ΔΙΑΚΗΡΥΞΗ ΔΕΑ- 420038

ΕΚΠΟΝΗΣΗ ΜΕΛΕΤΗΣ ΣΚΟΠΙΜΟΤΗΤΑΣ, ΜΕΛΕΤΗΣ ΚΟΣΤΟΥΣ ΟΦΕΛΟΥΣ ΚΑΙ ΛΟΙΠΩΝ ΜΕΛΕΤΩΝ ΚΑΙ ΠΑΡΟΧΗ ΥΠΟΣΤΗΡΙΚΤΙΚΩΝ ΥΠΗΡΕΣΙΩΝ ΓΙΑ ΤΟ ΕΡΓΟ «ΔΙΑΣΥΝΔΕΣΗ ΝΟΤΙΩΝ ΚΑΙ ΔΥΤΙΚΩΝ ΚΥΚΛΑΔΩΝ ΜΕ ΤΟ ΕΣΜΗΕ (Δ' ΦΑΣΗ ΔΙΑΣΥΝΔΕΣΗΣ ΤΩΝ ΚΥΚΛΑΔΩΝ)»

ΤΕΥΧΟΣ 4

ΤΕΧΝΙΚΟ ΜΕΡΟΣ

Call for Tender SCD[1]- 420038

"Carrying out of Feasibility Study, Cost Benefit Analysis (CBA) and other studies and provision of Supporting Services for the project "Interconnection of South and West Cyclades to HETS (Cyclades Interconnection Phase D)"

ISSUE 4

TECHNICAL DESCRIPTION

[1] SCD: Supply Chain Department of IPTO

Terms of Reference

Technical Description

For the assignment:

"Carrying out of Feasibility Study, Cost Benefit Analysis (CBA) and other studies and provision of Supporting Services for the project "Interconnection of South and West Cyclades to HETS (Cyclades Interconnection Phase D)"

1. Introduction

The project "Cyclades interconnection Phase D" constitutes the Phase D of the wider project of interconnection of Cyclades with the Mainland System (Hellenic Electricity Transmission System, HETS). The previous Phases A, B, and C referred to the project "Interconnection of Cyclades with the Hellenic Electricity Transmission System", which is under construction. More specifically, the implementation of Phase A of the Cycladic interconnection project has been commissioned and set to operation within the first months of 2018. It comprises the connection of Syros island with Lavrio along with the interconnections with Paros, Mykonos and Tinos. After its completion the local autonomous power generation plants will be put into the state of cold reserve. Phase B is under construction and is envisaged to be accomplished in the first semester of 2020. It includes the construction of a new GIS substation in Naxos and its connection with Paros and Mykonos. In parallel the upgrade of already existing submarine cable between Andros-Livadi (South Evia) and Andros-Tinos with the installation of a new submarine cable AC XLPE 150 kV of nominal capacity 200MVA has been decided and is at the stage of implementation. The replacement of the submarine cable Andros-Livadi has been completed within 2019 and the completion of the second part Andros-Tinos has been completed in February 2020. The project of Naxos interconnection is under construction and expected to be commissioned in 2020. Phase C includes the completion of the interconnection with the immersion of the second cable between Lavrio and Syros, to provide full reliability of supply to the islands. The project that is under construction is expected to be commissioned in 2020.

The project of Cyclades interconnection Phase D refers to the extension of the interconnection of the Northern Cyclades (Cyclades Phases A, B and C) with the connection to the HETS of Western and Southern Cyclades. It involves the interconnection of Thira, Folegandros, Milos and Serifos in a closed loop to the interconnected System of Northern Cyclades via Naxos S/S and to the HETS to Lavrio EHV S/S. The interconnection consists of five underground and submarine cable circuits of around 350 km length, as well as the construction of four GIS substations on the islands. It is expected to be fully commissioned in 2024 and the respective budget is estimated to 386 million euros for the System (IPTO) and approximately 63 million euros for HEDNO .
The project is expected to allow the reliable electricity supply of the Western and Southern Cyclades from the HETS, creating also an additional strong connecting route from HETS to all the Cycladic Islands, and thus permitting the substitution of the production of local conventional power stations (oil and diesel), with significant environmental and economic benefits.

The project has been included for the first time in TYNDP 2019-2028, which is expected soon to be approved by RAE.

The project is the cluster 19.1 both in the TYNDP 2019-2028 and also in the current TYNDP 2021-2030 submitted to RAE. In Annex I more details within the new TYNDP 2021-2030 for the project is provided, while in Annex II the most recent configuration is presented.

