringing together the expertise, network, experience and capacity to deliver BRES projects. Hurdles 3 and 4 are different for every island. Nevertheless, the cost of electricity could be significantly reduced if a solution if these hurdles could be found. The third hurdle is strongly dependent on the size, population density, topology and land-use characteristics of an island. BRES solutions require approximately 1 hectare per 150 people. That means that if an island has a population density of 300pax/km2, the space requirement for a BRES is about 2% of the total island surface. This means that most islands can become energy independent by making 2% of their surface available for their energy supply. In addition to the utilization of conventional solar installations, alternatives exist as:

- Agrivoltaics, combining crop cultivation and solar power generation.
- Floating solar on lakes and bays, and in the future possibly in the open ocean.
- Utilization of an abundance of roof-based solar installations, allowing to charge central batteries during the day.

Each of these solutions come with their own challenges, but offer pathways to full energy independence if conventional ground based solar installations are unfeasible.

6 Conclusions

It is evident that baseload renewable energy systems can cost-competitively replace diesel engines. This white paper clearly shows that BRES are capable of lowering the overall electricity generation costs for islands by at least 25%, in some cases possibly even by 40%.

The consequences are far reaching, as any decrease in cost of electricity between 25% and 40% will provide island inhabitants and local business with significantly more economic option space. Local governments will be able to levy a small tax on energy usage, something that typically doesn't happen in these geographies today. Islands will stop being dependent on the import of oil, suffer less from fluctuating electricity prices, become energy autarkic and can keep cash flows from their energy system on their island.

The above-mentioned economic arguments are complemented by the huge environmental gain with the reduction of CO_2 emissions. Island power generation assets are, which can now be mitigated whilst providing economic benefits.

