CABO VERDE
THE MID - ATLANTIC GATEWAY
TO THE WORLD'S ECONOMY

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The National Program for Energy Sustainability (NPES)

The long-term strategy is to accomplish the transition to an energy sector that is:

- secure,
- efficient,
- sustainable, without reliance on fossil fuels and,
- capable to insure universal access and energy security.

The National Program for Energy Sustainability (NPES)

Main Axes

- Institutional Strengthening and Improvement in Business Environment
- Energy Market Reform
- Promotion of Energy Efficiency
- Renewable Energy Development
- Investments in Strategic Infrastructure

New Axes

- Promotion of Entrepreneurship and R&D
- Inclusion and Gender Equity

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Project Pipeline 2019 - 2030

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- Renewable Energy Development
- Promotion of Energy Efficiency
- Invest..s in Strategic Infrastructure
- Energy Market Reform
- Institutional Strengthening

ID	Projects	Total (M €)
ENER01	Wind and Solar IPPs	248,9
ENER02	Santiago PSP	50,1
ENER03	Battery Storage	60
ENER04	Distributed Generation	7
ENER05	Energy Efficiency Project	23
ENER06	Brava Sustainable Island (Phase 1)	8,5
ENER07	E-mobility	19,8
ENER08	Grid Reinforcement	39
ENER09	Financing of Risk Mitigation Instruments (De-Risking)	15
ENER10	Institutional Strengthening and Reform of the Organizational Structure of Energy Market	5,5
TOTAL (M€)		476,8

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Renewable Enegy Targuets

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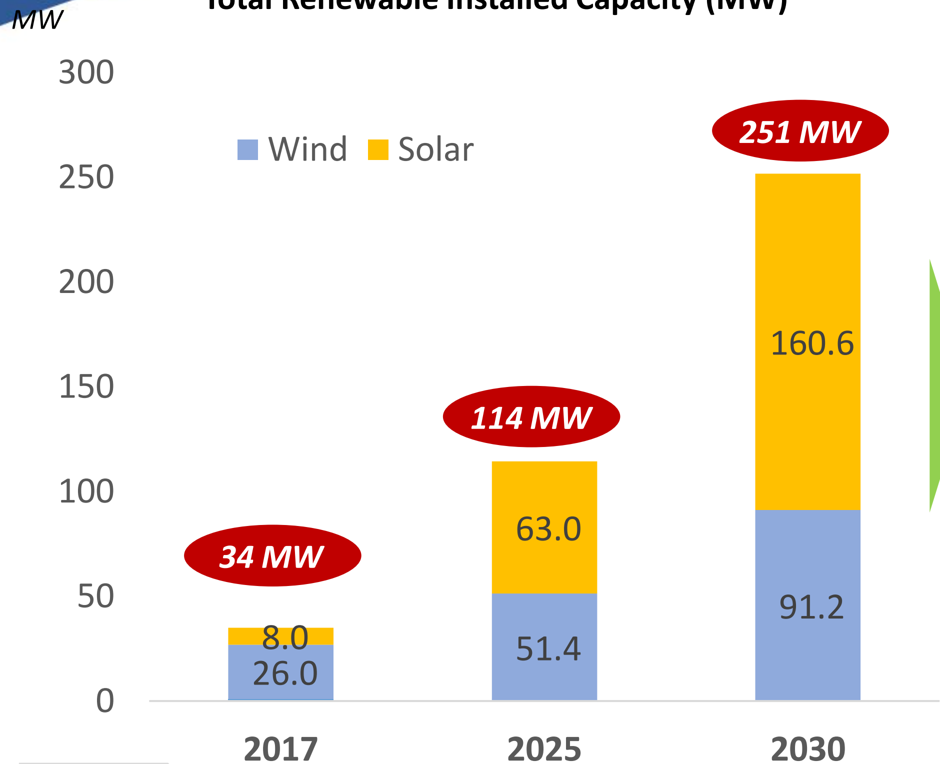
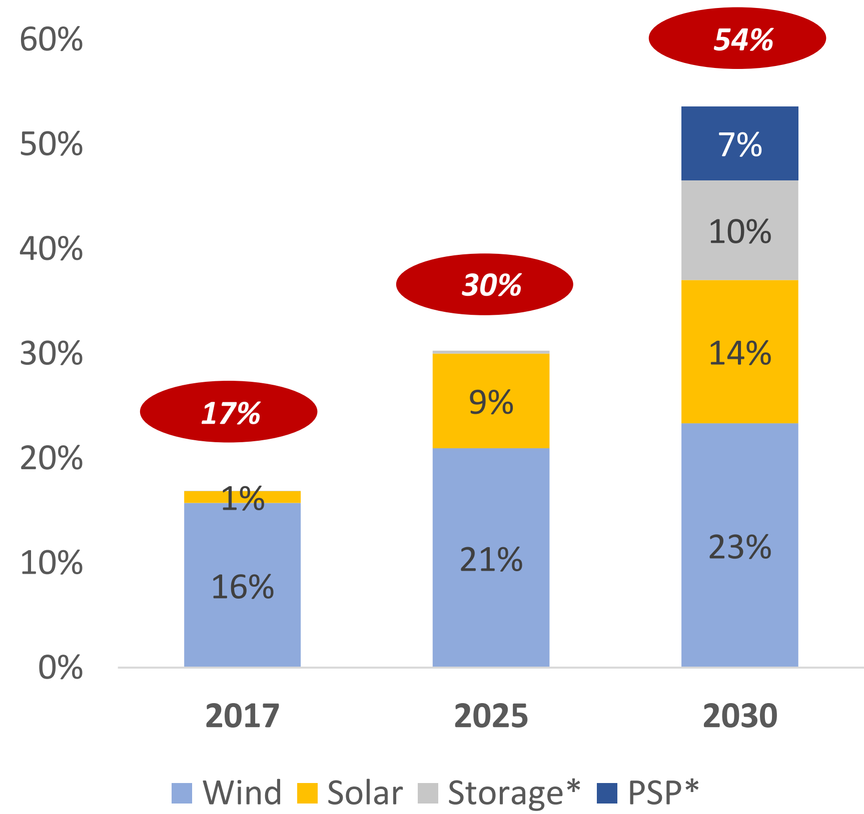
Total Renewable Installed Capacity (MW)