IPTO S.A. (the owner and operator of the Hellenic Transmission System), as the project's promoter, aims to obtain co-financing in the framework of EU Funds and thus IPTO is obliged to prepare and submit the information required, referred to in Article 101 (information necessary for the approval of a major project) of Regulation (EU) No 1303/2013. Important elements of the information required, among others, are a Feasibility Study and a Cost Benefit Analysis (CBA). Moreover, the CBA is necessary to submit request for financing by EIB or other financial institutions.

The aim of this document is to describe the technical specifications for the tendering of the Feasibility Study, Cost Benefit Analysis and other studies and for the provision of supporting services to IPTO.

2. Feasibility Study

The Feasibility Study focuses on the evaluation of alternative solutions for the future electricity supply of the islands of South and West Cyclades taking into consideration the environmental constraints set by the EU Directives 75/2010 and 2192/2015 regarding the evolution of the generation mix in the power system of the islands.

3. Cost Benefit Analysis (CBA) & Executive Summary

The project "Cyclades Interconnection Phase D" is considered as a "Major Project" in the framework of EU funds (Article 100 of Regulation (EU) No 1303/2013). Its total eligible cost amounts approximately to € 453 million[2] (excluding contingencies and VAT), exceeding the € 50 million financial threshold set by the above regulation and certain other provisions.

The CBA is an analytical tool for judging the economic advantages or disadvantages of an investment decision by assessing its costs and benefits in order to assess the welfare change attributable to it and the contribution to EU cohesion policy objectives. The Cost Benefit Analysis is explicitly required, among other elements, as a basis for decision making on the co-financing of major projects included in Operational Programs (OPs) of the European Regional Development Fund (ERDF) and the Cohesion Fund.

The CBA, including a financial and economic analysis and a risk assessment, constitutes a crucial part of the information required for the approval of a major project (Article 101 of Regulation (EU) No 1303/2013).

[2] Annex III provides the estimated budget of the project "Cyclades Interconnection Phase D" and its components

The CBA will be carried out by taking into consideration and complying with:

a) The **Guide to Cost Benefit Analysis of Investment projects**[3], Economic appraisal tool for Cohesion Policy 2014-2020" (issued by EC, Directorate General for Regional and Urban policy) for "major projects" (hereinafter referred as **"CBA Guide"**).

b) the **"Climate Change and Major Projects"** [4]Outline of the climate change related requirements and guidance for major projects in the 2014-2020 programming period. Climate change adaptation and mitigation considerations are integrated in the preparation and approval of major projects.

The Economic Analysis, which is part of the complete CBA will apply:

- **IPTO's Manual[5] "Guidelines for carrying out CBA for projects included in HETS", which transfers the 2nd CBA Guideline[6] of the ENTSO-E into Greek system**
- **2nd ENTSO-E Guideline For Cost Benefit Analysis** of Grid Development Projects, Approved by the European Commission 27 September 2018 or any other newest version of ENTSO-E CBA Guideline that will be probably approved and be in force when the study will be conducted

The request for co-financing by ERDF and Cohesion Fund of the current project will be done under the programming period 2021-2027. In this context the Consultant will take into consideration and follow any new guidelines issued by EU authorities in the meantime.

The CBA is structured in the following seven steps:

3.1 Description of the context

Description of the social, economic, political and institutional context in which the project will be implemented.

3.2 Definition of the objectives

From the analysis of all the contextual elements provided from the previous step the regional and/or sectorial needs that can be addressed by the project must be assessed, in compliance with the sectorial strategy prepared by Greece and accepted by the European Commission.

3.3 Identification of the project

Includes:

- the physical elements and the activities (type of infrastructure, type of intervention, service provided, location, etc.) that will be implemented and to achieve a well-defined set of objectives.

[3] http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

[4] https://ec.europa.eu/clima/sites/clima/files/docs/major_projects_en.pdf

[5] IPTO submit the Manual to RAE for approval in February 2020

[6] https://tyndp.entsoe.eu/Documents/TYNDP%20documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf

- the body responsible for implementation and its technical, financial and institutional capacities
- the impact area and the final beneficiaries

3.4 Technical feasibility & Environmental Sustainability

Technical feasibility and environmental sustainability are among the elements of information to be provided in the funding request for major projects. Although technical feasibility and environmental sustainability analysis are not formally part of the CBA, their results must be concisely reported and used as a main data source within the CBA. Detailed information should be provided on: demand analysis, options analysis, environmental and climate change considerations, technical design, cost estimates and implementation schedule.

3.5 Financial Analysis

The **Financial Analysis** is carried out in order to:

- assess the consolidated project profitability
- assess the project profitability for the project owner (IPTO)
- verify the project financial sustainability.

It is carried out in accordance with the Discounted Cash Flow (DCF) method and in compliance with the Commission Delegated regulation 480/2014.