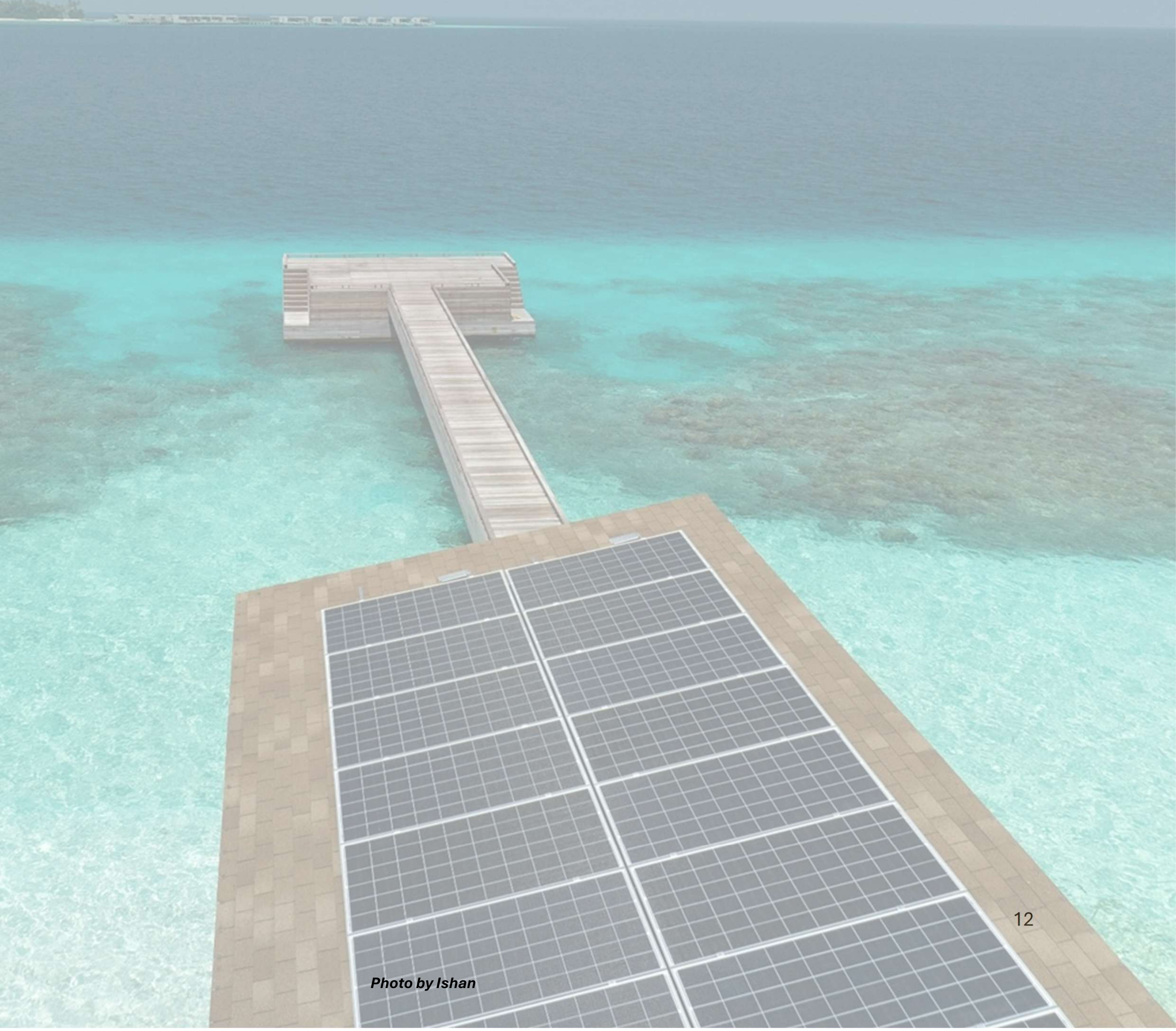


Photo by Ishan

Annex 1: About Charged Islands & Elestor

Charged Islands has the mission to deliver energy independence to islands. We believe that it is possible to significantly reduce the high energy costs on islands by means of renewables, storage and further electrification. Baseload Renewable Energy Systems offer only advantages;

- ✓ Significant reduction of cost of electricity,
- ✓ Energy independence,
- ✓ Reduction of CO_2 emissions and
- ✓ Numerous other advantages

Charged Islands is a company formed by a team of seasoned energy industry professionals. Our main goal is to develop projects on islands that deliver the BRES promise. In this way, we fill the gap in knowledge, understanding and access to technology & finance that often prevails (as described in chapter 4 of this document). Whenever required, we can also provide advisory services, as long as it contributes to the company mission statement.

Mohamad Alameh mohamadalameh@chargedislands.com

Willem de Vries willemdevries@chargedislands.com

Elestor develops and manufactures long-duration-energy storage solutions- flow battery systems. These systems are designed to deliver low-cost storage capacity, making them especially suitable for island and remote applications where affordable, large-scale energy storage is critical for integrating renewable power. Because the energy capacity (MWh) and power components (MW) are decoupled, Elestor's technology enables cost-effective scaling of storage duration, an important advantage for isolated grids with high renewable penetration.

The batteries are well suited for hot ambient environments, as the flow battery design is robust, tolerant to temperature variations, and free from thermal runaway risks associated with some conventional battery technologies. Elestor's systems are based on non-toxic, abundant materials, improving safety, environmental compatibility, and permitting—key factors for deployment in sensitive island ecosystems.

Designed for durability, Elestor batteries offer a lifetime of up to 25 years with zero energy capacity degradation and unlimited amount of cycles, resulting in low lifecycle costs and reliable long-term operation for island grids and microgrids.

Floris van Dijk floris.vandijk@elestor.com

Annex 2: Assumptions & Detail results

Appendix Table 1: Site characteristics and PV layout for the island case studies. *Geographical coordinates and PV layout parameters used in the simulations for Bonaire, Cabo Verde and Guadalcanal, including latitude, longitude and PVGIS-derived optimal tilt and azimuth angles.*

Island	Bonaire	Cabo Verde	Guadalcanal
Latitude (°)	12.044	15.046	-9.551
Longitude (°)	-68.254	-23.644	160.316
PV Tilt (PVGIS optimal, °)	12.0	17.0	7.0
PV Azimuth (PVGIS optimal, °)	196.0	213.0	75.0