Storage (MWh)	0	6	615

Percentage of Renewable Energy Generation



* Storage and PSP % represents part of renewable generation stored and discharged through inverters or turbine

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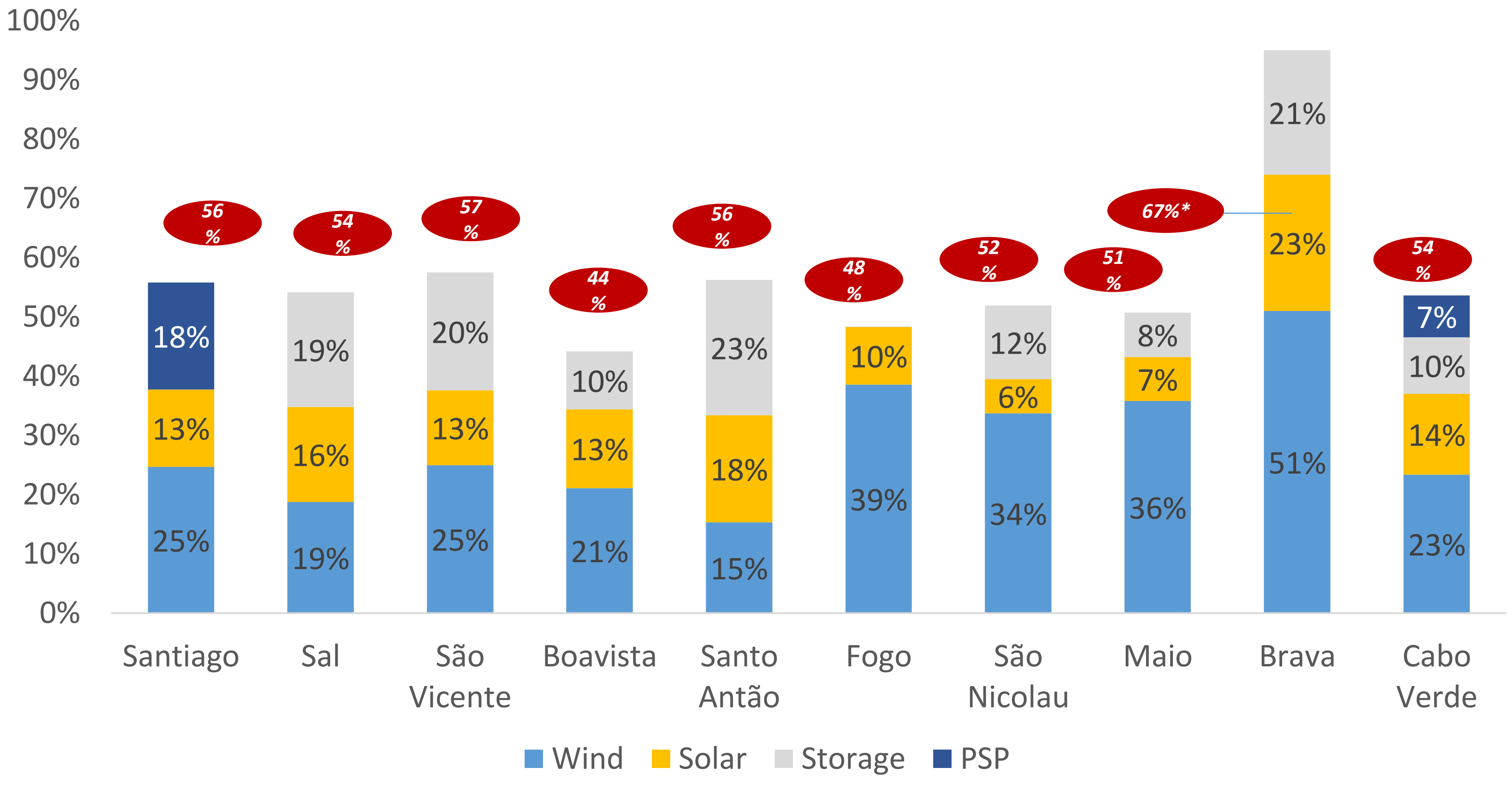
Fonte CV Master Plan 2018-2040

