

*Introduction:*

*The National Energy Efficiency and Renewable Energy Action (NEEREA) is a national financing mechanism dedicated to the financing of loans in energy efficiency, renewable energy, and green buildings. NEEREA is a joint initiative between the Central Bank of Lebanon (BDL) and the Ministry of Energy and Water (MEW). NEEREA receives the technical support of the United Nations Development Programme (UNDP) through funding by the Global Environment Facility (GEF).*

*The Technical Support Unit to the Central Bank of Lebanon (BDL) at LCEC is dedicated to offer BDL technical assistance to evaluate the eligibility of submitted loans to benefit from the EU-funded subsidy. This task is financed by the European Union (EU).*

*Important Notes:*

***1. All sentences written in italic format in these Guidelines are for instructions purposes only. These sentences should be replaced in the technical feasibility study.***

*2. This guide is for instructional purposes. It is designed to help potential beneficiaries and contractors in preparing comprehensive technical reports and proposals VFDs and VVVFs installation/replacement.*

*3. This guide is a mandatory requirement towards facilitating the green loan applications and ensures sufficient and proper technical and financial analysis.*

*4. This guide is prepared by the Lebanese Center for Energy Conservation- Technical Support Unit to the Central Bank of Lebanon, and is available for public use.*

*5. This guide is divided into 9 sections that would ideally be available in the submitted technical report of a loan application. The last section offers general notes on the format of the report.*

*6. For questions, clarifications, or suggestions, please contact the LCEC: 01-569101 or by email:* [*energy@lcec.org.lb*](mailto:energy@lcecp.org.lb)

|  |
| --- |
| ***Evaluation of projects requesting financing of VFDs and VVVFs under NEEREA will be based on these issued VFD and VVVF Guidelines. Contractors are entailed to abide by the requirements set in these guidelines and must submit the technical reports following the steps and regulations clearly identified.*** |

Table of Contents

[1. Introduction 4](#_Toc528323976)

[1.1 Variable Torque Applications: Pumps and Fans 4](#_Toc528323977)

[1.2 Constant Torque Applications: Lifts/Elevators and Escalators 6](#_Toc528323978)

[2. Technical Analysis VFDs for Pumps/Fans and VVVF for Escalators and Elevators 8](#_Toc528323979)

[3. Yearly Energy and Cost Savings 9](#_Toc528323980)

[3.1 VFDs for pumps/fans Savings 9](#_Toc528323981)

[3.2 VVVF for Elevators/Escalators Savings 10](#_Toc528323982)

[4. Financial Analysis 11](#_Toc528323983)

[4.1 VFDs for pumps/fans Financial Analysis: 11](#_Toc528323984)

[4.2 VVVFs for elevator/escalators Financial Analysis: 12](#_Toc528323985)

[5. Green House Gas Emissions Reduction 13](#_Toc528323986)

[6. Post-Installation Monitoring 13](#_Toc528323987)

[7. Conclusions 13](#_Toc528323988)

[8. Appendices 14](#_Toc528323989)

[9. General Notes 14](#_Toc528323990)

[10. Tables 15](#_Toc528323991)

# 1. Introduction

## 1.1 Variable Torque Applications: Pumps and Fans

*[This section should include the objective of the proposed VFDs installation/replacement, the financial criteria and technical/operational limitations, the conclusions on the technical and economic evaluation of the project, a summary of the proposed system, annual energy savings and cost savings using a table format]*

*[Give a brief description of the proposed system and highlight the key advantages of VFDs for the specific application of the project]*

A detailed summary of the proposed system is provided in this section in the tables here below:

*[Supplier’s Signature] [Client’s Signature]*

**VFDs for Pumps**

|  |  |
| --- | --- |
| **Annual Current Pumps Energy Usage (kWh)** |  |
| **Annual Current Pumps Energy Cost (USD)** |  |
| **Annual Energy Usage with VFD (kWh)** |  |
| **Annual Energy Cost with VFD (USD)** |  |
| **Annual Energy Savings (KWh)** |  |
| **Annual Cost Savings (USD)** |  |
| **Initial Implementation Cost ($)** | South Façade  Total |
| **Payback Period** |  |
| **Net Present Value (NPV)** |  |
| **Total amount of CO2  avoided per year (kg)** |  |