Appendix Table 2: Summary of generic assumptions applied across all islands*, including discount rate, project lifetime, fuel price assumptions and other system-wide parameters used to calculate CAPEX, LCOS and LCOE. CAPEX assumptions are conservative, and a 10-year project lifetime is used to reflect realistic contract and financing horizons rather than technical lifetimes of PV and storage assets.*

Category	Parameter	Value / Setting
Economic	PV CAPEX	650 €/kW
	Battery energy CAPEX	120 €/kWh
	Battery power CAPEX	120 €/kW
	LDES energy CAPEX	Confidential[11]
	LDES power CAPEX	Confidential
	Diesel fuel cost	300 €/MWh
	Discount rate (WACC)	10%
	Financial lifetime	10 years
	Unforeseen cost multiplier	1.10 (Applied to Capex)
Battery (LFP)	Charge / discharge efficiency	0.95 / 0.95
	SOC min / max	5% / 100%
	Standing losses	0% per hour
LDES	Charge / discharge efficiency	0.85 / 0.85
	SOC min / max	5% / 100%
Solver	Framework	PyPSA linear optimisation
	Config	Load 10 MW, perfectly flat
	Time resolution	1-hour
	Weather data	PVGIS-ERA5 2005–2022 hourly

Further notes with regard to Appendix Table 2:

- The 10-year lifetime is chosen to approximate PPA and financing horizons, even though the underlying assets can operate significantly longer. As a result, no explicit salvage value or profit generation after those initial ten years is modelled; this biases the results modestly towards higher LCOE and LCOS and can be regarded as a conservative estimate of BRES economics.

[11] *The reader is advised to contact Elestor in case of interest.*

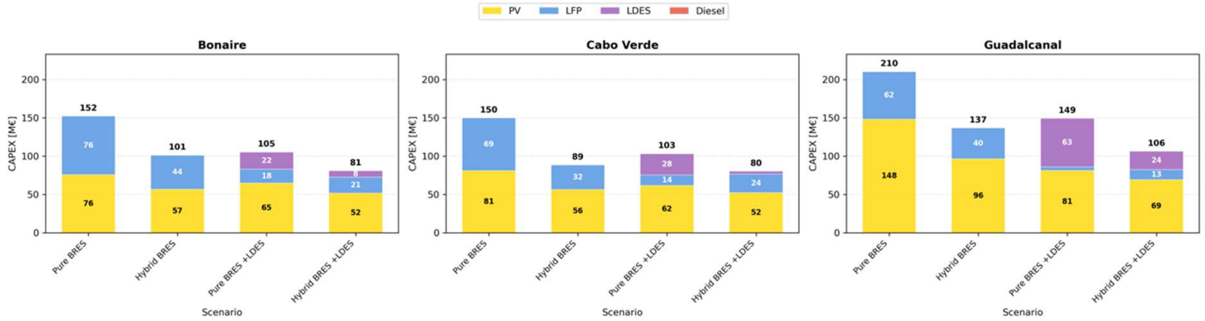
- The CAPEX assumptions are conservative and well above contemporary numbers applicable on mainland Europe as we assume a 20-30% markup for projects executed on (remote) islands. The scale of the modelled projects (i.e. 10MW of BRES often resulting in projects >100M-EUR CAPEX) should avoid that the local top-up becomes higher than 30%.
- The solar setup has not been optimized to fit demand patterns and local solar conditions. Such an optimization would improve the LCOE for each case probably.
- For practicality's sake, various omissions were done that can have noticeable influence on the total CAPEX and LCOE. The most important omissions are:
  - Local topology & geology
  - Local costs as SPV maintenance costs and land lease costs
  - Tailored cost of capital
  - Solar or BESS degradation, which are expected to be minimal in the assessed 10 years
  - Taxation
  - Diesel price not adjusted for low Full Load Hours
  - Addition of other (possibly existing) renewables. It is probable that addition of specific other renewables, in particular wind, could result in even better LCOE numbers from BRES

Appendix Table 3: *Storage utilisation of LFP and LDES in BRES (+LDES) configurations*
Installed energy, annual discharge to the load and equivalent full cycles per year for LFP and LDES in the Pure BRES (+LDES) and Hybrid BRES (+LDES) configurations on Bonaire, Santiago (Cabo Verde) and Guadalcanal. The table illustrates how LFP provides high-cycle, short-duration flexibility, while LDES operates with fewer cycles per installed MWh and covers deeper, less frequent energy deficits.

