Ancillary services in aCTIVe distribution networks bAsed on moniToring and control tEchniques

Project: **ACTIVATE**

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List of Acronyms

Acronym	Meaning
AB	Advisory Board
ADN	Active Distribution Network
AS	Ancillary Services
AUTH	Aristotle University of Thessaloniki
BESS	Battery Energy Storage Systems
CMU	Central Monitoring Unit
DRES	Distributed Renewable Energy Sources
DSO	Distribution System Operator
DynA	Dynamic Analysis
DUTH	Democritus University of Thrace
ESS	Energy Storage Systems
HV	High voltage
JRC	Joint Research Centre
LV	Low voltage
MIMO	Multiple-Input Multiple-Output
MV	Medium voltage
NREL	National Renewable Energy Laboratory
PI	Principal Investigator
SISO	Single-Input Single-Output
ST	Sub-Tasks
TSO	Transmission System Operator
TM	Technical Meeting
WP	Work Package
PHIL	Power hardware-in-the loop

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Executive summary

The purpose of the Project Management Handbook is to define the project organisation, operating procedures, and roles of all members of the research group related to day-to-day project activities. It describes the work breakdown of all Tasks in all work packages (WPs) and the initial time frame within which each individual work must be completed.

Finally, D7.1 establishes a List of Milestones and a Risk and Contingency Plan for evaluating the progress and success of the work within each WP.

The use of the present Project Management Plan can ensure better collaboration among the individual researchers and groups.

The Project Management Plan is a deliverable (D7.1), which is intended to be used by all the project members, in order to ensure quality assurance of project processes and outputs and prevent possible deviations from the project work plan.

1. WP1 - Requirements engineering and state-of-the-art

The work of this WP is divided into three tasks to cover the state-of-the-art and requirements related to the three following project key objectives, respectively. Dr. G. Kryonidis, Mr. A. Nousdilis, and one PhD candidate will participate in Task 1.1. Dr. E. Kontis, Mr. PhD candidate, and one PhD candidate will participate in Task 1.2. Prof. N. Papanikolaou and one PhD candidate will participate in Task 1.3. The PI will also participate by coordinating the research efforts of the three groups.

1.1. Ancillary services solutions (Task 1.1)

- **Participants**: G. Kryonidis, A. Nousdlilis, PhD candidate
- **Effort**: 6 months (M01 – M06)

Table 1: Task 1.1 schedule.

	2020											
	J	F	M	A	M	J	J	A	S	O	N	D
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
WP1												
Task1.1												
Task1.2												
Task1.3												

The subtasks of Task 1.1 are:

- Subtask 1.1.1 **[G. Kryonidis]**: Update the literature database with the state-of-the-art solutions for ADNs problems (overvoltages, voltage unbalances, and overloading of network equipment).
  Deadline: M01 (end of January 2020)
- Subtask 1.1.2 **[A. Nousdilis]**: Update the literature database with the state-of-the-art methods for voltage unbalance mitigation and ESS sizing for inertia.
  Deadline: M02 (end of February 2020)
- Subtask 1.1.3 **[PhD candidate]**: Extensive study of the literature database regarding network overloading and power smoothing.
  Deadline: M05 (end of May 2020)
- Subtask 1.1.4 **[All, PI]**: Brainstorming regarding the adopted solution.
  Deadline: M06 (end of June 2020)

Table 2: Task 1.1 outputs.

• **Output 1:** Part of the report on the state-of-the-art and technical solutions.. **[G. Kryonidis, A. Nousdilis, PhD candidate, PI]** **(M06)**.

1.2. Network monitoring technologies and techniques (Task 1.2)

- **Participants**: E. Kontis, PhD candidate, PhD candidate
- **Effort**: 6 months (M01 – M06)

Table 3: Task 1.2 schedule.