*[Supplier’s Signature] [Client’s Signature]*

**VFDs for Fans**

|  |  |
| --- | --- |
| **Annual Current Fans Energy Usage (kWh)** |  |
| **Annual Current Fans Energy Cost (USD)** |  |
| **Annual Energy Usage with VFD (kWh)** |  |
| **Annual Energy Cost with VFD (USD)** |  |
| **Annual Energy Savings (KWh)** |  |
| **Annual Cost Savings (USD)** |  |
| **Initial Implementation Cost ($)** | South Façade  Total |
| **Payback Period** |  |
| **Net Present Value (NPV)** |  |
| **Total amount of CO2  avoided per year (kg)** |  |

## Constant Torque Applications: Lifts/Elevators and Escalators

*[This section should include the objective of the proposed VVVF installation/replacement, the financial criteria and technical/operational limitations, the conclusions on the technical and economic evaluation of the project, a summary of the proposed system, annual energy savings and cost savings using a table format]*

*[Give a brief description of the proposed system and highlight the key advantages of VFDs for the specific application of the project]*

A detailed summary of the proposed system is provided in this section in the table here below:

*[Supplier’s Signature] [Client’s Signature]*

**VVVFs for Elevators**

|  |  |
| --- | --- |
| **Annual Current Elevators Energy Usage (kWh)** |  |
| **Annual Current Elevators Energy Cost (USD)** |  |
| **Annual Energy Usage with VVVF Controller (kWh)** |  |
| **Annual Energy Cost with VVVF Controller (USD)** |  |
| **Annual Energy Savings (KWh)** |  |
| **Annual Cost Savings (USD)** |  |
| **Initial Implementation Cost ($)** | South Façade  Total |
| **Payback Period** |  |
| **Net Present Value (NPV)** |  |
| **Total amount of CO2  avoided per year (kg)** |  |

*[Supplier’s Signature] [Client’s Signature]*

**VVVFs for Escalators**

|  |  |
| --- | --- |
| **Annual Current Escalators Energy Usage (kWh)** |  |
| **Annual Current Escalators Energy Cost (USD)** |  |
| **Annual Energy Usage with VVVF Controller (kWh)** |  |
| **Annual Energy Cost with VVVF Controller (USD)** |  |
| **Annual Energy Savings (KWh)** |  |
| **Annual Cost Savings (USD)** |  |
| **Initial Implementation Cost ($)** | South Façade  Total |
| **Payback Period** |  |
| **Net Present Value (NPV)** |  |
| **Total amount of CO2  avoided per year (kg)** |  |

# Technical Analysis VFDs for Pumps/Fans and VVVF for Escalators and Elevators

*[This section should include the technical assessment of the proposed VFDs vs the conventional or existing system. A comparison between the VFDs and the chosen baseline is adopted to deduct energy and cost savings]*

*[All the related tables in annex to this section are not shown as examples, they must be filled and completed in this technical feasibility study and should include these minimum required information and details needed to assess the VFD proposal]*

*[In order to conclude on energy savings, cost savings and CO2 emissions reduction, a clear comparison is to be presented of the new to be implemented products and the baseline as BAU]*

*[This section must include the existing or BAU technical specifications and the new energy efficient solution technical specifications for pumps, fans, escalators and elevators]*

*[The below specific points are to be taken into consideration in the feasibility study to be presented:*

* *The baseline differs per application. In pumps or fans, the baseline could be DOL or Star Delta as per the scale of the system.*
* *If both applications, pumps and fans, are proposed as energy conservation measures; then Table 1 (presented in annex) is to be presented separately per application.*
* *For each type of fan/pump in Table 1 (presented in annex), a load profile in Table 2 (presented in annex) must be studied and presented.*
* *In VVVF calculations in Table 3 (presented in annex), the calculations must be presented. Usually, the manufacturer company provides energy saving percentage when you implement VVVFs. The percentage ranges between 30% and 40%]*

*[Presentation of the preset voltage to frequency ratios of the VFD is required in this section. The ratio of voltage to frequency, called a linear ratio, is recommended for positive displacement compressors with constant torque loads while the ratio of voltage to frequency to the power of 2, called a squared ratio, is recommended for centrifugal fans, pumps and compressors with variable torque loads]*