2030 Renewables penetration per Island



* Only technically achievable 67% renewable penetration in Brava has been considered

Energy Eficiency

Etiquetas Energéticas de Cabo Verde

Etiqueta de Garantia

Etiqueta Comparativa

Energy efficiency in buildings

Energy efficiency for appliances

Pilot demonstration projects

Replication and dissemination

Electric Mobility charter:

- Strategic vision for the adoption of electro-mobility in the country and the implementation of a public charging infrastructure.
- Key objectives:
  - Public Administration with 100% of electrical vehicles by 2030.
  - National public charging infrastructure by 2030.
- All vehicles to be electric by 2050

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Power System Objetives

1. Increase electricity share from renewables
- To reduce energy dependency on fossil fuels

2. Guarantee stability and security
- Power system enhancement in presence of higher renewable sources

3. Reduce losses
- Losses have relevant values in the country

4. Generation & operation cost reduction
- Leading to lower cost of electricity for customers

5. Facilitate the integration of Distributed Energy Resources
- Customer empowerment and microgrids

6. Increase the efficiency of the electricity consumption
- Demand increase management and consumption pattern collection

7. Improve the quality of supply of customers
- To reduce outages

8. ICT and Cyber Security Enhancing
- Guarantee the adequacy of communication infrastructure and its security

9. E-Mobility and transport electrification
- Develop public infrastructure for charging management of electrical vehicles

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Ongoing IPP Projects

- Development of 37 MW of RE as IPPs is underway
  - 5 MW solar PV IPP in Boa Vista Island (Gamma Solutions);
  - 13 MW wind farm IPP in Santiago (cabéolica exp. project);
  - 5 MW solar on São Vicente Island (APP/ Impulso);
  - 5 MW solar on Sal Island (APP/ Impulso);
  - 10 MW solar IPP in Santiago Island (on going tender);
  - Repowering existing 5MW solar in Santiago and 2,5 MW in Sal;

Ongoing Storage Projects

- **BESS 1MW/1MWh in Sal (to be concluded in Dez2022).**
- New BESS 5MW/5MWh in Sal (cabéolica exp. project)
- New BESS 5MW/5MWh in Santiago (cabéolica exp. project)
- BESS 5MW/5 MWh for Boavista;
- BESS 4MW/4 MWh for S. Vicente;
- **PSP 20MW/160MWh for Santiago**

2. WHY OF CHOSEN SAL ISLAND FOR PROJECT IMPLEMENTATION

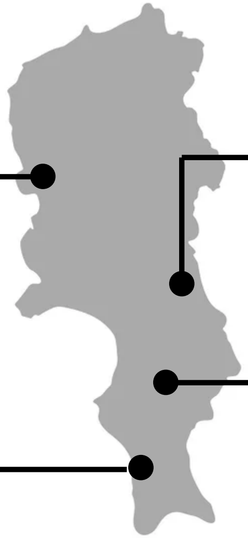
RENEWABLE PENETRATION RATE

2018	2019	2020	2021
26.4%	27.6	28.3%	29.3%

- ✓ Currently is the Island with the Highest Penetration Rate
- ✓ Curtailment of Wind Farm injection is being applied to Prevent System instability
- ✓ Ongoing projects to increase RE Installed Capacity

