The Link between Power Investments, Incomes and Jobs in Cape Verde

Final Report

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Contents

EXECUTIVE SUMMARY

In this study a framework is developed by Steward Redqueen (SRQ) to quantify the employment and income effects of the Africa Finance Corporation (AFC) and Finnfund's investments in power infrastructure in Cape Verde. These investments were made in Cabeolica – a renewable energy firm operating four wind farms with a combined capacity of 25.5MW across four islands in Cape Verde: Santiago (9.4 MW), Sao Vincente (6.0 MW), Sal (7.7 MW), and Boa Vista (2.6MW).

Methods

The methodology used in this study to estimate the economic impact of investments in the electric power sector in Cape Verde largely follows the one developed and tested during previous studies conducted by SRQ in the Philippines and Turkey (International Finance Corporation), Uganda (CDC Group plc), India and Uruguay (Proparco), Senegal (Private Infrastructure Development Group) and Nigeria (Nigeria Infrastructure Advisory Facility). In these studies, the current power supply and demand situation in the country in question were analysed and a counterfactual situation of what would have happened had new generation capacity not been commissioned was constructed. In this way, changes in electricity price and employment relative to a hypothetical case in which DFI-invested projects were not realized were calculated. The manner in which additional capacity affects outages and production times of companies to determine if and how changes in production affect employment and income generation was also analysed.

The composite methodology developed in this research project consists of analyses of existing data sources to quantify how power availability and affordability affect economic output. In particular, the following methods were utilized:

1. Construction of an electricity price model based on the available supply and demand information in Cape Verde and construction of a situation in which Cabeolica is added to the power fleet;
2. Analysis of Cape Verde's outage data from Electra's (the Cape Verdean electricity and water utility) annual reports, as well as analysis of the relation between outage time and firms' production response, based on data from the World Bank Enterprise Survey lastly carried out in Cape Verde in 2009;
3. Estimation of the related economic output and employment increase in Cape Verde using input-output modelling and employment intensity data from the country.

The study is based on desk research and telephone interviews with Cabeolica and stakeholders from the power sector in Cape Verde. For the analysis, publically available macro-economic and power sector data was used, as well as financial and commercial data from Cabeolica.

Key findings

1. Cape Verde has an installed capacity of 162 MW, of which about 65 MW is effectively in use, based on annual average utilization rates. About 77% of the total installed capacity is thermal (HFO/Diesel), 16% is wind, and about 7% is solar;
2. Between 2011 and 2012, the AFC and Finnfund-supported wind company Cabeolica added 25.5 MW of renewable capacity to the country's fleet. Adjusted for annual average utilization, Cabeolica added 8.6 MW of capacity, or about 14.4% addition to the total effective supply;
3. The demand for electricity, peaking at 68 MW in 2016, is met predominantly by thermal generation;
4. By adding cheaper renewable load than the thermal plants, Cabeolica is estimated to have decreased the weighted average generation costs in the country by 7.7%. This reduction is to be interpreted compared to the counterfactual situation in which Cabeolica would not have been added to the grid, and its production was instead done by thermal sources. Given that electricity prices in Cape Verde are not yet fully reflective of all costs in the system, it cannot be concluded if the

decrease in generation cost has led to decreases in the final consumer electricity price. The lower generation cost supports the transition towards a more cost reflective energy tariff and thereby improves the financial situation of Electra and the government.

5. The partial shift from thermal generation to wind is estimated to have led to displacement of 11.8% of Cape Verde's 2016 imported fuel, valued at €10.6 million (based on a price of CV 68/kg, or EUR 0.61/kg), equal to 2.1% of the country's trade deficit. Lower fuel utilization in the energy mix also translates to lower overall CO_2 emissions. Based on its 2016 generation, Cabeolica is estimated to have contributed to the avoidance of 58.7 kt of CO_2 emissions, or approximately 12% of Cape Verde's total 2016 emissions, valued at EUR 0.2 million.
6. By adding capacity to the grids of four islands of Cape Verde, Cabeolica is estimated to have contributed to the decrease in outage time on the four islands by an average of 50%. This reduction in outages is estimated to have increased the annual production time of firms on these islands by an average of 2%. Translated into national increase of production, Cabeolica is estimated to have increased Cape Verde's firm output by 0.2%, or EUR 3.8 million.
7. The employment effect related to this increase in production is estimated at approximately 390 jobs, of which 370 are in electricity-dependent sectors and 20 are in agriculture. Due to wide-spread underemployment in Cape Verde, many of the calculated jobs could represent people affected (i.e. people receiving incomes from occasional work activity) rather than formal jobs in full-time equivalents.
8. Through day-to-day operations, Cabeolica supports €3.1 million in value added, directly and indirectly, through salaries, profits, and taxes, equivalent to 0.32% of GDP. Also Cabeolica supports more than 50 jobs indirectly in the economy. Additionally, Cabeolica contributed to developing the technical skills of Cape Verde's labour force by sourcing and training local employees and shared learnings with representatives from renewable countries in neighbouring African countries.
9. These results reflect the effect of adding Cabeolica's four wind farms to Cape Verde's fleet, without taking into consideration attribution factors of the proportion of AFC and Finnfund's respective investments into Cabeolica.

Impact of Cabeolica

AFC and **FINNFUND** invested **€ 16** million out of total **€60.9** million in **CABEOLICA,** a renewable power company with **4 WIND FARMS** in Cape Verde.

Cabeolica added **25.5 MW** of installed capacity or **8.6 MW** adjusted for utilization

The additional capacity of Cabeolica led to estimated

8% DROP IN GENERATION COSTS, resulting in

22% IMPORTED FUEL DISPLACED in 2016 valued at **€10.6 MILLION** , equal to **2%** of Cape Verde's **TRADE DEFICIT**

59 KT CO_2 EMISSIONS AVOIDED, equal to **12%** of Cape Verde's **EMISSIONS** in 2016 valued at **€ 0.2 MILLION**

50% DROP IN OUTAGE TIME on the four islands,

which led to increased firm production and the creation of

390 JOBS

€ 1.9 MILLION IN INCOMES

for households (salaries), firms (profits), and the state (taxes)

The annual operations of Cabeolica support **10 DIRECT** and **52 INDIRECT JOBS**

Cabeolica further benefits Cape Verde's economy through investments in **LOCAL SOURCING, KNOWLEDGE DEVELOPMENT** and **SHARING OF KNOW-HOW**

THE LINK BETWEEN POWER INVESTMENTS, INCOMES, AND JOBS IN CAPE VERDE

FOR AFRICA FINANCE CORPORATION AND FINNFUND

1 INTRODUCTION

The absence of reliable, adequate, and affordable power is recognised as one of the main barriers to broad-based economic growth and social development. Poor and/or expensive electricity supply stifles economic activity by reducing productivity and hampering the development of industry and trade which are important drivers of employment and growth.

Electricity in Cape Verde is produced predominantly by thermal power plants. Reliance on diesel and heavy fuel generation has led to high electricity tariffs, higher than in other Sub-Saharan African countries.

Contributing to Cape Verde's power sector development, the Africa Finance Corporation (AFC) and Finnfund invested in Cabeolica – a renewable energy firm operating four wind farms on Santiago (9.4 MW), Sao Vincente (6.0 MW), Sal (7.7 MW) and Boa Vista (2.6 MW).

The theory of change and previous research indicate that a stronger physical infrastructure, in particular in the power sector, has an important impact on economic development for shared prosperity and poverty reduction. The objective of this report is to assess the impact of AFC and Finnfund's power generation investments on incomes and employment in Cape Verde. By doing so, we aim to contribute to the understanding of how improvements in power availability and affordability affect development across economic sectors and actors.

Structure of report

The remainder of this report covers the following topics:

- Section 2 provides an overview of Cape Verde's economy and its power sector;
- Section 3 describes the analytical framework used to quantify how improvements of power availability and affordability brought about by Cabeolica impact the economy (forward effects), as well as the results of this analysis;
- Section 4 discusses the impact of Cabeolica from its annual expenses (backward results), as well as the additional non-financial value the company brings to Cape Verde's economy;
- Section 5 summarises the main conclusions of the analysis and presents a few recommendations.

Acknowledgements

The authors acknowledge Engº Rito Évora (Director of Energy, Ministry of Industry, Trade, and Energy), Engº Jansénio Delgado (Renewable Energy Expert, ECOWAS Regional Center of Renewable Energy and Energy Efficiency), and Engº João Fonseca (Electra Board Advisor), for taking the time to share with us their knowledge of Cabeolica's impact on the power sector in Cape Verde. The authors would also like to acknowledge the Cabeolica staff that provided data for the report.

2 CAPE VERDE: ECONOMY AND POWER PROFILE

2.1 Macro-economic profile

Cape Verde is a small state comprising ten islands, nine of which are inhabited, and is situated approximately 500 km off the west coast of Africa. The ten islands are grouped into the *Barlavento*, or Windward Islands, including Santo Antao, Santa Luzia, Sao Nicolau, Sal, and Boa Vista, and the *Sotavento*, or Leeward Islands, which include Maio, Santiago, Fogo, and Brava. The country has a population of roughly 560,000 people, more than half of whom live on the island of Santiago, where the capital city, Praia is located. Cape Verde has one of most politically stable and democratically inclusive governance systems in Africa. In the 2017 Ibrahim Index of African Governance, Cape Verde was ranked fourth in terms of overall governance and rule of law and first in terms of participation and human rights.

A middle income country, in 2016 Cape Verde had a gross domestic product (GDP) of USD 1.6 billion in current US dollar value (USD 1.8 billion in constant 2010 US dollar value).[1] After a period of stagnant growth between 2012 and 2014, the economy grew by 1.1% and 3.6% in 2015 and 2016 respectively. In comparison, other small states[2] have on average been growing at a slower and/or declining rate (Exhibit 1) over that period. GDP is expected to continue its upward trajectory in 2018, with an expected growth of 4%, driven by a growing tourism sector and rising private consumption.[3]

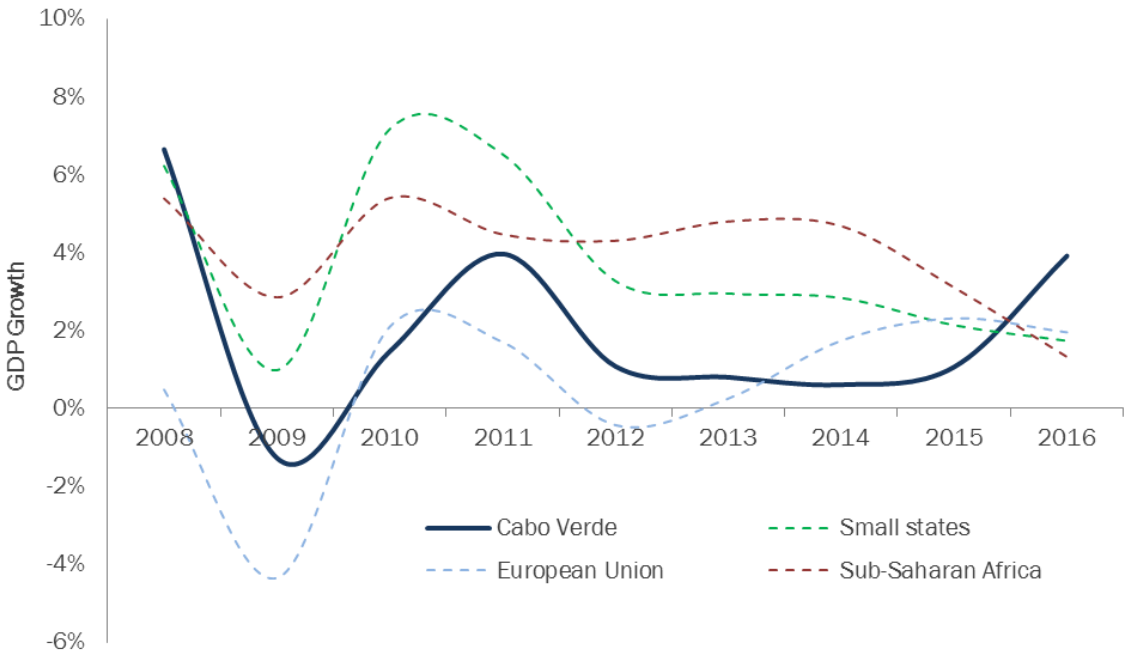

Exhibit 1: Annual GDP growth (source: World Bank)

The Cape Verdean economy is dominated by the services sector, which accounts for more than 70% of GDP. The remainder includes the industrial (20%) and agricultural (10%) sectors. The services sector depends largely on tourism, especially from Europe, but also commerce, transport and public services.