The main parts of the Financial analysis refer to:

- investment cost, replacement costs and residual value
- operating costs and revenues
- sources of financing (EU grant, national public contribution, loans or equity, etc.)
- financial profitability
- financial sustainability

The inflows for the financial analysis include:

- operating revenues from the provision of services (charges paid by the users, ITC revenues, etc.)
- sources of financing
- subsidies and other financial gains

The outflows relate to the following:

- Development costs (e.g. studies, rights of way, environmental planning) and project management costs
- Material and assembly cost, including installation and commissioning

- Other construction costs, including temporary solutions, waste management and environmental costs
- Operating costs (incl. ITC costs)
- Maintenance costs
- Replacement cost
- Reimbursement of loans and interest payment
- Taxes on capital/income and other direct taxes

The **project profitability** is measured by the following key indicators[7]:

- Financial Net Present Value **FNPV (C)** and Financial Rate of Return **FRR (C)** on investment (before EU grant)
- Financial Net Present Value **FNPV (K)** and Financial Rate of Return **FRR (K)** on national capital (after EU grant).

The calculation of the above key indicators contributes to deciding if the project requires EU financial support. The **funding gap rate** quantifies the needed grant (EU and national contribution/grant).

The **financial sustainability** of the project will also be verified. The project is considered as financially sustainable when the risk of running out of cash in the future, both during the investment and the operational stages is negligible.
The difference between inflows and outflows will show the deficit or surplus that will be accumulated each year of the analysis. Sustainability occurs if the generated cumulative cash flow is positive for all the years considered.

It is important to ensure that the project does not risk suffering from a shortage of capital. Proof of disposal of sufficient resources to cover future costs should be provided in the sustainability analysis.

3.6 Economic Analysis

An economic analysis will be carried out to appraise the project's contribution to social welfare.

The Economic Analysis will apply:

- **IPTO's Manual "Guidelines for carrying out CBA for projects included in HETS", which transfers the 2nd CBA Guideline of the ENTSO-E into Greek system**
- 2nd ENTSO-E Guideline For Cost Benefit Analysis of Grid Development Projects, Approved by the European Commission 27 September 2018 or any other newest version of ENTSO-E CBA Guideline that will be probably approved and be in force when the study will be conducted

[7] see Annex IV

Once all the costs and benefits of the project have been quantified and valued in money terms the economic performance of the project will be measured by calculating the following indicators (Annex V):

- **Economic Net Present Value (ENPV):** the difference between the discounted total social benefits and costs

- **Economic Rate of Return (ERR):** the rate that produces a zero value for the ENPV.

- **B/C ratio**: the ratio between discounted economic benefits and costs.

3.7 Risk Assessment

The recommended steps for assessing the project risks are:

- ***Sensitivity analysis***

It enables the identification of the critical variables of the project. Such variables are those whose variations have the greatest impact on a project's financial and economic performance. The sensitivity analysis is carried out by varying one variable at a time and determining the effect of that change on the FNPV and ENPV. As critical variables could be chosen those for which a variation of +/-1% of the value adopted in the base case gives rise to a variation of more than 1% in the value of the FNPV and ENPV.

- ***Qualitative risk analysis*** (incl. risk matrix)

Shall include the following elements:

- a list of adverse events to which the project is exposed
- a risk matrix for each adverse event
- an interpretation of the risk matrix including the assessment of acceptable levels of risk
- a description of mitigation and/or prevention measures.

- ***Probabilistic risk analysis*** *(required where the residual risk exposure is still significant)*

- ***Risk prevention and mitigation*** *(incl. Risk Management, which is the identification of strategies to reduce risks and based on risk assessment)*

Analytical description of each step is presented in the CBA Guide.

4. Report on Greenhouse Gas Emissions

The "Report of Greenhouse Gas Emissions" will be prepared. It will , take inputs from the Environmental Impact Assessment (EIA) Study for the project. The study will follow the guidelines of "Methodologies for the Assessment of Project GHG Emissions and Emission

Variations" (European Investment Bank, 2014) or any updated guide published by EIB or by EE responsible authorities.

5. **Report on Climate Change and Environmental Impact**

The "Report on Climate Change and Environmental Impact" will be prepared. It will be based on the Jasper's Guidance Note "The Basics of Climate Change Adaptation Vulnerability and Risk Assessment" and on the "Climate Change and Major Projects", publication of the European Commission (EC) for the programming period ERDF 2014-2020.Probably updated guidelines will be issued for the new programming period 2021-2027.

6. **Application Form (AF)**

The Application Form (AF), which constitutes the Request for Co-financing will be prepared. This is given in ANNEX II ("Format for submission of the information on a major project" for MAJOR PROJECT within EUROPEAN REGIONAL DEVELOPMENT FUND / COHESION FUND) of the Regulation 207/2015. The studies presented in the previous sections 2 το 5 are annexed to AF. Other technical and technoeconomic studies carried out by IPTO or by third parties could be also annexed.