Palmeira Thermal Power Station 13,5 MW (actual)

CABEOLICA Wind Farm (IPP) 7,65 MW



APP Independent Producer Thermal + PV

PV FATIMA IPP 2,25 MWp

5. FUNCTIONS & APPLICATIONS OF PILOT STORAGE SYSTEM

BESS Functions

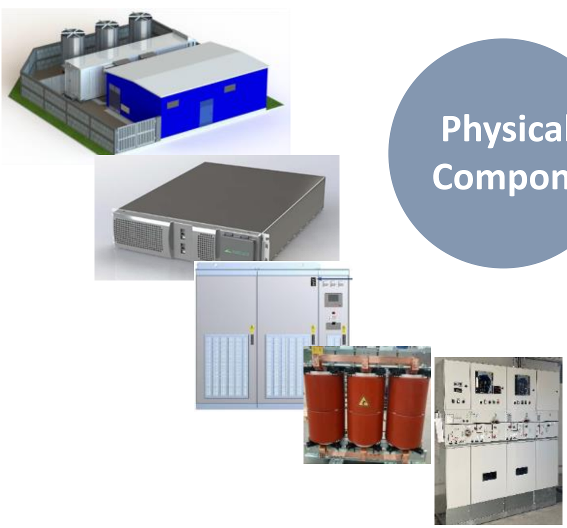
Autonomous

BESS response is autonomous based on events and pre determined settings

On Demand

BESS response is based on setpoints introduced by Operator

4. PILOT BATTERY STORAGE SYSTEM DESIGN AND COMPONENTS



BESS

Physical Compon.

Logical Compon.

- ✓ **1 MW / 1MWh AT PCC**

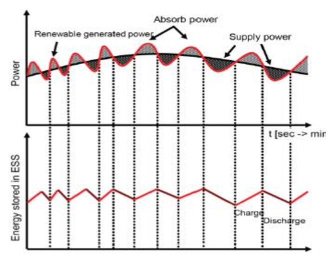
5. FUNCTIONS & APPLICATIONS OF PILOT STORAGE SYSTEM

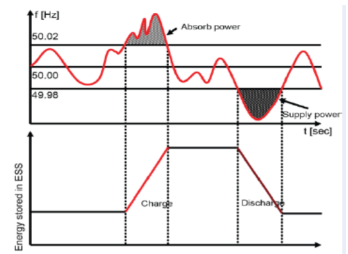
BESS Functions

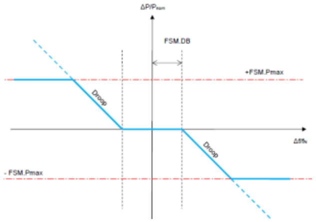
AUTONOMOUS

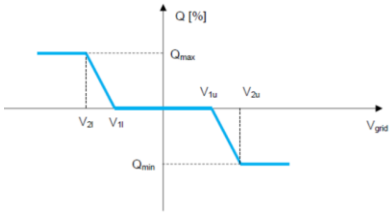
AUTONOMOUS FUNCTIONS

- Capacity Firming (RESF)
- Frequency Sensitive Mode (FSM)
- Voltage Control (Q (U) -REG)
- Power Factor Control - COSPHI-REG