Island	Scenario	Technology	Installed energy (MWh)	Discharge to load in full 18y period (MWh)	Equivalent full cycles per year
Bonaire	Pure BRES (+LDES)	LFP	146	858,162	327
		LDES	361	43,494	7
	Hybrid BRES (+LDES)	LFP	151	1,288,840	475
		LDES	103	37,574	20
Santiago	Pure BRES (+LDES)	LFP	150	872,423	324
		LDES	424	49,434	6
	Hybrid BRES (+LDES)	LFP	160	1,376,798	478
		LDES	62	15,064	14
Guadalcanal	Pure BRES (+LDES)	LFP	58	340,900	324
		LDES	1,292	555,328	24
	Hybrid BRES (+LDES)	LFP	135	1,168,390	480
		LDES	390	139,651	20

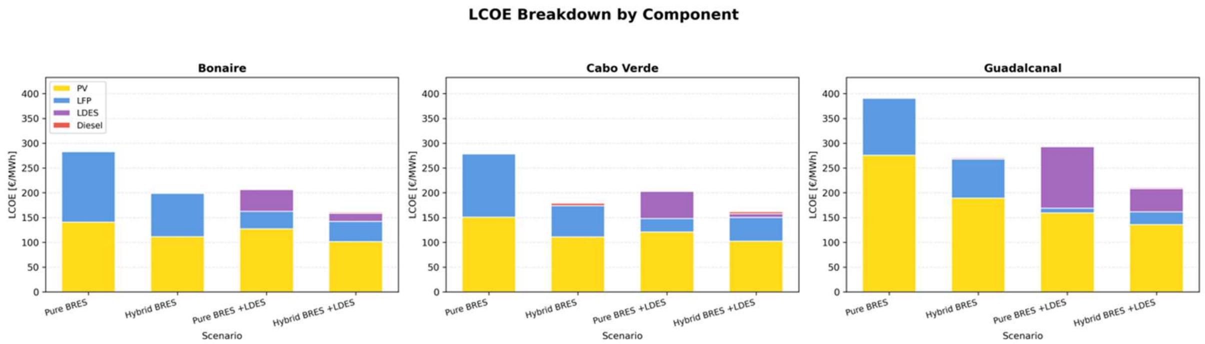
Appendix Figure 1: CAPEX breakdown for BRES configurations on three islands

Total investment cost (M€) for Pure BRES, Hybrid BRES, Pure BRES (+LDES) and Hybrid BRES (+LDES) on Bonaire, Cabo Verde and Guadalcanal. Bars are stacked by technology, showing the contribution of PV, LFP battery capacity and LDES to total CAPEX, with the scenario total indicated above each column



Appendix Figure 2: LCOE breakdown by component for BRES configuration on three islands

Stacked LCOE contributions of PV, LFP storage, LDES and diesel for Pure BRES, Hybrid BRES, Pure BRES (+LDES) and Hybrid BRES (+LDES) on Bonaire, Cabo Verde and Guadalcanal. The figure shows how adding limited diesel and LDES shifts the cost structure away from short-duration battery storage and lowers the overall LCOE of firm baseload supply.



Appendix Figure 3: Annual energy supply mix by technology for BRES configurations

Share of annual baseload demand supplied directly by PV, by LFP storage, by LDES and by diesel for Pure BRES, Hybrid BRES, Pure BRES (+LDES) and Hybrid BRES (+LDES) on Bonaire, Cabo Verde and Guadalcanal. Bars show how the introduction of LDES and limited diesel reshapes the balance between direct solar generation and stored energy.