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[1] All GDP and investment data courtesy of the World Bank Development Indicators database. https://data.worldbank.org/country/cabo-verde?view=chart

[2] Small states are characterized by the World Bank as having a small population, limited human capital, and a confined land area. The country group is diverse and includes 41 countries mostly in Africa, Europe, and the Asia-Pacific.

[3] Cape Verde Country Note. 2018 African Economic Outlook. African Development Bank.

GDP composition remained stable over the past years. Household consumption was the largest share of GDP in 2016, followed by investment, government expenditures and net imports (Exhibit 2). In 2016, Cape Verde exported $97.5m and imported $804m worth of goods and services, resulting in a negative trade balance of $706m.[4] Cape Verde's largest trading partners are Portugal, Nigeria, Spain and Italy. The close relationship between Cape Verde and its southern European trading partners exposed Cape Verde's economy to the Eurozone crisis. During the crisis, foreign investment, development aid and tourism from Europe declined. As a result, the Cape Verdean economy stagnated.[5] However, recent growth in the Eurozone following the crisis has in turn contributed to rising growth in household consumption and investment in Cape Verde. Increased investment, especially in tourism, is expected to continue through 2018.[6]

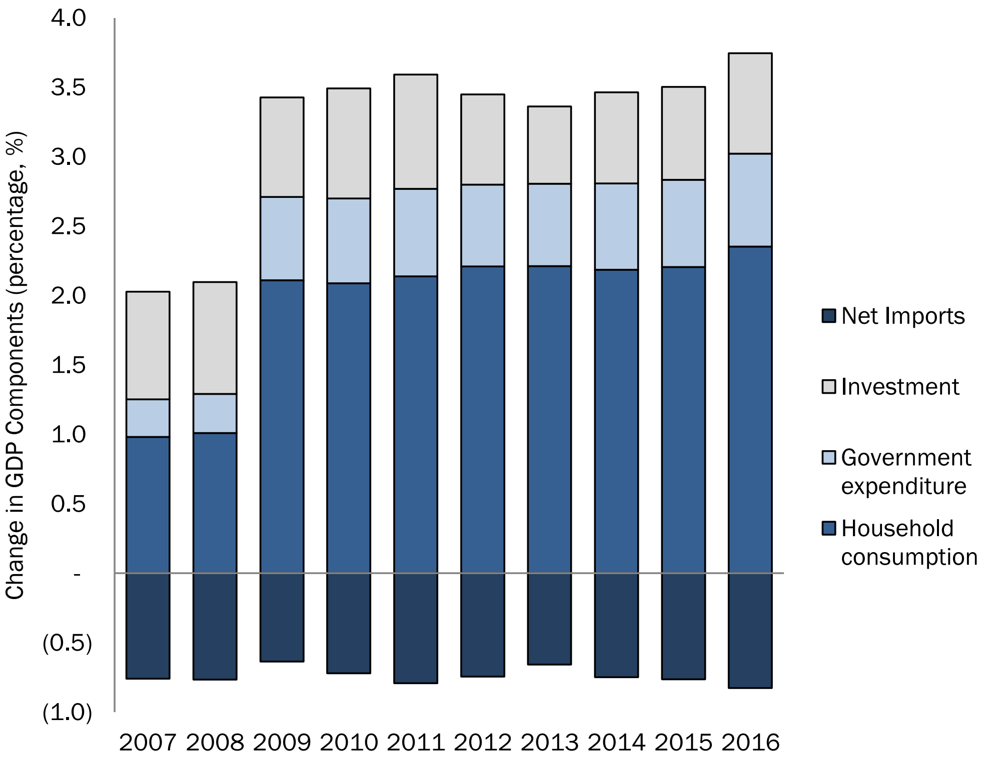

Exhibit 2: GDP components over time (constant '10 USD, source: World Bank)

The business environment in Cape Verde is good, relative to other Sub-Saharan African countries. However, there are bottlenecks inhibiting Cape Verde's growth potential. In the World Bank's Ease of Doing Business report, Cape Verde ranked 127th in 2017 (out of 190 countries), and ranked in the top third of African countries (15th out of 49 Sub-Saharan African countries). In the 2009 World Bank Enterprise Survey (the most recent year available), companies indicated that their greatest obstacles to growth were the large informal sector, obtaining access to finance, and getting access to electricity. Some 53% of firms interviewed identified electricity as a major business constraint. It should be mentioned that there has been significant progress in the power sector since the year of the survey, driven by investments in capacity and the grid.

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[4] Observatory of Economic Complexity. Accessed July, 2018. https://atlas.media.mit.edu/en/profile/country/cpv/#Trade_Balance

[5] Monteiro, Amilcar Aristides and Osmar Ferro. (2017). Cabo Verde: Multi-Sector Market Study Focused on Tourism Value Chain Development. Ministry of Foreign Affairs of the Netherlands, Enterprise Agency.

[6] Cape Verde Country Note. 2018 African Economic Outlook. African Development Bank.

Despite the recent growth of the Cape Verdean economy, high rates of unemployment (12%) and informality persist. The African Development Bank estimates that as many as 70% of the jobs in Cape Verde are in the informal sector.[7] Even though unemployment marked a modest decline from 15% to 12%[8] between 2016 and 2017, formal sector employment rate decreased from 54% to 52%.[9] In 2017, people mostly worked in the agricultural (19%), trade (15%), construction (10%) and public sectors (8%).

Cape Verde has a relatively low-carbon intense economy, emitting low amounts of carbon used per unit of GDP growth, compared to other countries in West and Sub- Saharan Africa. In 2016, Cape Verde emitted an estimated 0.28 kilotonnes (kt) of CO_2 per (constant 2010) dollar of GDP generated, less than half of Senegal's emission intensity (0.63 kt of CO_2) and nearly half the average Sub-Saharan African country emissions (0.53 kt of CO_2). Although Cape Verde's emissions intensity is relatively low, in its Intended Nationally Determined Contribution submission - a document provided by governments as part of the Paris Climate Agreement, specifying the efforts that will be taken by the country towards reducing its carbon emissions relative to a business-as-usual scenario where no or minimal efforts are taken - the country committed to achieving a 100% renewable energy rate by 2025. The government estimates that to achieve this goal it needs to reduce greenhouse gas emissions annually by 600-700 tCO_2eq.[10] The country is endowed with strong winds that blow for more than eight months out of the year, 350 days of sunshine and access to geothermal energy from volcanic activity below the islands.

2.2 Power sector overview

2.2.1 Governance

Exhibit 3 provides a graphical overview of the structure of the power sector in Cape Verde. The state-owned utility company *Empresa de Electricidade e Água* (Electra) SARL is the main entity within Cape Verde's power sector, with 77% of the capital owned by the State, 17% owned by the Social Security Institute (INPS) and the remaining 6% owned by the municipalities.[11] Electra is responsible for ensuring the supply and quality of both electricity and water resources in Cape Verde. Electra was created in the 1980's out of a merger of multiple entities that were responsible for water desalination and electricity production. In 2013, the government began restructuring Electra by creating two sub-entities with separate geographical jurisdictions. Electra Norte was created to manage the Windward Islands, while Electra Sul would manage the Leeward Islands. Additionally, the two sub-entities would promote working with private sector partners to manage the power and water sectors.[12]

Electra owns and operates the transmission and distribution (T&D) systems on each island in Cape Verde, with the exception of Boa Vista. *Águas e Energia de Boa Vista* (AEB) is a public-private entity that functions as an Electra sub-concessionary for the public service on the island of Boa Vista.

Agência de Regulaçao Económica (ARE) was established in 2004 to regulate the economic and financial activities in Cape Verde. Among others, ARE is responsible for setting the end-user tariffs for electricity and water, ensuring companies comply with regulations and advocating on behalf of the consumer.

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[7] Cabo Verde Country Strategy Paper 2014-2018. (2014). ORWA Department/SNFO. African Development Bank. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/2014-2018_-_Cape_Verde_Country_Strategy_Paper.pdf

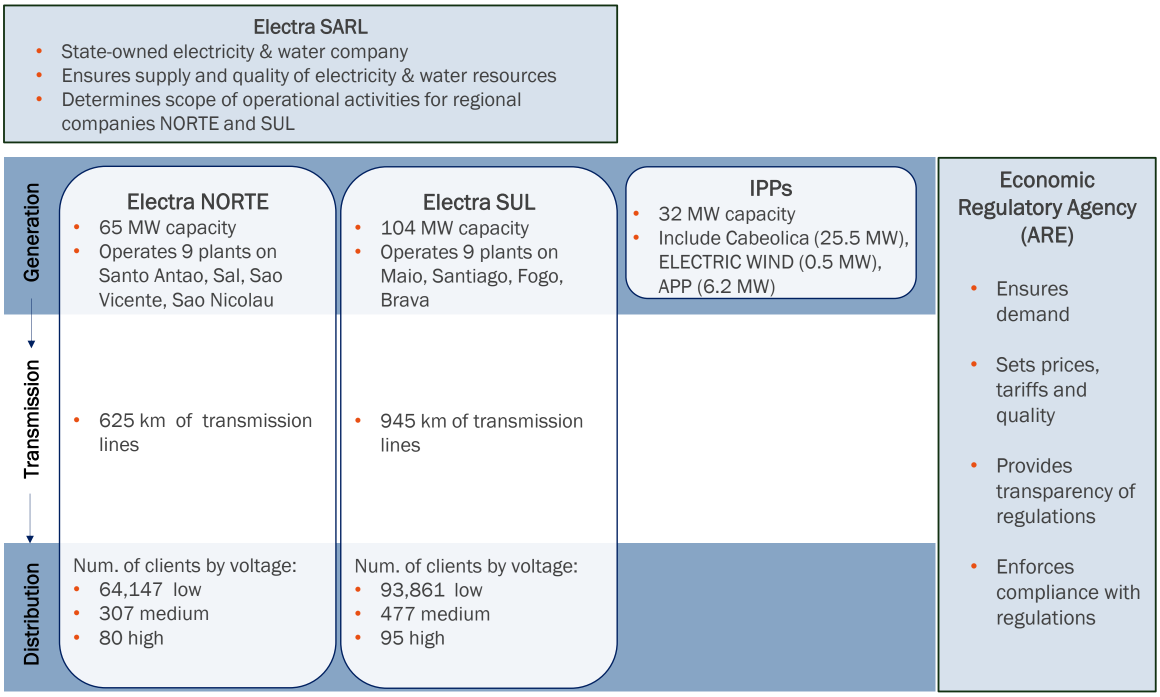
[8] Instituto Nacional de Estatistica Cabo Verde. 2017. http://ine.cv/indicadores/desemprego/

[9] Cabo Verde Statistical Yearbook 2016. (2017). Instituto Nacional de Estatistica (INE). http://ine.cv/publicacoes/anuario-estatistico-cabo-verde-2015/

[10] Cape Verde (2015): Intended nationally determined contribution of Cabo Verde. http://www4.unfccc.int/submissions/INDC/Published Documents/Cabo Verde/1/Cabo_Verde_INDC_.pdf

[11] Electra 2016 Annual Report.