5. FUNCTIONS & APPLICATIONS OF PILOT STORAGE SYSTEM

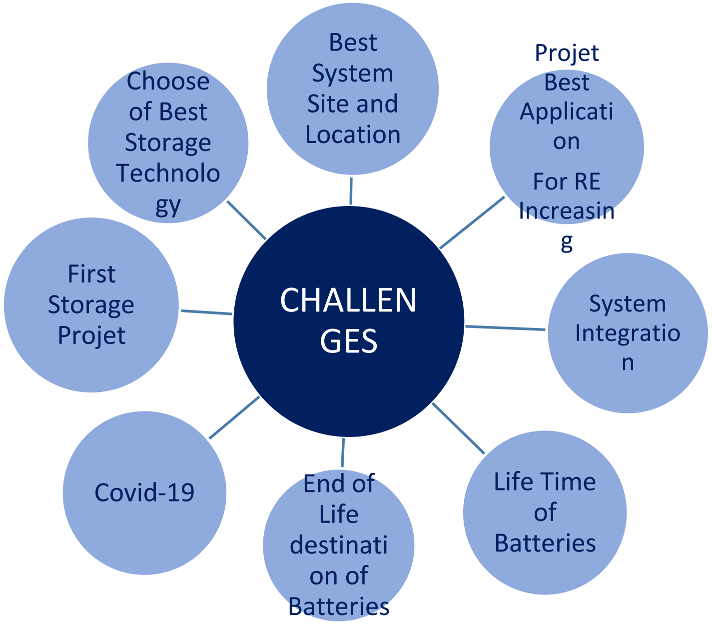
BESS Functions

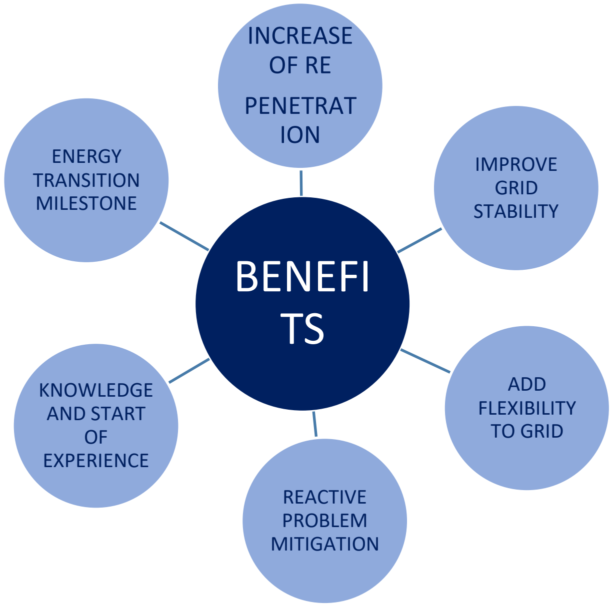
AUTONOMOUS

ON DEMAND FUNCTIONS

- (P) – Active Power (kW)
- (Q) – Reactive Power (kVAr)
- Dispatch program

6. CHALLENGES AND BENEFITS

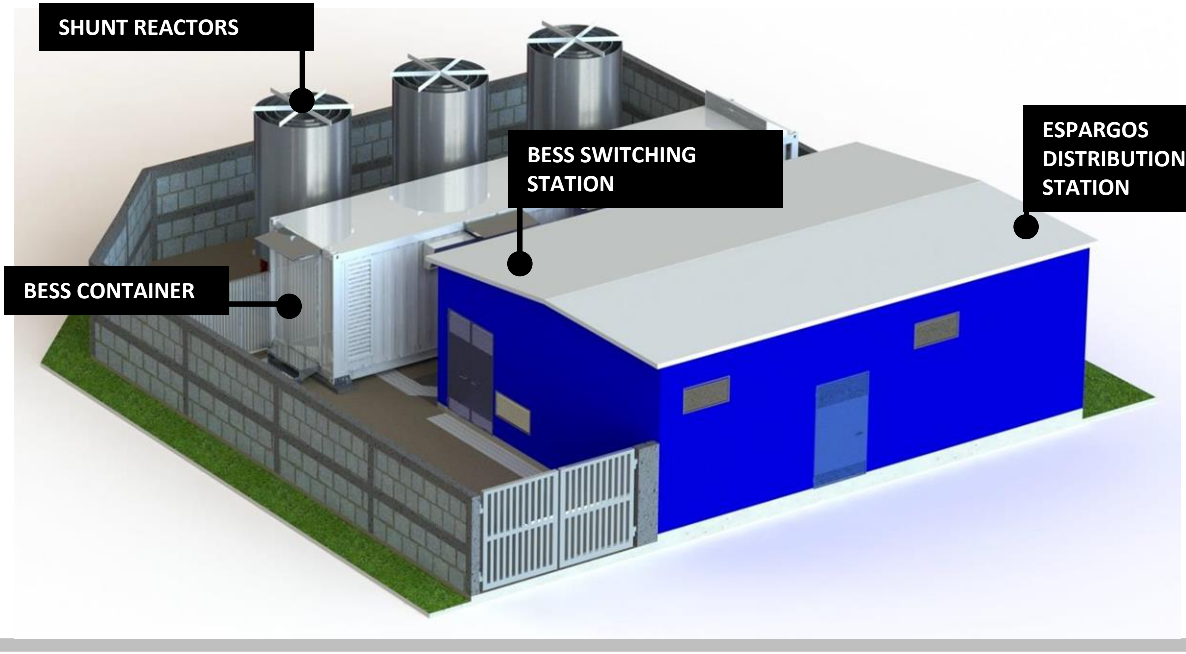




4. PILOT BATTERY STORAGE SYSTEM DESIGN AND COMPONENTS

Physical Compon.