7. **Dossier of Major Project.** Preparation of Dossier in close collaboration with the involved IPTO's employees and the Greek Ministry of Environment and Energy and the relevant Managing Authority for the Operational Programme of ERDF and CF.

8. **Provision of supporting services to IPTO for the submission of the Major Project Dossier to the European Commission.**

Supporting services will be provided to IPTO during the process of preparation and submission of all required studies and documents for acquisition of co-financing from the ERDF 2021-2027.

More specifically the supporting services refer to:

- Preparation of presentations, relevant documentation, suggestions in collaboration with IPTO and physical presence of the Consultant In the meetings with various involved agents (Ministry of Environment and Energy, managing authorities of the relevant Operational Programme under the framework of the national strategy reference framework, JASPERS [8], International Financial Institutions like EIB, etc.) during the process of request for co-financing.
- Coordination and close collaboration with IPTO's departments and employees in order to give thorough answers to possible questions asked by various involved agents.
- Modifications/Updates of the studies (Feasibility, CBA, Report on Greenhouse Gas

[8] JASPERS (Joint Assistance to Support Projects in European Regions). Their aim is to speed up the absorption of ESIF Funds intended to achieve greater cohesion in Europe, through projects which are planned, prepared, procured and run to the highest technical, social and environmental standards possible. In a similar fashion, they also help with the absorption of funds available under the Connecting Europe Facility (CEF) and the Instrument for Pre-Accession Assistance (IPA). They speed up the EU approval process by carrying out **an independent quality review,** which prepares the ground for the European Commission's decision. https://jaspers.eib.org/

Emissions, Report on Climate Change and Environmental Impact) due to assessment process by Jaspers up to their finalization and the issuing of the Action Completion Note (ACN) by Jaspers, which means the approval of AF and his Annexes (Studies).

- The Consultant will support IPTO in the submission of the **Major Project Dossier** to the European Commission with regard to all above studies and the AF until their final approval by the Commission (DG Comp and DG Regio).

9. Deliverables

1. ***Feasibility Study***
2. ***Cost Benefit Analysis (CBA),*** *fully applying the "CBA Guide", the 2nd CBA Guideline for the Economic Analysis and the "Climate Change and major projects" and its* ***Executive Summary***
3. ***Report on Greenhouse Gas Emissions***
4. ***Report on Climate Change and Environmental Impact***
5. ***Redaction of the Application Form (AF)***
6. ***Preparation of the "Dossier of Major Project" to be submitted to Commission***
7. ***Provision of supporting services to IPTO up to the final approval by the Commission (DG Comp and DG Regio)***

All deliverables will be in English.

10. Time schedule

The deadline for the completion of the Feasibility Study, the CBA and its executive summary (deliverables 1,2) and their submission to IPTO is six months (180 calendar days) from the date of signing of the respective contract. The deadline for Deliverables 3 & 4 is nine (9) months from the date of signing of the contract. Deliverables 5 and 6 will be submitted to IPTO twelve (12) months after the date of the signing of the contract. For the other part of the project, which relates to the support to be given to IPTO, as described above, the time schedule is 18 months from the date of signing of the respective contract.

ANNEX I:Interconnection of West and South Cyclades (Cyclades interconnection Phase D)