[12] Electra SA. http://www.electra.cv/index.php/2014-05-20-15-47-04/empresa/descricao



Electra SARL
- State-owned electricity & water company
- Ensures supply and quality of electricity & water resources
- Determines scope of operational activities for regional companies NORTE and SUL

Generation

Electra NORTE
- 65 MW capacity
- Operates 9 plants on Santo Antao, Sal, Sao Vicente, Sao Nicolau

Electra SUL
- 104 MW capacity
- Operates 9 plants on Maio, Santiago, Fogo, Brava

IPPs
- 32 MW capacity
- Include Cabeolica (25.5 MW), ELECTRIC WIND (0.5 MW), APP (6.2 MW)

Transmission

- 625 km of transmission lines

- 945 km of transmission lines

Distribution

Num. of clients by voltage:
- 64,147 low
- 307 medium
- 80 high

Num. of clients by voltage:
- 93,861 low
- 477 medium
- 95 high

Economic Regulatory Agency (ARE)
- Ensures demand
- Sets prices, tariffs and quality
- Provides transparency of regulations
- Enforces compliance with regulations

Exhibit 3: Overview of Cape Verde's power sector

2.2.2 Generation and consumption

Total installed power generation capacity in 2016 was 162 MW, 1.8 times larger than in 2009 (Exhibit 4). The rise in installed capacity was driven by thermal and renewable power, especially the wind capacity of Cabeolica commissioned in 2011. By 2012, Cabeolica added 25.5 MW of installed capacity to the system, raising the share of renewable energy in Cape Verde from 0% to nearly 23%. Thermal plants use imported diesel or fuel oil. Total effective capacity, calculated as installed capacity factoring in average annual plant utilization rates, was 68 MW in 2016.

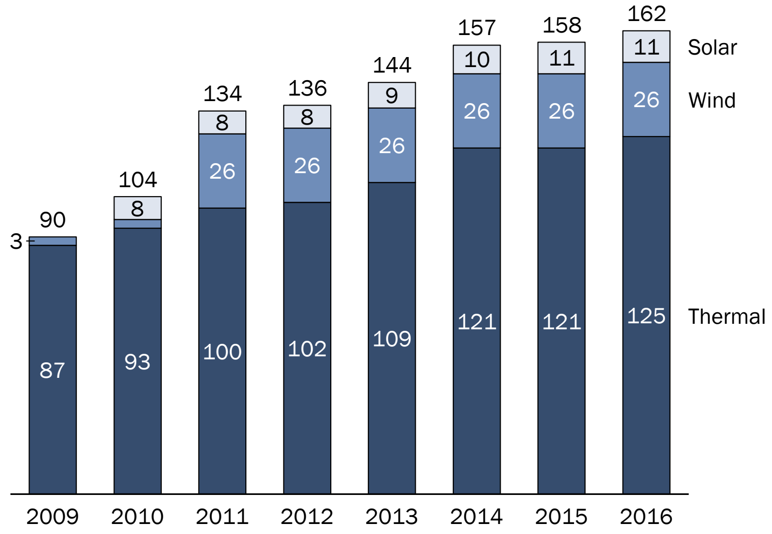


Exhibit 4: Installed capacity over time (in MW, source: Electra, IRENA)

Installed capacity varies by island. The island of Santiago has the highest level of installed capacity (51%), followed by Sao Vicente (17%) and Sal (16%).

In 2016, total generation was more than 443 GWh (Exhibit 5). Generation growth between 2010 and 2016 averaged 4%. Like installed capacity, total generation from renewables has been rising. The average annual growth rate was about 5.3% between 2010 and 2016. Despite this rise, 83% of total generation in 2016 was from thermal power.

Total electricity consumption per capita grew on average by more than 6% per year between 2009 and 2016, from 565 to 887 kWh (Exhibit 5). Santiago Island accounts for the majority of electricity consumption in the country (51%). Most electricity is consumed by economic activities (54%) and by households (39%), while the remainder is used for the production and desalination of water (7%).[13] However despite expectations of higher electricity consumption in the future,[14] consumption per capita has been flat since 2014.

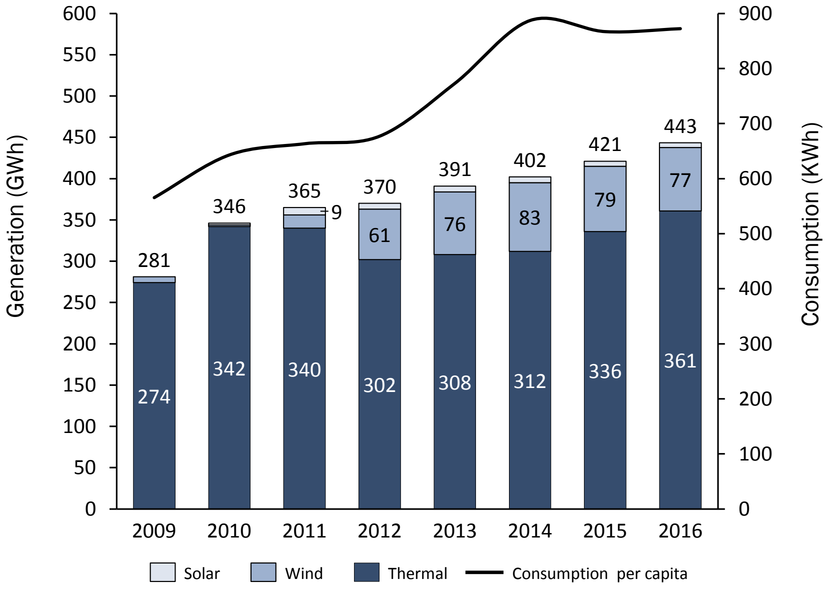


Exhibit 5: Total generation and consumption per capita over time (MWh, source: EIA)

Electricity transmission and distribution losses, which are mostly due to theft, are 27% on average but vary across islands and over time. In 2016 Santiago Island reported the highest losses (38%) whereas most of the other islands experienced losses of between 18-27%. Sal stands out with losses of only 2%. While losses rose by 1% on Santiago and Sao Nicolau between 2012 and 2016, they decreased on other islands by between 1-8%.

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[13] Monteiro, Amilcar Aristides and Osmar Ferro. (2017). Cabo Verde: Multi-Sector Market Study Focused on Tourism Value Chain Development. Ministry of Foreign Affairs of the Netherlands, Enterprise Agency.

[14] Cape Verde (2015): Intended nationally determined contribution of Cabo Verde. http://www4.unfccc.int/submissions/INDC/Published Documents/Cabo Verde/1/Cabo_Verde_INDC_.pdf

3 ECONOMIC IMPACT OF INVESTMENTS IN INCREASED POWER SUPPLY

3.1 Analysis framework

The analysis framework for the economic impact of increasing power supply is presented in Exhibit 6. SRQ previously applied this framework to estimate the economic impact of power sector investments in studies for IFC (in the Philippines and Turkey), CDC (in Uganda and Cameroon), PROPARCO (in India and Uruguay), the Private Infrastructure Development Group (PIDG, in Senegal), and the Nigerian Infrastructure Advisory Facility.

As illustrated from left to right in Exhibit 6, an increase in power generation capacity decreases the price of power and/or reduces the number of outages. Lower prices and fewer power outages increase the production level at which companies maximise their profits, which will in turn increase electricity use to produce more output.[15] Higher production translates into higher intermediate demand from other firms, both for users (e.g. manufacturing firm) and non-users of electricity (e.g. agriculture businesses or producers) and their generated value added. The resulting increase of value added raises both GDP and employment in Cape Verde. Finally, the higher GDP increases the demand for electricity, which increases the electricity price and offsets some of the before-mentioned effects. The framework does not include the effect of lower electricity prices on capital investment (either directly or indirectly), a feedback that may be relevant in the long run. The potential pathway of additional supply allowing more household consumers to connect to the grid is not included in the framework either. This is because residential consumption is not expected to significantly increase overall electricity use in the short term. Residents are often dependent on (rural) state electrification programs for connection to the grid, while most firms already have electricity connections and can benefit from more and cheaper power as soon as it is available.

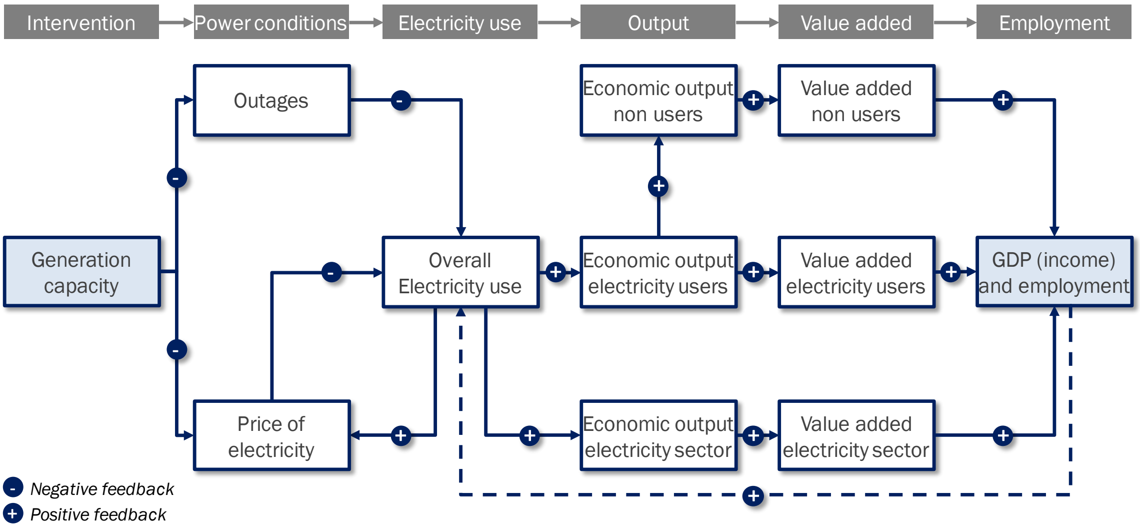

Exhibit 6: Analysis framework for the impact of increased power sent into the grid on GDP (value added) and employment

It is important to note that in different countries, one of the pathways is typically dominant. For example, the outage pathway will be vital in countries with very low reserve margins since insufficient capacity causes blackouts. In a country where the power sector is subsidised and prices are not cost-reflective, additional capacity would not necessarily lead to change in the price of electricity. The price pathway is especially relevant for countries where new capacity replaces existing expensive thermal

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[15] The exhibit depicts relationship between two variables. The negative relationship between e.g. electricity price and consumption means that a lower price is associated with more consumption (and vice versa).

generation. A lower price for electricity - due to more (and cheaper) generating capacity - can come about through two different pathways, depending on the specific power conditions. In countries where grid electricity is normally sufficient in quality and quantity, increased generation capacity lowers the price of electricity, depending on the short and long-run cost levels of additional capacity relative to the average wholesale electricity price. In countries where the grid is not able to deliver sufficient power (e.g. Nigeria) increased capacity will reduce the dependency of companies on expensive self-generation, thereby lowering their effective electricity cost.[16]

3.2 Impact via the price pathway

3.2.1 Methodology

To estimate the impact of Cabeolica on employment in Cape Verde, the impact of additional capacity on electricity prices was analysed.