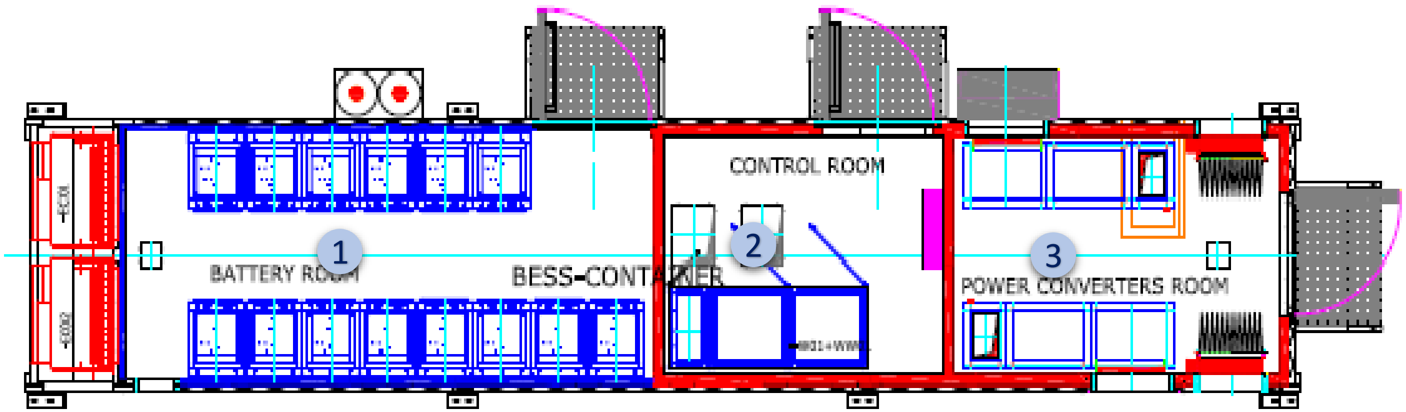
BUILDING 3D VIEW



4. PILOT BATTERY STORAGE SYSTEM DESIGN AND COMPONENTS

Physical Compon.

BESS CONTAINER



1. Battery room
2. Control room
3. Power Converter Room

Cabo Verde, Renewable Energy and Improved Utility Performance Project (WB/ESMAP Support)

- The estimated project cost is US$16.5 million equivalent, which includes the following sources of financing:
  - (a) US$3.5 million IBRD loan;
  - (b) US$3.5 million equivalent IDA credit;
  - (c) US$7.0 million loan from the Canada Clean Energy and Forest Climate Facility (CCEFCF);
  - (d) US$0.5 million grant from the CCEFCF;
  - (e) US$2.0 million grant from Global Infrastructure Facility (GIF).

Cabo Verde, Renewable Energy and Improved Utility Performance Project (WB/ESMAP Support)