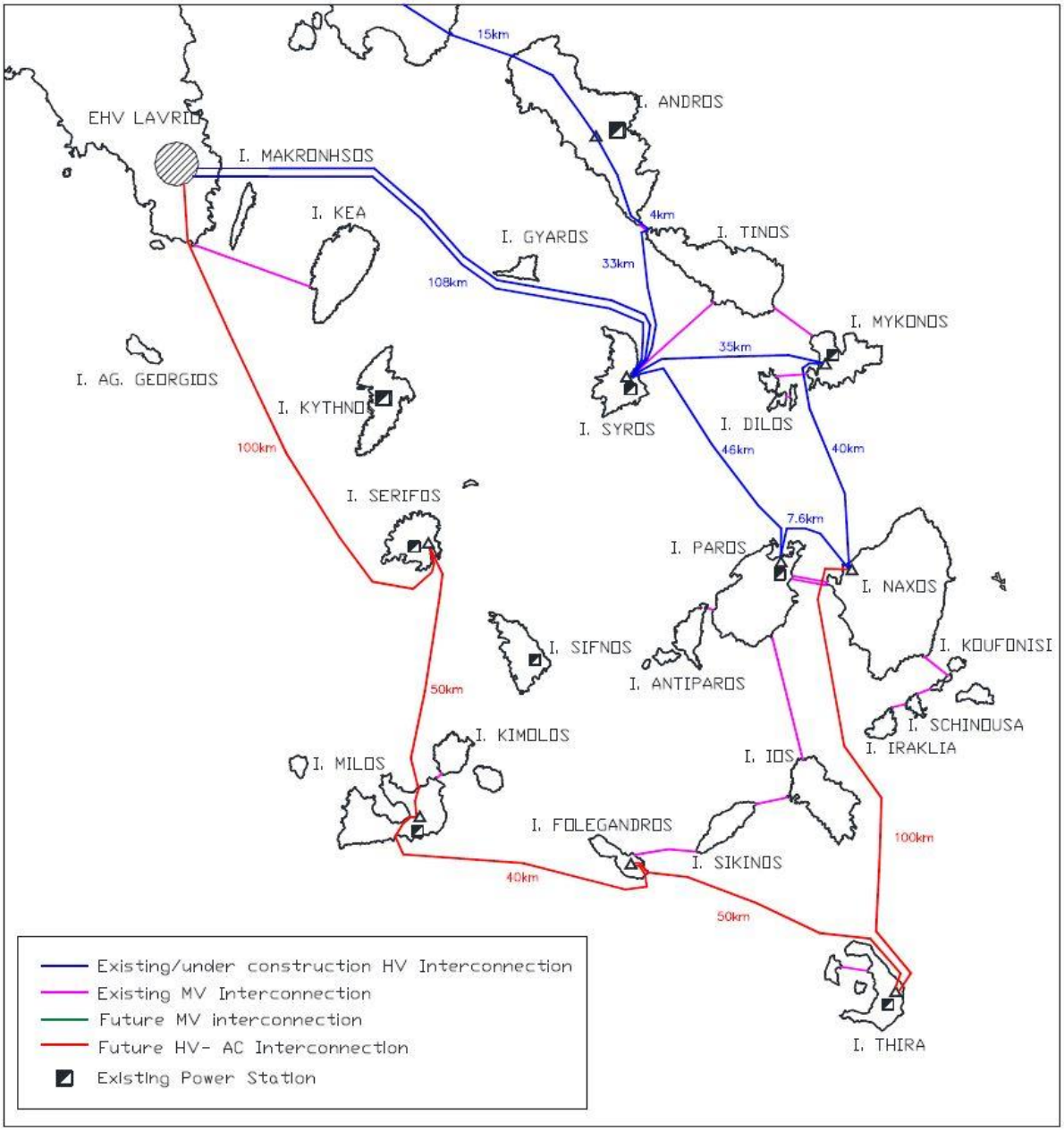
The Cyclades Interconnection Phase D project involves the interconnection of Thira, Folegandros, Milos and Serifos in a closed loop to the interconnected System of Northern Cyclades via Naxos S/S and to the HETS via Lavrio EHV S/S. The project is expected to allow the reliable electricity supply to the Western and Southern Cyclades from the HETS by also creating an additional strong connecting route between the HETS and all the Cycladic Islands. This will permit reduced operation or decommissioning of the islands' local conventional power stations (oil & diesel fueled) and increased RES penetration, with significant environmental and economic benefits.

In further detail, the basic outline of the project is as follows:

1. **Naxos - Thira:** interconnection via an 150 kV AC XLPE submarine cable with 200 MVA nominal capacity and 100 km length.
2. **Thira – Folegandros:** interconnection via an 150 kV AC XLPE submarine cable with 200 MVA nominal capacity and 50 km length.
3. **Folegandros - Milos:** interconnection via an 150 kV AC XLPE submarine cable with 200 MVA nominal capacity and 40 km length.
4. **Milos – Serifos:** interconnection via an 150 kV AC XLPE submarine cable with 200 MVA nominal capacity and 50 km length.
5. **Serifos - Lavrio:** interconnection via an 150 kV AC XLPE submarine cable with 200 MVA nominal capacity and 100 km length.
6. Construction of 4 GIS 150/20 kV substations on the islands of Thira, Folegandros, Milos and Serifos.
7. Installation of a Static Var Compensator (SVC) or Static Synchronous Compensator (STATCOM). The suggested island to be installed is Thira.