To start, the effect of the new plants on electricity generation costs was calculated based on a power supply-demand model. Reduction in the generation cost leads to a decrease in the end-user tariff only when the latter is fully cost-reflective. Despite existing regulatory frameworks, this is not yet the case in Cape Verde. Therefore, changes in the generation cost are not expected to have an impact on electricity end-user prices. This in turn means that businesses (and households) would not feel any changes as a result of their production activities, and their operations would not be affected. Therefore, no job creation effect is expected.

Nevertheless, the reduction in generation prices will have an impact on Electra and the government, since lower generation costs will bring the end-user tariff closer to cost reflective levels. This effect is mainly driven by displacing power produced by thermal plants which rely on expensive imported fuel. The need to purchase less fuel is expected to have led to costs savings for Cape Verde's government.

This approach, summarised in Exhibit 7, is explained in more detail in the sections below. Results reflect changes brought about by Cabeolica and do not take the Finnfund or AFC proportion of investment into account.

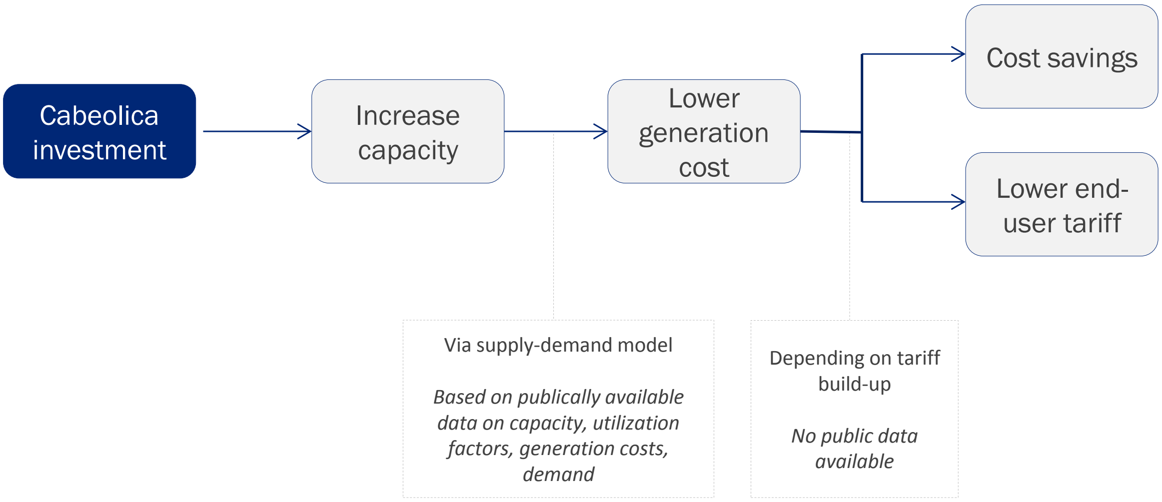

Exhibit 7: Price pathway approach

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[16] Although the quality of grid electricity may not be sufficient for some firms to switch from self-generation to grid power, at the level of an entire sector or economy this is not of great importance; electricity not used by one firm is available for another one.

3.2.2 Results

The effect of new capacity on the economy of Cape Verde is derived by constructing a power price model based on the specification of a power supply and demand curve. A power supply curve ranks all power plants in the country side-by-side, based on dispatch order commensurate with their capacity (in MW). For each plant, it gives the cost of supplying electricity.[17] The power supply curve is constructed by using information on the effective power generation fleet of Cape Verde, i.e. installed capacity adjusted for utilisation.

By combining the supply curve with the observed power demand of a country (in MW), the demand-weighted average generation cost can be determined. The impact of additional generation capacity is determined by deriving two power supply curves: one with and one without Cabeolica. Determining the weighted average generation cost for both situations allows the effect of adding generation capacity to the power fleet to be calculated.

This model has been shown to adequately reproduce observed price behaviour in the Philippines[18], Turkey[19], and Uganda[20].

Supply curve

To construct the country's supply curve, generation cost values (EUR per MWh) are assigned for each of the power plants in Cape Verde, based on plant technology specific data. The non-dispatchable plants, which must supply power when available (wind, solar), are placed at the left-hand side of the curve. A hypothetical supply curve based on the installed capacity excluding Cabeolica is presented in Exhibit 8. The supply curve, adjusted for utilization rate is presented in Exhibit 9. Additionally, Exhibit 9 shifts the supply curve to the right by adding Cabeolica's effective capacity of 8.6 MW (or a 14.4% increase).

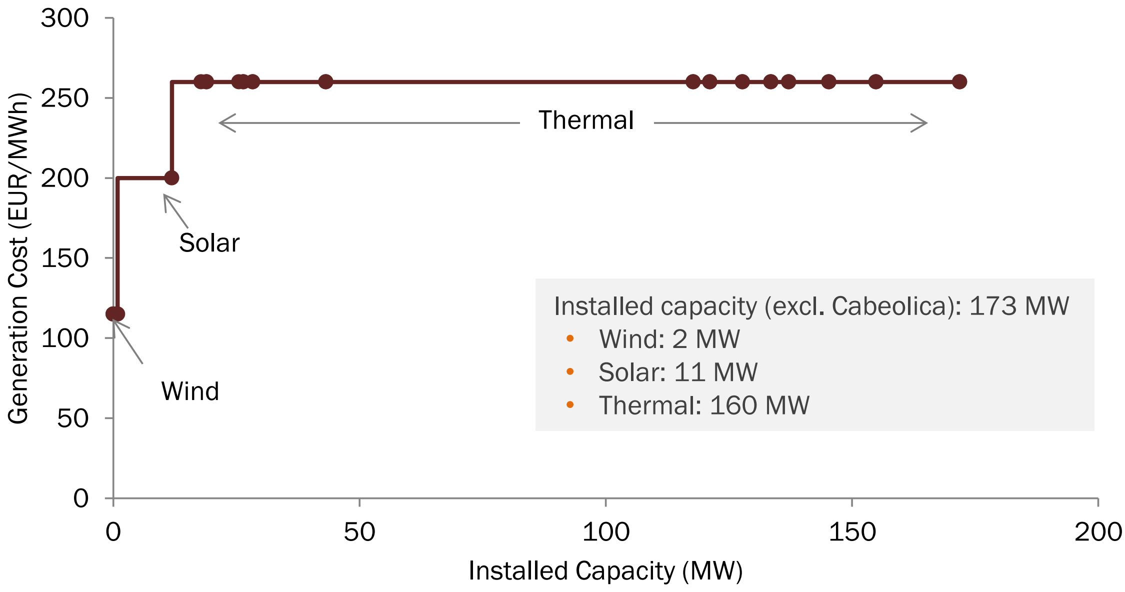

Exhibit 8: Installed capacity excluding Cabeolica

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[17] Data on costs per technology is courtesy of Bruno Lopez, Chief Financial Officer, Cabeolica. Personal correspondence. April, 2018. Cost of thermal plants is based on electricity fuel cost of CVE 68 per litre, as reported by ARE http://www.are.cv/images/stories/combustiveis/preos_c.social_081016.pdf

[18] Let's Work study on the impact of power investments in the Philippines, Steward Redqueen 2015.

[19] IFC, How Power Contributes to Jobs and Economic Growth in Turkey, 2016.

[20] CDC, What is the Link between Power and Jobs in Uganda 2016.

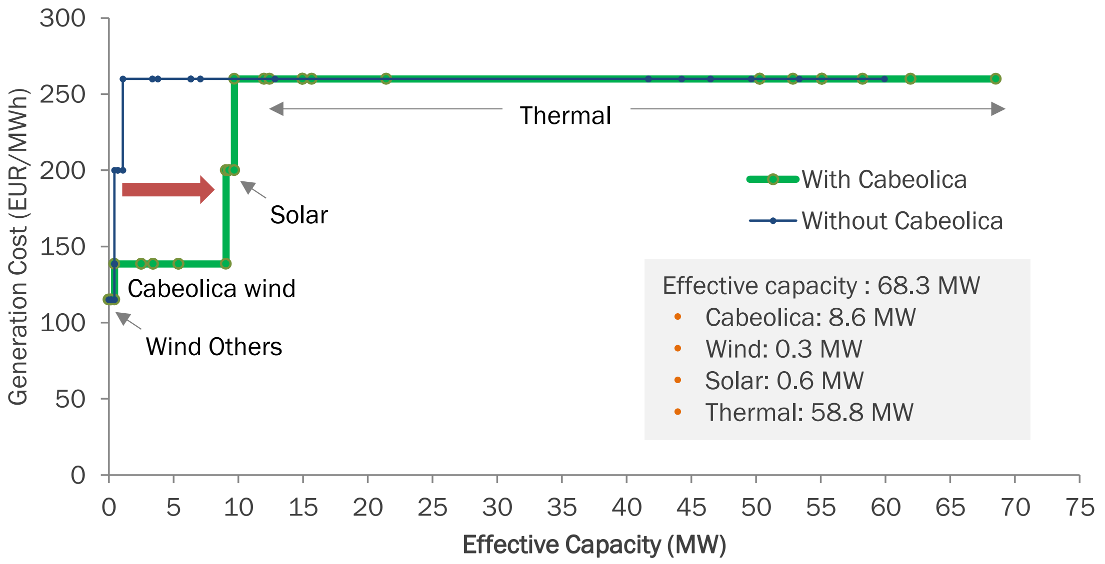

Exhibit 9: Effective supply curve with the addition of Cabeolica

Demand Curve

In order to determine electricity prices one needs to know the so-called power load (MW) curve, which essentially amalgamates the total power consumption in the system. The level of the power load curve over the course of a typical day, which is the total demand for electricity including losses in the system, is shown in Exhibit 10. The curve is based on the average hourly power load data for each day of 2016.[21] Demand for power peaks at 68 MW and occurs between 20:00 and 21:00. Peak demand is 1.3 times the average load (52 MW).