*[For the VFD to be eligible, VFD energy losses are to be maximum between 3% and 5% under the rated load]*

# Yearly Energy and Cost Savings

*[In this section, a detailed analysis of the energy consumption and savings should be provided. All Assumptions should be clearly specified (Energy average tariff, Days of operation per year, hours of operation per day, EDL vs Generator hours of operation…). Energy and Cost Savings must be detailed]*

## VFDs for pumps/fans Savings

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Month** | **EDL Energy Savings (kWh)** | **Generator Energy Savings (kWh)** | **EDL Savings (USD)** | **Generator Savings (USD)** |
| January |  |  |  |  |
| February |  |  |  |  |
| March |  |  |  |  |
| April |  |  |  |  |
| May |  |  |  |  |
| June |  |  |  |  |
| July |  |  |  |  |
| August |  |  |  |  |
| September |  |  |  |  |
| October |  |  |  |  |
| November |  |  |  |  |
| December |  |  |  |  |
| **Total** |  |  |  |  |
| **Total Energy Savings (KWh)** |  | | | |
| **Total Cost Savings (KWh)** |  | | | |

## VVVF for Elevators/Escalators Savings

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Month** | **EDL Energy Savings (kWh)** | **Generator Energy Savings (kWh)** | **EDL Savings (USD)** | **Generator Savings (USD)** |
| January |  |  |  |  |
| February |  |  |  |  |
| March |  |  |  |  |
| April |  |  |  |  |
| May |  |  |  |  |
| June |  |  |  |  |
| July |  |  |  |  |
| August |  |  |  |  |
| September |  |  |  |  |
| October |  |  |  |  |
| November |  |  |  |  |
| December |  |  |  |  |
| **Total** |  |  |  |  |
| **Total Energy Savings (KWh)** |  | | | |
| **Total Cost Savings (KWh)** |  | | | |

# Financial Analysis

*[The detailed financial proposal of all the products of the VFD/VVVF system must be provided in the below table format]*

## VFDs for pumps/fans Financial Analysis:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ref. No.** | **Item** | **Item Description** | **Quantity** | **Amount Needed (USD)** |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
|  | **Total Amount of the VFD system (USD)** | |  |  |

*[Add additional rows if needed]*

*[Details on system life and maintenance are to be mentioned in this section such as expectancy, yearly degradation factor, yearly maintenance cost, etc…]*

*[Three different parts must be studied to achieve a complete and clear financial analysis: the first one about all the parameters to take into consideration in the life cycle cost analysis, the second about the cash out-flows and the third discussing the cash in-flows]*

*[The following is an example to facilitate the financial analysis of the proposed system:*

* *Parameters of the VFD/VVVF LCC: total investment, interest rate, loan period, grace period, monthly payments through the loan’s period.*
* *Cash out-flows: file fees, insurance, grace payments, lease payments, etc…*
* *Cash in-flows: Cost savings from EDL, generator or any auxiliary energy source]*

*[All the information to be provided for the financial analysis must be clear, comprehensible and detailed]*

*[The net cumulative savings will be the essential data for concluding on the profitability and the return on investment. The following tables should be used in such analysis and more detailed tables can be provided according to the contractor or consultant detailed analysis]*

*Net Cumulative Savings*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Cash Out-Flows** | **Cash In-Flows** | **Total Cash Flow** | **Total Cumulative Cash Flow** |
| Year 1 |  |  |  |  |
| Year 2 |  |  |  |  |
| **Net Present Value (NPV)** | |  | **IRR** |  |

*[Add additional rows for additional years as needed]*

## VVVFs for elevator/escalators Financial Analysis:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ref. No.** | **Item** | **Item Description** | **Quantity** | **Amount Needed (USD)** |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |
|  | **Total Amount of the VVVF system (USD)** | |  |  |

*Net Cumulative Savings*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Cash Out-Flows** | **Cash In-Flows** | **Total Cash Flow** | **Total Cumulative Cash Flow** |
| Year 1 |  |  |  |  |
| Year 2 |  |  |  |  |
| **Net Present Value (NPV)** | |  | **IRR** |  |

# Green House Gas Emissions Reduction

*[This section is dedicated to the environmental part of the project to be implemented. The calculation of the avoided greenhouse gas emissions must be provided and detailed]*