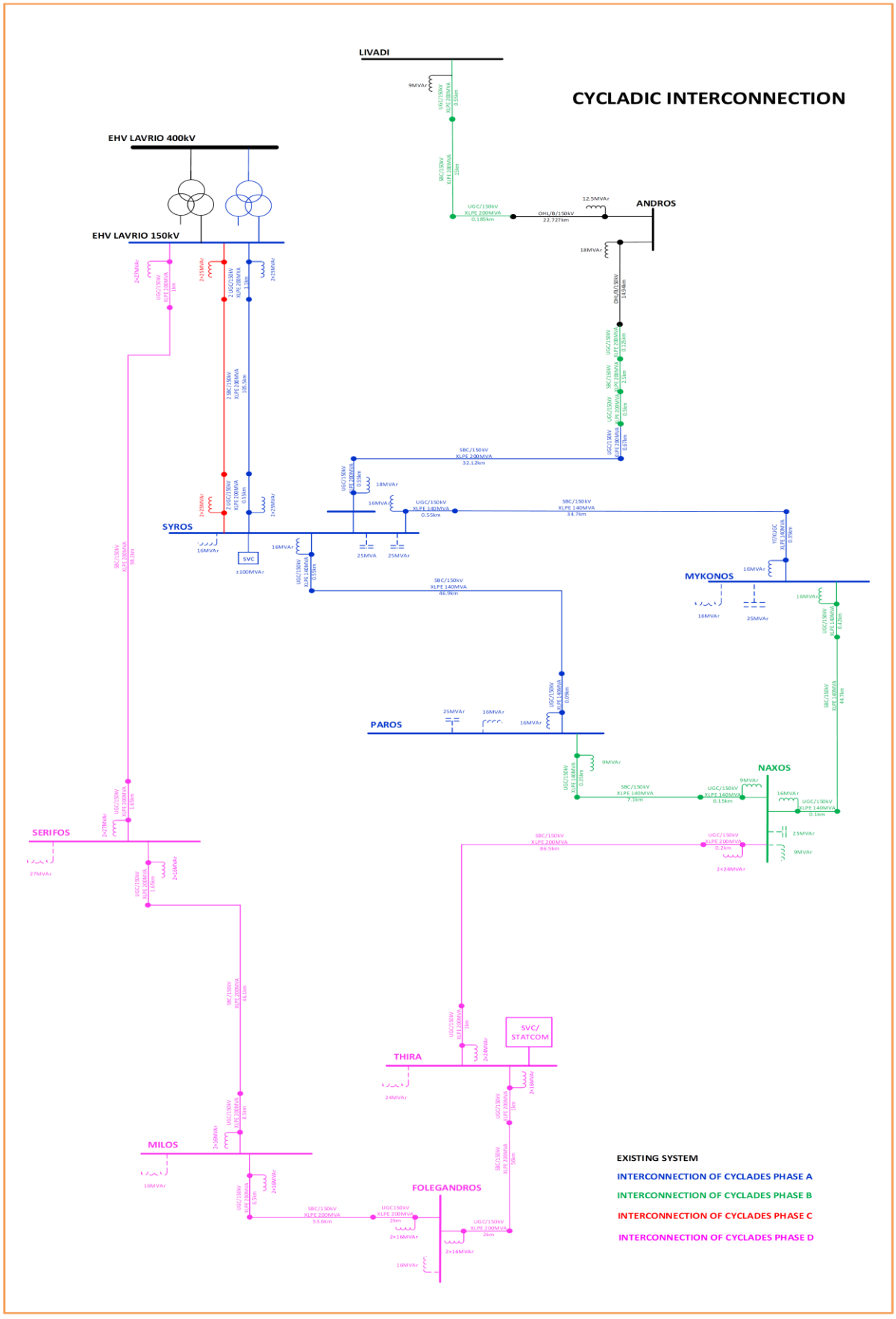
The aim of the project is to enable, after its completion, the majority of the local autonomous power generation plants of these islands to be put into the state of cold reserve. This will result to considerable cost savings for the PSO (Public Service Obligations) due to the reduced operation of the fossil fueled power generation units and the reduced CO_2 emissions.

The implementation of this project will be in two phases with the part of the project concerning the interconnection of Naxos to Thira being prioritized. Thira's annual load equals to approximately 60% of the total annual load of the islands to be interconnected. Hence, the fast implementation of the interconnection of Naxos to Thira will result to serving the majority of the islands' load from HETS units and so the economic benefits from the reduction of PSO (Public Service Obligations) will be quickly derived. Additionally, it is believed that if the auctioning of the project takes place in two phases, it will lead to increased competition (increased stakeholders participation) which will possibly result to the achievement of a lower project cost. Nonetheless, the partial implementation of the project will also provide the opportunity of maximum use of National Strategic Reference Framework (NSRF) funds.