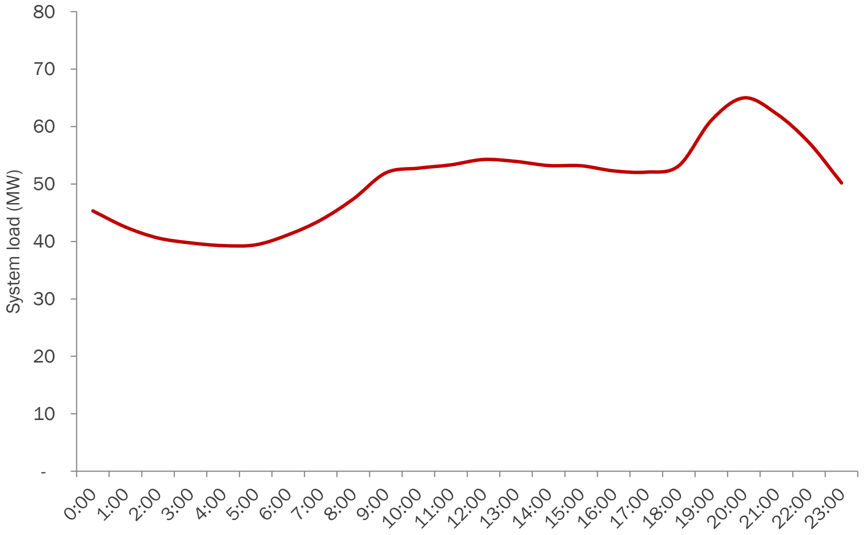

Exhibit 10: Demand curve (source: Electra, Cabeolica)

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[21] Data on daily load pattern in 2017 was provided by Cabeolica. The data was extrapolated to 2016 based on reported peak demand in 2016 from Electra's Annual Report.

Price model

The effect of Cabeolica on the average generation cost is determined by combining the two supply curves (Exhibit 9) with the demand curve. The results are shown in Exhibit 11. The red line illustrates the demand, while the coloured lines and the areas below them show the amount of capacity that is used to cover the demand. Without Cabeolica, the maximum renewable capacity (wind and solar) is used to supply less than 1 MW (1.3%) of demand. Thus, without Cabeolica the daily demand would be practically entirely met by thermal power. By contrast, with Cabeolica, the amount of demand covered by renewable energy increases. With the addition of Cabeolica, 9.5 MW (14%) of demand – previously covered by thermal – is covered by renewables.

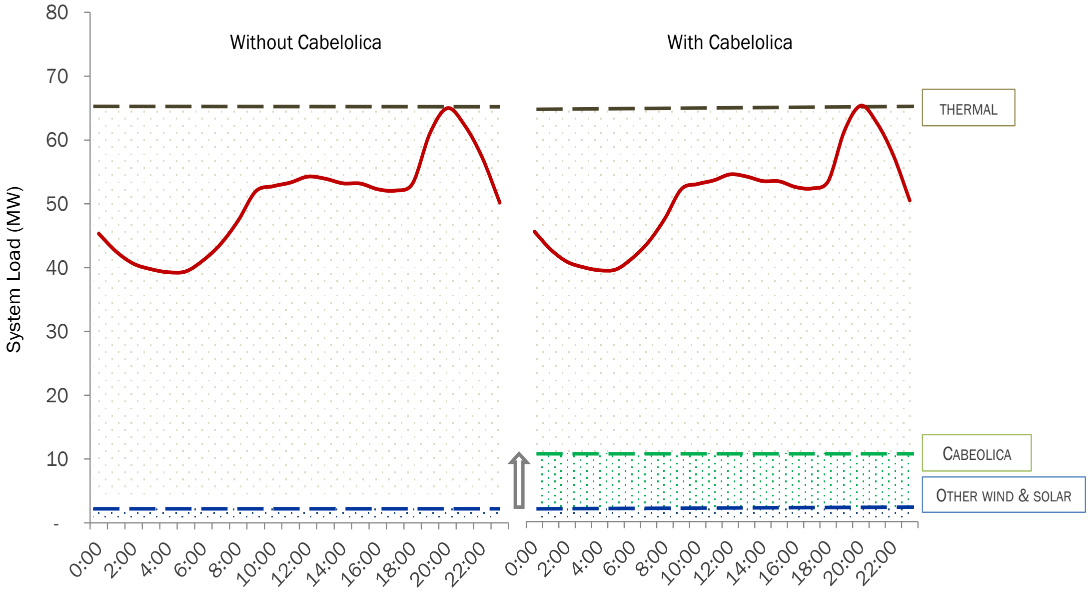

Exhibit 11: Supply versus demand with and without Cabeolica

Effect on price and savings

The supply and demand curves were combined in a price model, which matches the hourly demand to the available capacity and yields the (load-weighted) average generation cost per MWh for each month of the year. As indicated earlier, Cabeolica introduced additional capacity, displacing the equivalent of 8.6 MW of expensive thermal capacity. The power generated by the renewable plants is cheaper than thermal plants. The additional capacity is estimated to reduce the weighted average kWh cost by 7.7% (from estimated €0.259 to €0.239 per kWh (CVE 28.6 to CVE 26.4).

The price effect is more pronounced during periods of high wind speeds. During the months of the year when wind is the strongest (December – June), the capacity factors of Cabeolica's wind farms are higher and effective capacity is on average 10.7 MW. The value is 6.0 MW during low wind speed months. As a result, the generation cost effect is -9.6% during high wind speed months versus -5.4% during low wind speed months.

The modelled price effect relies on the generation costs of various technologies, as shown in the supply curves. The generation cost of thermal is based on 2016 fuel prices. In times of higher fuel prices, producing thermal power becomes more expensive, meaning that the downward price effect of Cabeolica would be more pronounced. Exhibit 12 shows the change in weighted average generation cost in Cape Verde due to the commissioning of Cabeolica given various levels of fuel price.

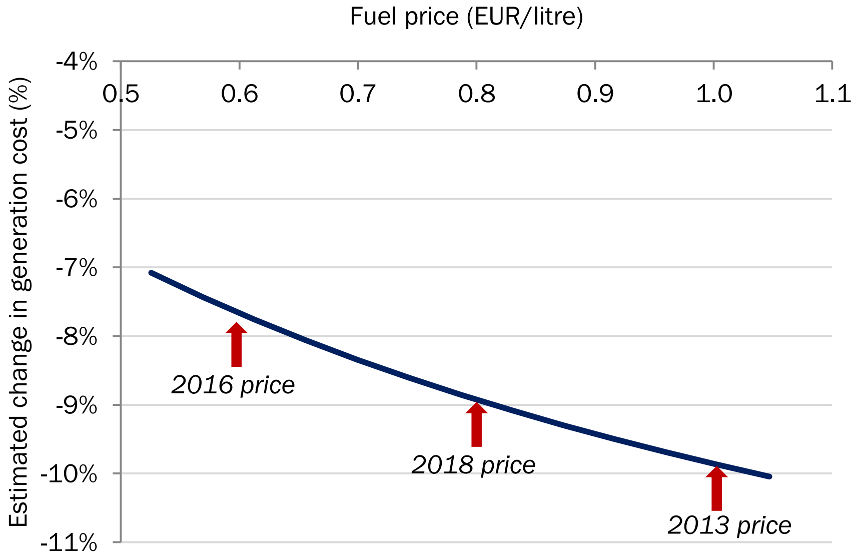

Exhibit 12: Change in weighted average generation cost due to Cabeolica for different prices of fuel

There is little publicly available data on the exact pricing structure of end-user tariffs (such as on the level of the T&D margins). This makes it challenging to determine exactly if and how end-user tariffs have decreased in response to lower generation costs.

Nevertheless, the lower generation costs mean that because of Cabeolica, final tariffs have come closer to cost-reflective levels. Therefore, the decrease of price of €0.02 per kWh (based on the average generation cost drop of 7.7%) would have improved the financial situation of Electra, by reducing the financial burden on the state. The switch from thermal to renewable production means that the country requires less imported fuel. The renewable plants produce energy that would have otherwise been produced by thermal generation, which means that they displace fuel purchases. Of the approximately 78 million litres of fuel imports used for thermal generation in Cape Verde in 2016[22], an estimated 22.2% (17 million litres) was displaced by Cabeolica[23], an equivalent value of nearly €10.6 million[24] or 2.1% of the country's trade balance[25].

Lower fuel use also translates to lower overall CO_2 emissions. Cabeolica is estimated to have contributed to the avoidance of 58.7 kt of CO_2 emissions in 2016, or approximately 12.0% of Cape Verde's total emissions.[26] The avoided emissions are valued at nearly EUR 235,000 based on a carbon price of EUR 4 per ton of emissions.[27] Based on the price needed to keep global warming below 2C – EUR 37 per ton – the amount would be EUR 2.1 million.[28]

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[22] Based on thermal generation (GWh) in Cape Verde and use of fuel per kWh from Electra Annual Report 2016

[23] Based on the 2016 generation of Cabeolica (75,500 MWh) and fuel use for thermal production of 230 litre/MWh (based on Electra reporting). The 22.2% is consistent with Cabeolica's share of total electricity generation from thermal (340,000 MWh). The value of the total imported fuel in 2016 is EUR 90 million (as estimated by IMF in Country Report No.16/366). This means the fuel savings brought about by Cabeolica represent 11.8% of the value of total imported fuel.

[24] Based on fuel price CV 68/kg reported by ARE.

[25] SRQ calculation based on trade balance of EUR 501 million from IMF Country Report No.16/366.

[26] Based on 0.778kg/kWh emission avoidance (source: On-Grid Solar PV versus Diesel Electricity Generation in Sub-Saharan Africa: Economics and GHG Emissions) and total emissions of Cape Verde of 491,000 tonnes (source: World Bank)

[27] Cabeolica has a contract with the Swedish Energy Agency where Certified Emission Reductions (CER) are sold for EUR 4 per ton.

[28] Financial Times, 2016. *BlackRock calls for higher carbon price to tackle climate change.* https://www.ft.com/content/bde6859a-9ac2-11e6-8f9b-70e3cabccfae

3.3 Impact via the outage pathway

3.3.1 Methodology

Outages can have a substantial impact on firm output and productivity. They can affect economic output through loss of production, restart costs, equipment damage, and/or spoilage of raw or (semi-) finished materials. There are a number of factors which can completely or partly mitigate these negative impacts. In addition to self-generation, firms can continue operations without electricity, reschedule production, adopt technologies that allow faster production during hours when power is available, or procure energy intensive semi-finished goods and thereby eliminate power-intensive production steps.

A complicating factor here is that outages occur for many different reasons: insufficient power generation capacity (often leading to planned load shedding); (unplanned) tripping of power plants; (planned) maintenance of the transmission and distributions networks; or (unplanned) faults in the network. Research shows that when reserve margins are low, additional capacity prevents blackouts or power rationing. In order to determine the effect of additional capacity on power outages one therefore has to:

1. Determine which fraction of the total outage time is caused by insufficient power supply;
2. Determine how an increase of power supply reduces the outage time caused by insufficient generation capacity (as determined in point 1);
3. Convert the outage time reduction into a relative increase of production time (in %) and economic production.