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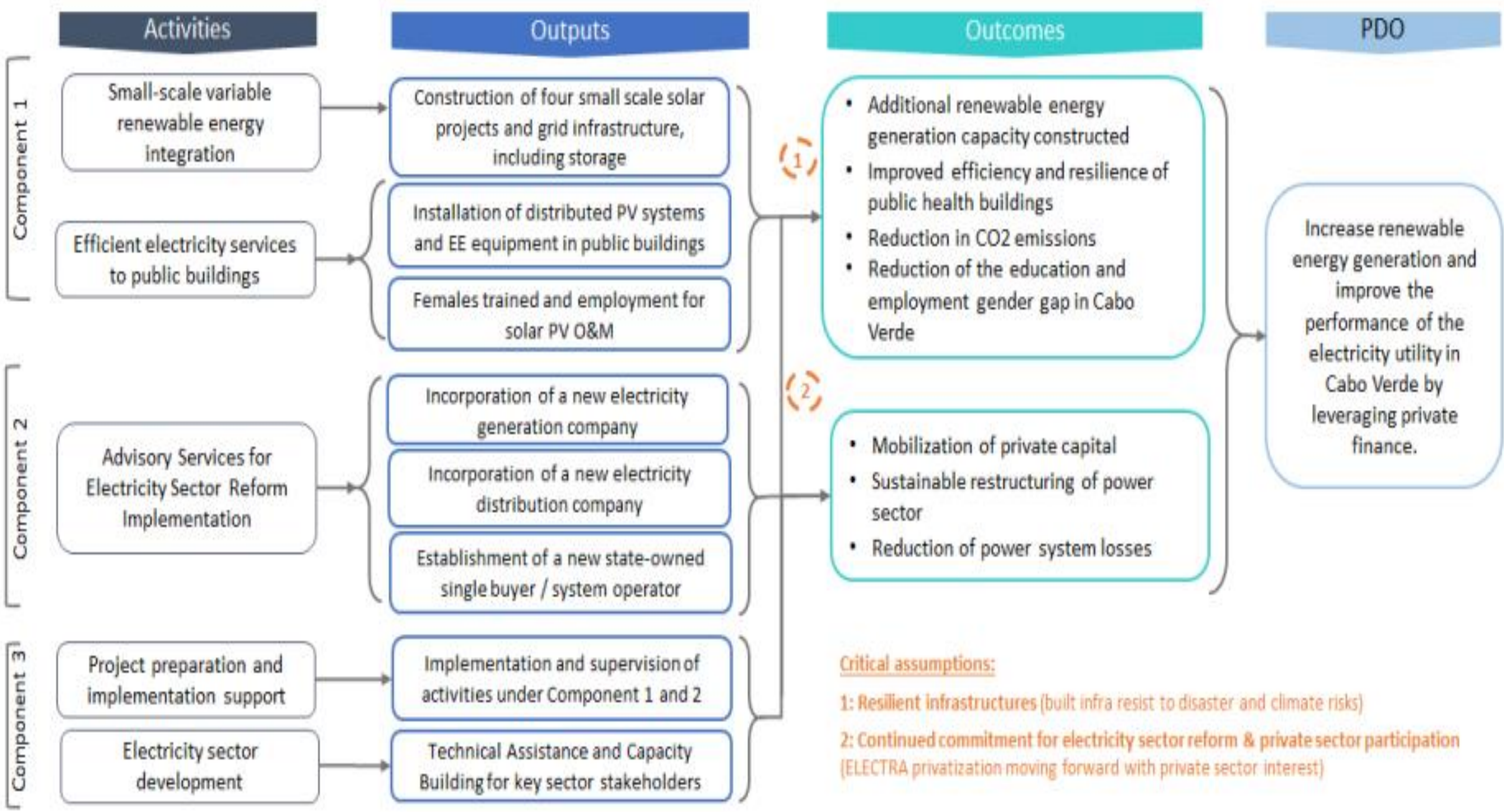
Figure 2. Theory of Change



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WB Suported

- **Four small-scale solar PV projects:**
  - **1.3 MW for Fogo Island;**
  - **1.2 MW for Santo Antão Island;**
  - **0.4 MW for Maio Island;**
  - **0.4 MW for São Nicolau**
  - **Battery storage investments for this systems are also been considered.**

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MRC | CONSULTANTS AND TRANSACTION ADVISERS
A member of the MRC Group of Companies