Map of the interconnection of Cyclades to HETS

ANNEX II: Diagram of the project Cyclades Interconnection to HETS



ANNEX III: ESTIMATED PROJECT BUDGET AND ITS COMPONENTS

Table 1. Estimated Project Budget (indicative)

Cyclades Interconnection Phase D- Estimated Budget	(€ million)
IPTO - SYSTEM	
Estimated Budget (Subprojects)	385,5
Project Management (PM) (1%)	3,9
Contingencies (9%)	**34,7**
Total Investment Cost- IPTO (incl. contingencies)	**424,1**
Total Investment Cost-IPTO (excl. contingencies)	**389,4**
HEDNO	
Estimated Budget (Subprojects)	62,7
Project Management (PM) (1%)	0,6
Contingencies (9%)	5,6
Total Investment Cost-HEDNO (incl. contingencies)	**69,0**
Total Investment Cost- HEDNO (excl. contingencies)	**63,3**
IPTO+HEDNO	
Estimated Budget (Subprojects)	448,2
Project Management (PM) (1%)	4,5
Contingencies (9%)	**40,3**
Grand Total Investment Cost- (IPTO+HEDNO) (incl. contingencies)	**493,1**
Grand Total Investment Cost- (IPTO+HEDNO) (excl. contingencies)	**452,7**

Table 2. Subprojects and estimated investment cost breakdown (indicative)

IPTO

A/A	Υποέργα	Subprojects	Budget (€)
1	Μελέτη βυθού	Seabed study	87.402
2	Υ/Σ Ζεύξης GIS Λαυρίου 150kV	GIS Substation in Lavrio 150 kV	1.513.907
3	Καλωδιακή Γ.Μ. 150 kV Λαύριο - Σέριφος	150 kV cable transmission line Lavrio-Serifos	100.019.858
4	Κατασκευή νέου Υ/Σ στη Σέριφο (Ζυγοί - Πύλες - Πηνία -Πυκνωτές)	New substation in Serifos (busbar - line bays - reactors - capacitors)	5.025.282
5	Κατασκευή νέου Υ/Σ στη Σέριφο (Μ/Σ - Πυκνωτές)	New substation in Serifos (transformer - capacitors)	4.000.000
6	Καλωδιακή Γ.Μ. 150 kV Σέριφος - Μήλος	150 kV cable transmission line Serifos - Milos	50.079.815
7	Κατασκευή νέου Υ/Σ στη Μήλο (Ζυγοί - Πύλες - Πηνία - Πυκνωτές)	New substation in Milos (busbar - line bays - reactors - capacitors)	5.020.440
8	Κατασκευή νέου Υ/Σ στη Μήλο (Μ/Σ - Πυκνωτές)	New substation in Milos (transformer - capacitors)	4.002.600
9	Καλωδιακή Γ.Μ. 150 kV Μήλος - Φολέγανδρος	150 kV cable transmission line Milos - Folegandros	40.032.078
10	Κατασκευή νέου Υ/Σ στη Φολέγανδρο (Ζυγοί - Πύλες - Πηνία - Πυκνωτές)	New substation in Folegandros (busbar - line bays - reactors - capacitors)	5.054.358
11	Κατασκευή νέου Υ/Σ στη Φολέγανδρο (Μ/Σ - Πυκνωτές)	New substation in Folegandros (transformer - capacitors)	4.002.600
12	Καλωδιακή Γ.Μ. 150 kV Φολέγανδρος - Θήρα	150 kV cable transmission line Folegandros - Thira	50.037.803
13	Κατασκευή νέου Υ/Σ στη Θήρα (Ζυγοί - Πύλες - Πηνία - Πυκνωτές)	New substation in Thira (busbar - line bays - reactors - capacitors)	5.063.082
14	Κατασκευή νέου Υ/Σ στη Θήρα (Μ/Σ - Πυκνωτές)	New substation in Thira (transformer - capacitors)	4.004.300
15	Καλωδιακή Γ.Μ. 150 kV Θήρα - Νάξος	150 kV cable transmission line Thira - Naxos	100.016.409
16	Προσθήκη καλωδιακής πύλης Γ. Μ. 150 kV & 2 πηνίων (150 kV/25 MVAr) στην Νάξο	Addition of a new 150 kV transmission line bay and 2 reactors (150 kV/25 MVar) in Naxos	1.509.207
17	Εγκατάσταση SVC στη Θήρα	SVC in Thira	6.016.707
	ΣΥΝΟΛΟ (ΑΔΜΗΕ)	**TOTAL (IPTO)**	**385.485.848**

HEDNO

A/A	Υποέργα	Subprojects	Budget (€)
1	Διασύνδεση ΜΤ Κύθνου- Σερίφου	MV Interconnection Kithnos-Serifos	12.144.000
2	Διασύνδεση ΜΤ Σίφνου- Σερίφου	MV Interconnection Sifnos-Serifos	9.932.000
3	Διασύνδεση ΜΤ Δονούσας-Νάξου	MV Interconnection Donoussa-Naxos	14.560.000
4	Διασύνδεση ΜΤ Αστυπάλαιας-Ανάφης-Θήρας	MV Interconnection Astipalaia-Anafi-Thira	26.080.000
	ΣΥΝΟΛΟ (ΔΕΔΔΗΕ)	**TOTAL (HEDNO)**	**62.716.000**