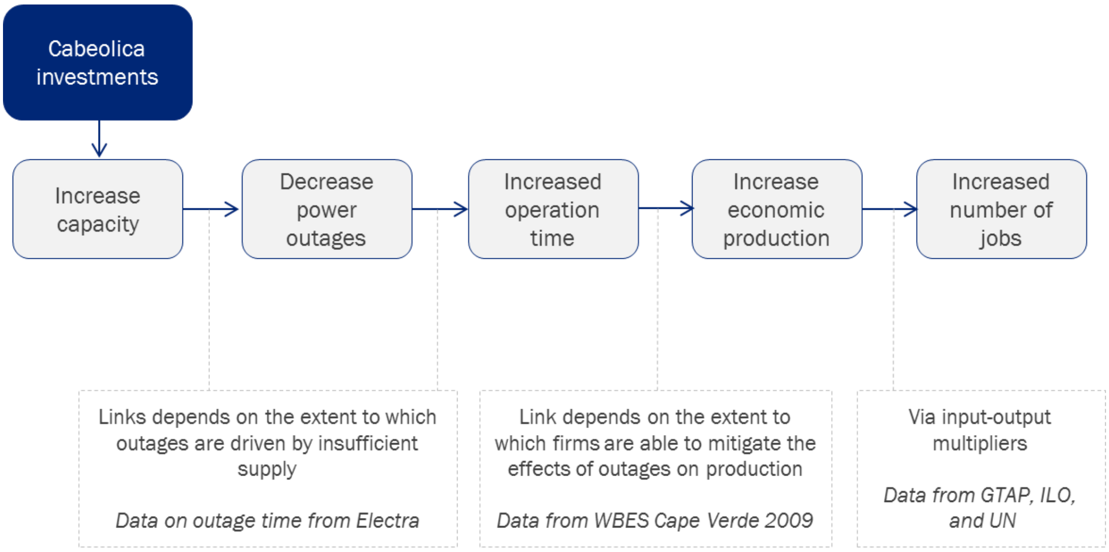

Exhibit 13: Outage pathway approach

To our knowledge, there is no publicly available data detailing the share of and change in outages due to load shedding in Cape Verde. However, Electra reports on the annual total number of outages experienced per island. In the absence of data on the causes of outages over time in Cape Verde, the total changes in outages – and the subsequent rise in operation time – are attributed in two different ways to the capacity supply added by Cabeolica, as explained in the following two paragraphs.

On Sao Vicente, Sal and Boa Vista the changes in outages are entirely attributed to Cabeolica; This assumption is not unrealistic given: (i) the large share of total capacity added by Cabeolica and (ii) the fact that there were no other substantial developments in the power sector (such as other substantial additional capacity or T&D projects finalized) during the period from 2011 to 2012 when the Cabeolica plants began operations on these islands;

On Santiago the changes in outages are partially attributed to Cabeolica. The change in outages attributed to Cabeolica is different because there were other investments in the power sector between 2011 and 2012 in power supply and the T&D network. In mid-2012, expansion of a thermal power plant in Palmerejo by Electra was completed and installed capacity increased by 22 MW, from 26 MW to 48 MW. [29] However, since the expansion was finished halfway through the year, only half the additional capacity is considered to have contributed to reducing outages. Thus the highest proportion of the change in outages on Santiago attributable to Cabeolica is the ratio of Cabeolica's additional supply and the combined additional supply of Cabeolica and Palmerejo, approximately 46%. At the same time, in 2012 Electra finalised projects in refurbishment/extension of substations, transmission lines, and interconnection lines between areas on the island.[29] Given the different nature of these investments, it is challenging to estimate which part of the outage reduction was due to the T&D projects versus Cabeolica. It is realistic that the attribution of Cabeolica should be more than 0% (given that it added significant capacity to the island). Due to lack of data, for this report, we will use a lower attribution range of 25%.[30] Therefore results for Santiago will be based on a range to account for the low (25%) and high (46%) attributable share of outages of Cabeolica.

For three of the four islands that Cabeolica operates on – Santiago, Sao Vincente, and Sal – the change in outage time for the year that Cabeolica began operations is used proportionate to the total potential operations time for the year. Since there was no data on the change in outage time for Boa Vista, the average change in operations time for the other three islands per 1% increased capacity is used and applied to the percentage capacity increase on Boa Vista. Doing so does not consider changes in outage on other islands, since there are no Cabeolica wind farms there.

To translate the change of operations time on the four islands to overall country change, the change in operations time of each island is weighted by its contribution to national GDP. Subsequently the national change in production is translated to the change in time attributable to Cabeolica in firms' production output and employment generation.

As in the previous section, results presented below reflect changes brought about by Cabeolica and do not take Finnfund or AFC attribution into account.

3.3.2 Results

Increase in capacity

As previously reported, in terms of effective capacity contribution (based on utilisation factors of the wind farms), Cabeolica added approximately 14.4% to the country's total capacity in operation.

Decrease in power outages

Exhibit 14 presents the annual outage time in Santiago, Sao Vincente, and Sal between 2010 and 2014. In the exhibit, the difference in total outage hours in the years before and after the respective Cabeolica farms came online is indicated. Electra does not report outage times for Boa Vista.

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[29] Electra Annual Report. 2012.

[30] Even though this lower range is more randomly selected than the higher range, it is not unrealistic. Cabeolica's additional supply on Sao Vicente reduced outages by a similar amount (7 hours) as in Santiago (after considering 46% attribution). However, considering that Cabeolica added 60% of the installed capacity on Santiago that it did on Sao Vicente (12% versus 20%), we can conclude that the capacity added on Santiago would reduce outages by about 4 hours (60% of 6.7 hours). Thus the lowest proportion of the change in outages on Santiago attributable to Cabeolica is the ratio of the four hours lowered on Sao Vicente to the total unattributed change in hours on Santiago (15.5 hours), approximately 25%.

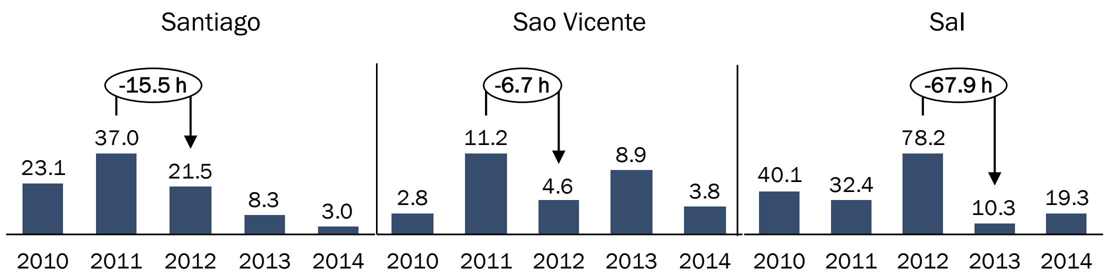

Exhibit 14: Outage time change (hours) (Source: Electra annual reports)

Increased operation time for companies

Increased generation capacity reduces the length of power outage time and in turn increases the time that companies can operate. Based on average 2,880 hours of operation annually[31], it is estimated that:

- On **Santiago**, where Cabeolica added 12% of capacity, the 15.5 hours reduction of outages, of which between 4 hours and 7.2 hours are attributed to Cabeolica, equals between an estimated 0.14% and 0.25% increase in operations time for firms. The average change in outages was 5.5 hours and the average change in operations time was 0.19% (the latter average figure will be used for calculations hereafter for ease of reporting);
- On **Sao Vincente**, where Cabeolica added 20% of capacity, the 6.7 hours reduction of outages equals an estimated 0.23% increase in operations time for firms:
- On **Sal**, where Cabeolica added 24% of capacity, the 67.9 hours reduction of outages equals an estimated 2.4% increase in operations time for firms.

To calculate the increase in operations time for **Boa Vista**, where, the change in operations time from a 1% increase in capacity on the other islands (0.05%) is multiplied by the relative increase in capacity on Boa Vista due to Cabeolica. Given that Cabeolica's farm doubled available capacity on the island, the result is a 5.25% increase in operation time. [32]

Finally, the weighted average of the operation time increase of the four islands based on their GDP contribution is used to derive the overall national decrease in outages attributable to Cabeolica. It is estimated that the additional generation capacity translates to a 0.58% increase in production time in Cape Verde (see Table 1).

Increase of economic output

Increased operations time from lower outages should in general translate into an increase in economic production, i.e. economic output. However, as mentioned above, many firms are able to mitigate the impact of outages. In the 2009 World Bank Enterprise Survey (the most recent year available) companies report on the length of time they experienced outages and the resulting lost sales. Table 2 shows the average and median operations time lost by companies because of outages and the corresponding sales lost. The percentage of operations time lost due to outages ranged between 4 – 12% and the percentage of sales lost due to outages ranged between 0 – 5%.

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[31] Based on 240 hours of business operations per month.

[32] Average increase of operations time from other islands in 0.052% per 1% increase in capacity; calculation is 100%*0.052/1%

Table 1: Operation time increase

	GDP contribution (% total) Source: INE	Change in outage time due to Cabeolica (hrs) Source: Electra	Change in operations time (%) Source: SRQ calculation
Santiago	54.90%	5.5	0.19%
Sao Vincente	15.95%	6.7	0.23%
Sal	10.54%	67.9	2.36%
Boa Vista	4.26%	N/A	5.25%
Other Islands	14.34%	0	0.00%
Cape Verde weighted average			**0.58%**

The losses are divided by the outage time to derive the so called mitigation factor of firms by category. It shows the extent to which firm sales (output) are affected by lost time due to outages. A factor of less (more) than one implies that for each hour of operation time lost due to outages, companies lose (gain) less than one hour of production (output). The fact that the factors for almost all company categories (size and sector) are less than one implies that for each hour of outages, companies lose less than one hour of production time. It also means that for each hour gained as outages are reduced, companies gain less than one hour of production.

Firms in Cape Verde are able to dampen the impact of outages, as illustrated by the low total mitigation factor. Medium firms are the most affected by outages whereas micro firms are the least affected. However, the differences between small, medium, and large firms in mitigation factor are small. That micro firms have the lowest mitigation factor may reflect their more flexible work schedule and lower dependence on electricity to generate output.

Table 2: Report firms' outages, losses and estimated mitigation factor (Source: WBES)

Company Type	Outage (% of operation time)		Losses (% of sales)		Mitigation Factor
	Average	Median	Average	Median	Mid-point
Micro (<5)	14%	2%	2%	0%	0.1
Small (5 – 19)	12%	4%	8%	2%	0.5
Medium (20 – 99)	10%	4%	10%	1%	0.6
Large (>99)	8%	6%	4%	1%	0.5
Manufacturing	15%	5%	6%	0%	0.4
Services	10%	4%	5%	0%	0.3
Total	**12%**	**4%**	**5%**	**0%**	**0.3**

Service companies have a lower mitigation factor compared to manufacturing firms, meaning that they lose relatively less output during outages. This is as expected given that most manufacturing companies rely on electricity for their production activities.

Multiplication of the relative operation time increase (Table 1) by the mitigation factor and subsequently by the total sector economic output[33] results in the change of economic output per sector due to Cabeolica. The results are presented in Exhibit 15.