CLEANHORIZON
The Energy Storage Experts

Presentation of main results from the BESS analysis in 5 islands in Cabo Verde

Objetives

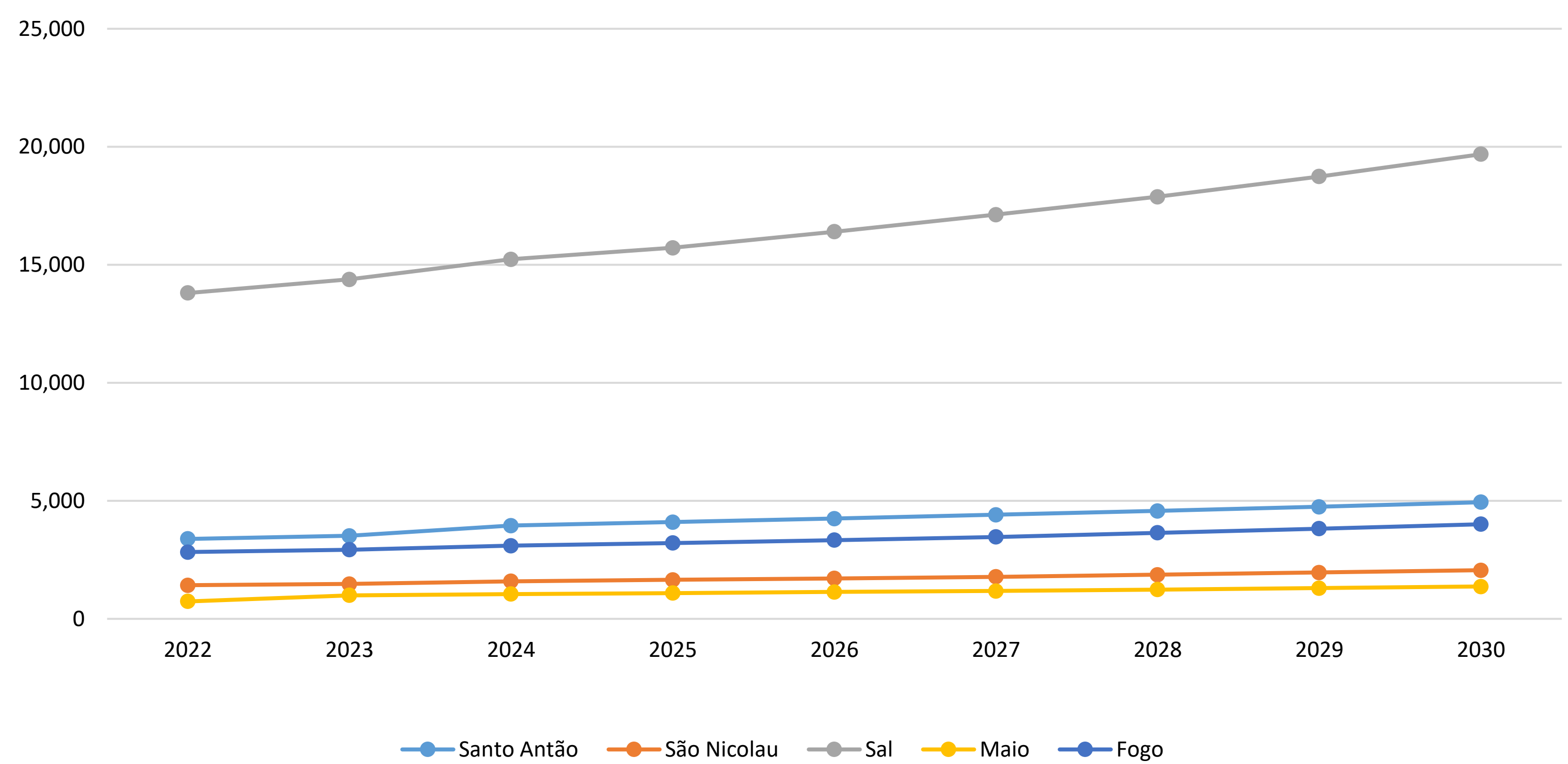
- **To conduct the analysis until 2040 and in order to determine how much new renewable capacities, taking into account the evolution of the load on 5 islands of Cabo Verde: Sal, Maio, Fogo, Santo Antão and São Nicolau;**
- **To determine the optimal amount of battery energy storage systems to install on those islands in order to comply with the ambitious renewable penetration goals set by the national Master Plan issued in 2018-2040, as well as to minimize the cost of electricity generation on those islands;**
- **To see if the addition of a battery can optimize the dispatch of existing plants to minimize the cost of electricity production;**
- **The 100% renewable target by 2040 would require further analysis which goes beyond the scope of our study.**

Table 2: Total electricity demand in the business as usual scenario for each island.

Yearly demand for each island	2020	2025 (Interpolated by consultant)	2030	2040
Sal	114.4 GWh	147.40 GWh	180.4 GWh	201.6 GWh
Santo Antão	18.9 GWh	20.1 GWh	21.4 GWh	22 GWh
Fogo	14.7 GWh	15.8 GWh	16.9 GWh	18.2 GWh
São Nicolau	6.96 GWh	7.42 GWh	7.87 GWh	8.41 GWh
Maio	6.29 GWh	7.43 GWh	8.56 GWh	12.2 GWh

Evolution of the load per island from 2022 to 2030

In kW



	Project implementation options	
	Size of the storage system considered for the project implementation	**Justification for the project**
Sal	5 MW / 5 MWh	Grid stability and reserve provision
Maio	0.5MW/1MWh	Cost reduction and reserve provision
Fogo	2.08 MW / 2.08 MWh	Grid stability and reserve provision
Santo Antão	1.4 MW / 2 MWh	Grid stability and reserve provision
São Nicolau	0.5MW / 1MWh	Cost reduction and reserve provision

- Storage is used in two main ways to minimize the total cost associated with electricity generation over the period 2025 - 2040:
- **Reserve supply :** Thermal power plants have reserve obligations, which prevent them from generating electricity at their maximum capacity. Thus, generation plants with low SRMCs cannot be operated at their maximum, and the system must resort to using plants with higher SRMCs, which increases the overall cost of electricity generation.
- Thus, storage can provide the reserve obligation of thermal entities with low short-term marginal cost, so that they can be used to their maximum capacity and the use of power plants with higher SRMC can overall be reduced.
- **Load Shifting:** When thermal power plants have technical constraints such as minimum generation, when demand is low, the production of renewables must be capped. Storage can intervene to charge the otherwise capped energy during periods of low demand and discharge it in the evening when demand is higher, to avoid the use of peak power plants which are usually expensive.

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Thank you!

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