ANNEX IV: CALCULATION OF FINANCIAL PERFORMANCE INDICATORS

Financial Net Present Value (FNPV)

This indicator represents the discounted economic cash-flow of the project. It shall be calculated according to the following formula:

$$FNPV = \sum_{t=f}^{c+T} \frac{R_t - C_t}{(1+i)^{(t-n)}}$$

Where:

- ***c*** is the first full year of operation
- R_t: is the revenue from the operation in year t (in the revenues of year t+T the residual value of the project is included)
- **Ct** is the sum of CAPEX and OPEX on the year *t*
- ***n*** is the year of analysis
- ***i*** is the Financial Discount Rate (FDR) of the project
- ***f*** is the first year of revenue or cost

If FNPV is positive the project generates a net profit. The FNPV reflects the financial viability of a project in absolute values and it is considered the main
financial performance indicator.

Financial Internal Rate of Return (FIRR)

This indicator represents the financial viability of the project being its ability to generate revenues higher than its investment and operational costs. The indicator is defined as the discount rate that produces a zero FNPV.

Therefore a project is considered financially desirable if the FIRR exceeds its Financial Discount Rate.

The Financial Benefit/Cost ratio (FB/C)

This indicator is the ratio between the discounted benefits and the discounted costs.

$$FB/C = \frac{\sum_{t=f}^{c+T} \frac{R_t}{(1+i)^{t-n}}}{\sum_{t=f}^{c+T} \frac{C_t}{(1+i)^{t-n}}}$$

Where:

- ***c*** is the first full year of operation
- R_t: is the revenue from the operation in year t (in the revenues of year t+T the residual value of the project is included)
- **Ct** is the sum of CAPEX and OPEX on the year *t*

- ***n*** is the year of analysis
- ***i*** is the Financial Discount Rate (FDR) of the project
- ***f*** is the first year of revenue or cost

If FB/C exceeds 1, the project is considered as financially efficient as the revenues outweigh the costs on the time horizon.
These performance indicators should be seen as complementary to FNPV.

ANNEX V: CALCULATION OF ECONOMIC PERFORMANCE INDICATORS

Economic Net Present Value (ENPV)

This indicator represents the discounted economic cash-flow of the project. It shall be calculated according to the following formula:

$$ENPV = \sum_{t=f}^{c+T} \frac{R_t - C_t}{(1+i)^{(t-n)}}$$

Where:

- ***c*** is the first full year of operation
- **Rt** is the social benefit induced by the project on year *t*. The benefit on year c+T also includes the Residual Value of the project.) The benefit refers mainly to Socio-Economic Welfare, SEW, which is the benefit indicator B2. Moreover, other monetized benefits, such as benefits from variation of losses (benefit indicator B4), should be taken into account.
- **Ct** is the sum of CAPEX and OPEX on the year *t*
- ***n*** is the year of analysis
- ***i*** is the Economic Discount Rate of the project
- ***f*** is the first year of induced social welfare ($\Delta SWEU$) or cost

If ENPV is positive the project generates a net benefit. The ENPV reflects the performance of a project in absolute values and it is considered the main performance indicator.

Economic Internal Rate of Return (EIRR)

This indicator represents the economic viability of the project being its ability to generate social welfare higher than its investment and operational costs. The indicator is defined as the discount rate that produces a zero ENPV.

Therefore a project is considered economically desirable if the EIRR exceeds its Social Discount Rate.

The Economic Benefit/Cost ratio (EB/C)

This indicator is the ratio between the discounted benefits and the discounted costs.

$$EB/C = \frac{\sum_{t=f}^{c+T} \frac{R_t}{(1+i)^{t-n}}}{\sum_{t=f}^{c+T} \frac{C_t}{(1+i)^{t-n}}}$$

Where:

- ***c*** is the first full year of operation
- **Rt** is the social benefit induced by the project on year *t*. The benefit on year c+T also includes the Residual Value of the project.) The benefit refers mainly to Socio-Economic Welfare, SEW, which is the benefit indicator B2. Moreover, other monetized benefits, such as benefits from variation of losses (benefit indicator B4), should be taken into account.

- **Ct** is the sum of CAPEX and OPEX on the year *t*
- ***n*** is the year of analysis
- ***i*** is the Economic Discount Rate of the project
- ***f*** is the first year of induced benefit or cost

If EB/C exceeds 1, the project is considered as economically efficient as the benefits outweigh the costs on the time horizon.
These performance indicators should be seen as complementary to ENPV and as a way to assess/compare projects of different sizes (different level of costs and benefits).