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[33] Reported by INE

The output effect is estimated for two groups of economic agents:

- Companies/sectors that directly benefit from the reduction of outages – firms operating in the manufacturing or service sectors depend on electricity for their operations (to various extents) and thus directly benefit from the lower outage duration;
- Companies/sectors which do not directly benefit from the reduction of outages – firms operating in the agriculture sector do not rely on electricity for their operations. Therefore, lower outage duration does not have a direct effect on agricultural production. However, agro-businesses will benefit indirectly due to increased procurement from other sectors affected by the change in price (most notably food & beverage manufacturing). We quantify this effect using the West Africa Region Input-Output table.[34] Based on this table, we calculate how a EUR 1 million output increase in the sectors affected from the lower electricity outages translates into higher output for the agriculture sector. Using these multipliers, we estimate the total increase in agricultural output related to the higher production of the electricity-dependent sectors.

Based on the outage multiplier, the mitigation factors, and the output of sectors, the production output related to the decrease of outages is estimated at an average of EUR 3.8 million (or between EUR 3.6 – 4.06 million based on the low and high attribution), among firms which are dependent on electricity use[35] (as presented in Exhibit 15).

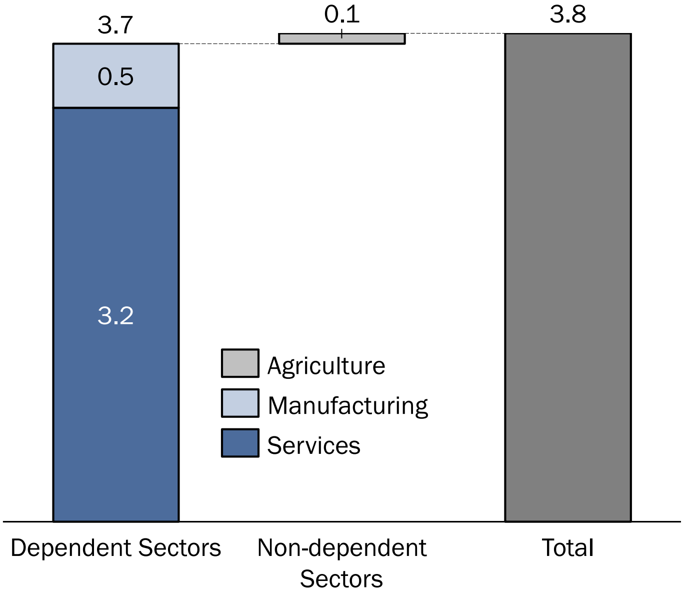

Exhibit 15: Change in economic output and share of sector (EUR m)

Companies in the manufacturing sector up-scaled production by an average of EUR 0.5 million (0.3%), and the services sector increased output by an average of EUR 3.2 million (0.19%). Businesses in agriculture did not directly benefit from less outage time given their negligible use of electricity. However, due to the increased production –and thus procurement– from the 'dependents', the agro-sector also expanded its output in order to meet the growing demand for its products. This procurement effect increased total economic output value by an average of EUR 0.08 million (0.2%). The total output increase in Cape Verde was thus approximately EUR 3.8 million, equal to 0.2% of total economy output. See Appendix 2 for a table of the effects.

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[34] The most recent IOT that includes Cape Verde comes from the Global Trade Analysis Program (GTAP).

[35] Increased output in energy dependent sectors implies higher carbons emissions. However, the additional emissions are likely to be negligible and as such were not accounted for in the estimate provided of emissions avoided.

Effect on incomes and employment

To translate the sectoral changes in economic output into income and employment effects, we use output-to-GDP multipliers and employment intensities for different economic sectors in Cape Verde. For this, we used data from the National Accounts of Cape Verde, published by the UN.[36] The latest available output, GDP, and employment data is from 2016.

Using sector data on GDP and output, we calculate how each EUR of output increase translates into GDP for the respective sector. The estimated result is a total GDP increase of EUR 1.9 million (average of EUR 1.8 – 2.0 million based on the low and high attribution), as shown in Exhibit 16 (left-hand side).

Using the output produced in the corresponding sector and year, for ten economic sectors (ISIC Rev. 3 classification) we calculated the number of jobs needed in a sector to produce one unit of output (in EUR), i.e. the employment intensity of the sector. An average of 390 (average of between 370 – 410) jobs can be attributed to the additional capacity of Cabeolica, which is equivalent to 0.2% of the total employment (Exhibit 16, right-hand side). Most jobs are supported in the service sectors (315, or 0.2% service sector jobs), which experienced the highest output growth. Approximately 20 additional people were involved in agricultural production (0.01%). Many employment opportunities are not permanent and could entail a few hours of work. Therefore these employment results should not be interpreted as jobs in full-time equivalents (FTE), but as people affected.

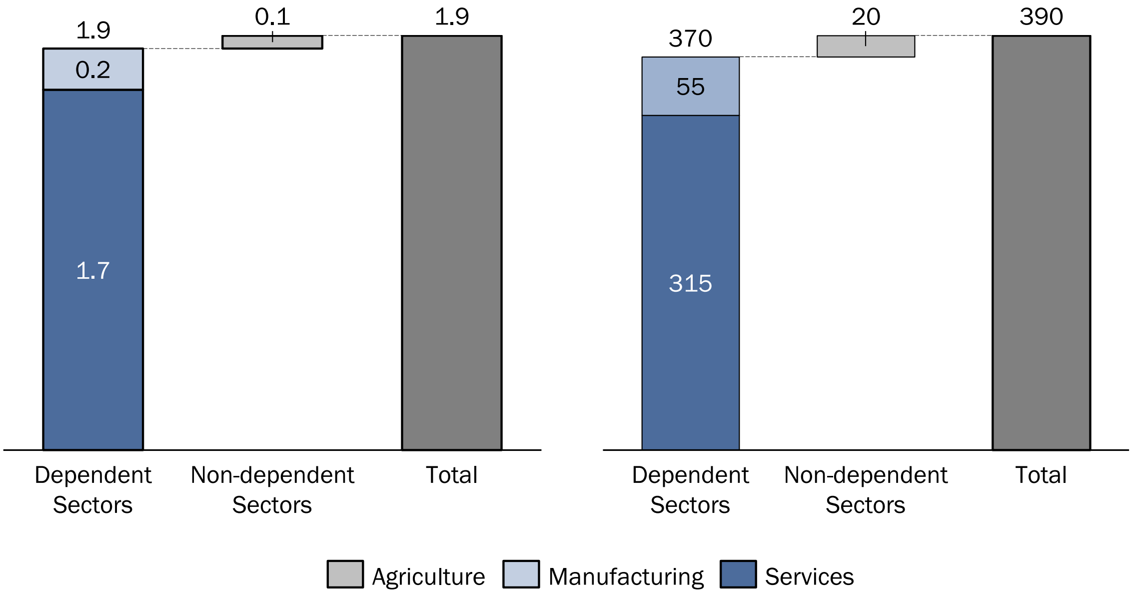

Exhibit 16: Value added (left, EUR m) and employment effects (right, number of people)

3.4 Multipliers and comparison

Cabeolica accounts for 8.6 MW of effective capacity, adding 14.4% to Cape Verde's effective power base. The results derived in Sections 3.2 and 3.3 presented the total effect of this new capacity to the economy. In Table 3 we express the price and employment results as key ratios – per 1% and per 1 MW increase in effective capacity.

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[36] National Accounts Statistics: Main Aggregates and Detailed Tables https://read.un-ilibrary.org/economic-and-social-development/national-accounts-statistics-main-aggregates-and-detailed-tables-2016-five-volume-set_d3642f52-en#page9

Table 3: Key multipliers (per 1% and 1MW effective capacity)

	Per 1 % capacity increase	Per 1 MW capacity increase
Δ Generation cost (%)	-0.54%	-0.90%
Δ Production time	0.04%	0.07%
Δ Employment (# jobs)	27	45

The generation cost effect in Cape Verde is lower than the one estimated by Steward Redqueen in Senegal. This is due to the lower unit generation cost of the PIDG-supported plants relative to Cabeolica, and the higher generation cost of thermal plants used in the Senegal analysis.

The job multipliers for Cape Verde are lower than the ones for Uganda, where we estimated that each additional 1 MW of capacity led to 807 jobs. The lower response can be explained by the fact that the additional capacity in Uganda contributed to a relatively larger decrease in outage time and consecutively, in increase in on operation time of firms (0.14% increase in operation time compared to 0.05% in Cape Verde). This can be attributed to the fact that Uganda had much higher shortage of power compared to Cape Verde. Furthermore, during the times of load shedding, companies in Uganda seem to have been much less equipped to mitigate the effect of outages (e.g. by rescheduling production or using generators). That means that each percentage increase in production time in Uganda led to a higher increase in production than in Cape Verde. Last but not least, the Ugandan economy is more labour intensive, meaning each unit increase of output would translate into more jobs than in Cape Verde.

4 ECONOMIC IMPACT OF PLANT OPERATIONAL EXPENSES

In addition to the forward economic impact (stemming from the productive use of the electric power it generates), Cabeolica affects the economy through the spending related to construction and operation of the power plants and from their backward economic (i.e. supply) linkages. These include the direct (related to value added and employment generated at the power plant both for construction and operations), and indirect (at the level of the suppliers and the suppliers' suppliers) effects.[37]

4.1 Methodology

Money flows related to constructing and operating power plants are traced using the Input-Output methodology, which is commonly used by academics and practitioners in impact assessments. This allows for the quantification of GDP and employment impact. The key-ingredient in this process is the Social Accounting Matrix (SAM), as depicted in Exhibit 17. The SAM describes the financial flows of all economic transactions that take place within an economy; it is a statistical and static representation of the economic structure of a country. In the SAM the number of columns and rows are equal because all sectors or economic actors (industry sectors, households, government, and the foreign sector) are both buyers and sellers. Columns represent buyers (expenditures) and rows represent sellers (receipts). As shown in Exhibit 17, consumption induces production which leads to financial transfers between the various sectors which subsequently generate incomes for households (salaries), governments (taxes) and companies (profits and savings). The latter three represent the GDP (value added) effect related to the financial transaction.

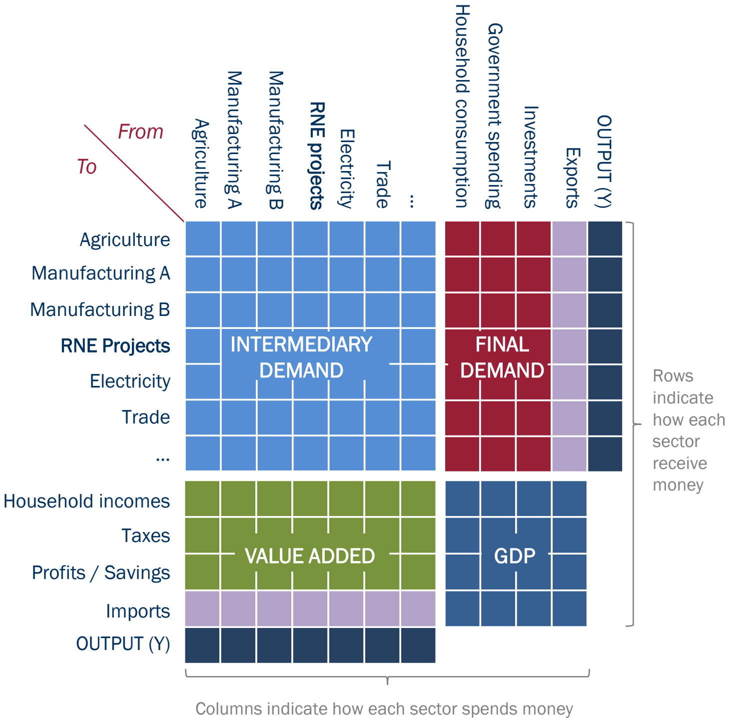

Exhibit 17: Social Accounting Matrix

Sales revenues generated by Cabeolica in 2017 were spent on procurement from local and foreign suppliers, on employee salaries and tax payments. To calculate the related impact, we follow the

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[37] Induced effects are calculated only for the employment results and not for the value added results in order to avoid double-counting of the (effects of) household incomes.

plants' expenditures through the West African region SAM, which includes Cape Verde, and eight other nearby countries.[38] This is done by adding their expenditures pattern as a separate column in the SAM. In this way we can determine how spending of the four plants induce production down their local value chains (i.e. for their suppliers, and the suppliers of the suppliers), and how this subsequently leads to salaries, taxes, and profits.