# Post-Installation Monitoring

*[In case of data logging and monitoring, include in this section the most important parameters that will be measured]*

# Conclusions

*[The conclusion of the VFD/VVVF system proposal must include the following:*

* *Summary of recommendations, estimated annual energy savings (kWh), estimated cost savings, projected investment cost and payback period in the table format below:*

*Summary Table of the proposed PV system*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Measure*** | ***Energy Savings (kWh/year)*** | ***Cost Savings ($/year)*** | ***Implementation Cost*** | ***Payback Period*** | ***tCO2 reduced*** |
|  |  |  |  |  |  |

* *ESCO’s or Solar Energy Company’s recommended action plan and implementation schedule*
* *Statement by the client on which recommendations will be implemented and timeframe for implementation]*

# Appendices

*[Information of significant importance, which cannot be presented as a part of the text report (because of number of pages, quality of presentation, etc.) shall be presented as appendices]*

*[The appendices should include:*

* *Details of all products specifications*
* *Details on simulation tools employed and calculations method*
* *Construction and physical characteristics and warranties conditions for concerned products]*

# General Notes

*[Documentation – All numbers related to the results should be supported by information showing how they were derived. This includes all energy produced; cost savings, investment and payback information]*

*[Mathematical accuracy – All calculations in the report should be checked for mathematical accuracy]*

*[SI units must be used in all parts of the report]*

*[Grammar and style – The report should be written in proper prose. The language should be clear, concise and understandable]*

*[All graphs and plots should be properly labelled and show the dates and conditions when the data was taken]*

# Tables

Table 1: BAU vs VFD systems consumption

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Application Type Pumps/Fans (*with a Reference Code if available)*** | **Location\*** | **Pump/Fan Type** | **Quantity** | **Full Load Power (KW)** | **Operation hours per day (hrs)** | **Operation Days per year (days)** | **BAU System** | | **EE System** | |
| **Controller Type** | **Annual Energy Consumption (KWh)** | **Controller Type** | **Annual Energy Consumption (KWh)** |
| *Domestic Water Pump DW1* | *B1* | *Centrifugal* |  |  |  |  |  |  |  |  |
| *Exhaust Air Fan F1* | *B2* | *Belt Driven Centrifugal* |  |  |  |  |  |  |  |  |
| **Total Annual Energy Consumption (KWh)** | | | | | | |  | |  | |
| **Total Annual Energy Savings (KWh)** | | | | | | |  | | | |

Table 2: VFD Load Profile Analysis

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Part Load Performance** | | | **BAU System (Constant Speed or Other)** | | | **EE System with VFD** | | |
| **Flow Demand (%)** | **Operation hours per day (hrs)** | **Operation Days per year (days)** | **Full Load Power (%)** | **Power (KW)** | **Annual Energy Consumption (KWh)** | **Full Load Power (%)** | **Power (KW)** | **Annual Energy Consumption (KWh)** |
| 0% |  |  |  |  |  |  |  |  |
| 10% |  |  |  |  |  |  |  |  |
| 20% |  |  |  |  |  |  |  |  |
| 30% |  |  |  |  |  |  |  |  |
| 40% |  |  |  |  |  |  |  |  |
| 50% |  |  |  |  |  |  |  |  |
| 60% |  |  |  |  |  |  |  |  |
| 70% |  |  |  |  |  |  |  |  |
| 80% |  |  |  |  |  |  |  |  |
| 90% |  |  |  |  |  |  |  |  |
| 100% |  |  |  |  |  |  |  |  |

Table 3: BAU vs VVVF systems consumption

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Item (Elevator/Escalator)** | **Zone/Block** | **Type/Series** | **Manufacturer** | **Race (m)** | **Cabin Speed (m/s)** | **Number of Floors** | **Motor Nominal Power (KW)** | **Average Number of Travels per Day** | **BAU Annual Energy Consumption (KWh)** | **EE Annual Energy Consumption with VVVF (KWh)** |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
| **Total Annual Energy Consumption (KWh)** | | | | | | | | |  |  |
| **Annual Energy Savings (KWh)**  *\*Specify the % of savings given by the manufacturer\** | | | | | | | | |  | |