To calculate the job effects of the related production, we make use of sector-specific employment intensities showing the number of employees needed in a certain economy/sector to produce one unit of output. These intensities are based on the latest output and employment statistics (2016) from the national statistics institution and the UN National Accounts database.

4.2 Results

Operations

The value added and employment results, are presented in Exhibit 18. Cabeolica generates an estimated EUR 3.1 million in value added in salaries, profits, and taxes through its day-to-day operations. Of the total value added an estimated EUR 2.3 million was generated directly by Cabeolica and the remaining EUR 0.7 million was supported indirectly throughout the economy. The largest share of direct value added came from the taxes paid by Cabeolica in 2017, a total of EUR 1.8 million, in the form of value added tax, corporate income tax and withholding tax. In 2017 Cabeolica paid EUR 0.3 million in salaries and earned a profit of EUR 0.9 million. It is estimated, using a combination of Cabeolica financial data and Input-Output modelling (see Section 4.1), that indirectly, Cabeolica supported an estimated EUR 0.4 million in salaries, EUR 0.16 in profits, and EUR 0.16 in taxes. The total value added contribution by Cabeolica in 2017 was equivalent to 0.32% of Cape Verde's GDP.

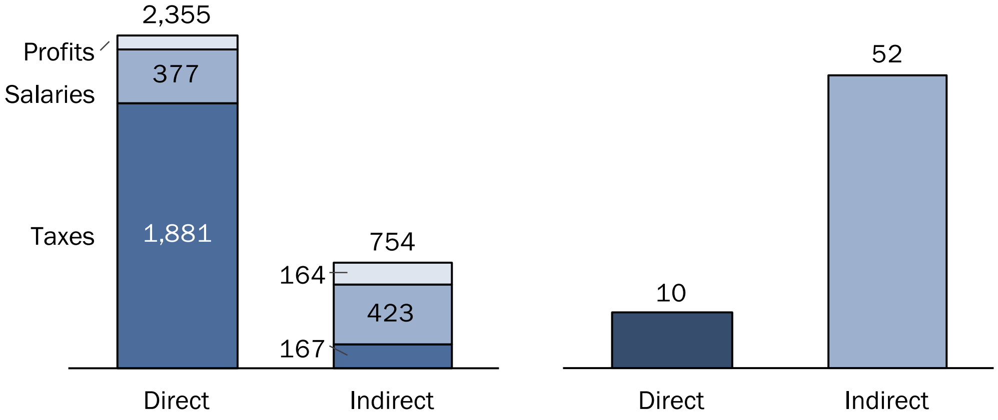

Exhibit 18: Value added (left, EUR 000) and employment effects (number people)

In terms of employment, Cabeolica directly employed 10 people and supported an estimated 52 additional jobs throughout its value chain. The indirect jobs include jobs at the level of Cabeolica's direct suppliers (36 jobs), as well as at the level of the suppliers' suppliers (15 jobs). Half of these indirect jobs are in the services sectors, driven by Cabeolica's local expenses on professional services (finance, audit, marketing, insurance security, etc.). Thus, for every one job at Cabeolica, there are 5.2 jobs supported elsewhere in the economy.

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[38] The other countries include Gambia, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Saint Helena and Sierra Leone.

Additional qualitative impacts

Alongside the quantified economic impacts described above, Cabeolica has had broader societal impacts in the country. Although harder to measure, these effects are notable. They include developing the technical knowledge of Cape Verde's work force, sharing project learnings with representatives from neighbouring Sub-Saharan African countries, and contributing to the placement of the ECOWAS Regional Center for Renewable Energy and Energy Efficiency (ECREE) in Cape Verde. These impacts were confirmed in telephone conversations with three experts familiar with Cabeolica and the power sector in Cape Verde.

Cabeolica has been developing the technical knowledge of Cape Verde's work force by hiring local staff and training both internal and external workers. The company is staffed by local Cape Verdeans. This includes management staff, technical managers, and turbine operators who are responsible for repairs and maintenance and are trained by Vestas. Furthermore, Cabeolica worked with Electra staff to help manage dispatch after the addition of the renewable energy to the grid.

The success of Cabeolica in Cape Verde has had spill-over effects in neighbouring countries. Because Cabeolica provided a proof-of-concept for large scale non-hydro renewable energy projects in Sub-Saharan Africa, it attracted representatives from other countries (including Senegal, Mali, Cote d'Ivoire, Nigeria, Ghana) who wanted to learn how Cabeolica overcame various logistical and financial challenges (such as managing high dispatch from renewable power, building on four separate islands and operating in a low demand environment). Lake Turkana in Kenya – a 310 MW wind farm in Kenya – is a concrete example of a project whose implementation benefited from know-how of Cabeolica.

Finally, as a large and influential renewable energy project, Cabeolica is credited as one of the reasons the ECOWAS placed ECREE in Praia. ECREEE hosts conferences and invites visitors to Cape Verde to learn more about implementing renewable energy projects in their home countries.

5 CONCLUSION AND RECOMMENDATIONS

Based on the results discussed in this report the following conclusions can be drawn:

1. Cabeolica – an AFC and Finnfund supported renewable power company – added 8.6 MW of effective capacity, equal to an increase of 14.4% of Cape Verde's effective power supply;
    a. The additional power supply reduced the average generation cost in Cape Verde by 7.7% by displacing expensive thermal generation;
    b. Displaced thermal generation lowered the need for imported fuel by 17 million litres, equivalent to €10.6 million or 2.1% of Cape Verde's 2016 trade balance;
    c. Lower fuel usage also contributed to avoiding CO_2 emissions equivalent to 58.7 kt of CO_2, or approximately 12% of Cape Verde's 2016 total emissions;
2. Firms in Cape Verde experience outages between 4 – 15% of operations time. After Cabeolica began producing power, outages on the islands where Cabeolica operates were reduced by 50% on average;
    a. Reduced outages are estimated to have increased total operations time for firms in Cape Verde by 0.6%. As a result, total output in the economy increased €3.8 million or 0.2%;
    b. Increased production from lower outages supported an estimated €1.9 million in incomes and 390 jobs in the economy;
3. Through day-to-day operations, Cabeolica supports €3.1 million in value added, directly and indirectly, through salaries, profits, and taxes, equivalent to 0.32% of GDP. Also Cabeolica supports more than 50 jobs indirectly in the economy. Additionally, Cabeolica contributed to developing the technical skills of Cape Verde's labour force by sourcing and training local employees and shared learnings with representatives from renewable countries in neighbouring African countries.

Considering the developments in Cape Verde's power sector and the findings of this report, we make the following recommendations:

1. This study, along with others we have conducted in the power sector, shows that the impacts from investments in power vary depending on certain characteristics of the local energy sectors. When considering investing in (renewable) power, organizations need to take the following in consideration with respect to the economic impact of their investments:
    a. Low reserve margins imply that the power sector is more prone to blackouts and therefore additional energy supply leads to reduced outages, higher production and more jobs;
    b. A high dependence on fossil fuels for generating energy leads to displacement of expensive thermal generation and avoidance of carbon emissions;
    c. The effect of displacing thermal on the overall generation cost will depend on the difference between the cost of fuel and renewables. When fuel price are high, investing in cheaper renewable capacity will have a high impact on the generation cost. However, some thermal could still be cheaper than renewable from feed-in-tariffs.
    d. The effect of lower generation costs is different depending on whether or not tariffs are cost reflective. If tariffs are not cost reflective, as is the case in Honduras, a lower generation cost moves the energy situation closer to a cost reflective price, reducing the need for government support, driving the sector closer to a market-based model. Whereas, if tariffs are cost reflective, a lower generation cost leads to lower end user tariffs, higher electricity consumption, more production and more jobs.

2. The study has demonstrated that inclusion of relatively cheaper power capacity to Cape Verde's grid can decrease generation costs. The country has a target to reach 100% renewable energy by 2025. Achieving this goal might require innovative technologies such as batteries, which could improve the capacity for wind to cover base load by storing surplus energy. Given batteries' vast potential and decreasing cost, this could be a potential area of investment for AFC and Finnfund.
3. Cabeolica's wind power already represents nearly 20% of the total power generated in the country. Additional investments in capacity will be needed to reach the 100% renewable ambition, including in renewable base load power. Given the geothermal potential of the country, supporting geothermal generation projects might be an opportunity for investors to help lower electricity costs while reducing its import dependence.

ANNEX 1: DEFINITIONS

Term	Definition
Installed capacity	The capacity of an electricity generator based on the maximum output of electricity it can produce without exceeding design limits. Expressed in megawatts (MW).
Effective capacity	The capacity of a power plant estimated based on the average annual electricity produced, i.e. factoring in its utilization rate. Expressed in megawatts (MW).
Utilization rate	A percentage measure of the levels at which an electric generator operates over a specific period of time. Calculated as the ratio of the actual generation to the maximum possible output over that time period.
Load-shedding	The deliberate shutdown of electric power in a part or parts of a power-distribution system, generally to prevent the failure of the entire system when the demand strains the system's capacity.
Generation cost	The cost of the plant to produce energy over a certain period of time. Expressed in Euro per kilowatt hour (EUR/kWh).
Tariff	The price of consuming electricity over a certain period of time. Usually set by a regulatory agency or in a spot market.
Reserve margin	A measure of a systems ability to meet energy demand with available supply over a certain period of time.
Dispatch order	The sequence in which power plants are utilized to supply power to the grid based on their cost of generation and the level of demand. Plants with lower generation costs supply power first followed by more expensive plants as demand increases.
Power load	The total sum of all power consumption in the grid at a given period of time. Peak consumption typically is mid-day and in the evening when individuals are working or cooking.
Mitigation factor	A measure of the responsiveness of a firm's (or a sector's) output as outages (as a share of production time) change. Calculated as the ratio of the percentage of outage time to the percentage of total sales lost due to outages.

ANNEX 2: CHANGE IN OUTPUT ON AVERAGE FROM OUTAGE EFFECTS BY SECTOR

Sector	**Δ Output (EUR m, %)**	**Δ GDP (EUR m, %)**	**Δ Employment (Number, %)**
Agriculture (non-dependent)	0.08 (0.06%)	0.06 (0.02%)	19 (0.06%)
Manufacturing (dependent)	0.49 (0.3%)	0.19 (0.23%)	55 (0.23%)
Services (dependent)	3.22 (0.19%)	1.66 (0.19%)	313 (0.00%)
Total	**3.79**	**1.91**	**387**