	2020											
	J	F	M	A	M	J	J	A	S	O	N	D
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
WP1												
Task1.1												
Task1.2												
Task1.3												

The subtasks of Task 1.2 is the literature review of the following topics:

- Subtask 1.2.1 **[L. Kontis, PI]**: Dynamic equivalent models for the analysis of distribution grids
  Deadline: M03 (end of March 2020)
- Subtask 1.2.2 **[L. Kontis, PhD candidate]**: Static equivalent models for the analysis of distribution grids
  Deadline: M03 (end of March 2020)
- Subtask 1.2.3 **[PhD candidate, L. Kontis]**: Identification techniques for the modal analysis of power systems.
  Deadline: M03 (end of March 2020)
- Subtask 1.2.4 **[PhD candidate, L. Kontis]**: Multi-signal identification techniques
  Deadline: M03 (end of March 2020)
- Subtask 1.2.5 **[L. Kontis, PhD candidate]**: Real-time estimation of inertia time constants
  Deadline: M05 (end of May 2020)
- Subtask 1.2.6 **[PhD candidate, PhD candidate]**: Network monitoring techniques.
  Deadline: M05 (end of May 2020)
- Subtask 1.2.7 **[All, PI]**: Brainstorming regarding the proposed architecture, i.e., D3.2.
  Deadline: M06 (end of June 2020)

Table 4: Task 2.1 outputs.

• **Output 1 (D1.1):** Part of the report on the state-of-the-art and technical solutions. **[All, PI]** **(M06)**.

1.3. Development of converter (Task 1.3)

- **Participants**: PhD candidate, N. Papanikolaou
- **Effort**: 6 months (M01 – M06)

Table 5: Task 1.3 schedule.

	2020											
	J	F	M	A	M	J	J	A	S	O	N	D
Month	1	2	3	4	5	6	7	8	9	10	11	12
WP1												
Task1.1												
Task1.2												
Task1.3												

The subtasks of Task 1.3 are:

- Subtask 1.3.1 **[PhD candidate]**: Update the literature review with the state-of-the-art technologies for power converters. Specifically:
  - the technical specification regarding the power control,
  - communication,
  - recording capabilities
  - implementation requirements.

  Deadline: M06 (end of June 2020)
- Subtask 1.3.2 **[All, PI]**: Brainstorming regarding the adopted solution. M03 (March 2020)

Table 6: Task 3.1 outputs.

• **Output 1:** Part of the report on the state-of-the-art and technical solutions. **[PhD candidate, N. Papanikolaou, PI]** **(M06)**.

1.4. WP Outputs

- **Participants**: All

Table 7: Outputs of WP1.

	2020											
	J	F	M	A	M	J	J	A	S	O	N	D
Month	1	2	3	4	5	6	7	8	9	10	11	12
WP1						**MS1**						
Task1.1						**D1.1**						
Task1.2												
Task1.3												

Table 8: WP1 outputs.

• **Output 1 (D1.1):** Report on the state-of-the-art and technical solutions. This will be obtained from the corresponding parts of each Task. [All, PI] **(M06)**. • **Output 2 (MS1)**: Literature review – state-of-the-art.

2. WP2 - Ancillary services solutions for DSOs and TSOs

The strategies and optimization procedure proposed in ACTIVATE will be developed, using the findings of Task 1.1. All research members of ACTIVATE working on DSO-/TSO-oriented ancillary services solutions) will participate in this WP. During this WP, a technical meeting (TM) will take place in DUTH (Kimmeria campus, Xanthi) during the 12th month of the project. In the first technical meeting (TM1), the progress and possible technical issues of all ACTIVATE aspects (WP2, WP3) will be discussed. However, special emphasis will be given in the proposed ancillary services solutions, thus members from AUTH will participate. The work of this WP is divided into the following three tasks:

2.1. Development of control strategies to tackle network operational issues (Task 2.1)

Scope of this task is to tackle the following operational issues (M04 – M12):

- Overvoltages
- Voltage unbalances (applicable only to LV networks)
- Overloading of network equipment (mainly of lines and transformers)

This Task is divided into the following STs**.**

- ST 2.1.1: Voltage regulation in LV networks
- ST 2.1.2: Voltage regulation in MV networks
- ST 2.1.3: Voltage unbalance mitigation in LV networks
- ST 2.1.4: Overloading of network equipment

Table 9: Task 2.1 schedule.

	2020											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
WP2												
Task2.1												

2.1.1. Voltage regulation in LV networks (Subtask 2.1.1)

- **Participants:** PhD candidate, G. Kryonidis, MSc student
- **Effort:** 3 months (M04-M06)

Development of a local controller that coordinates the response of both the ESSs and DRESs to tackle overvoltages (as a function of the voltage at PCC or emulating a PI controller). PV units will be considered as the main DRES type. The proposed method will exploit the reactive power capability of the DRESs as well as the storage capacity of the ESSs to tackle overvoltages and undervoltages. Additionally, two types of interfacing between the PV and ESS will be considered. The first type is the ac-coupled and the second type is the dc-coupled. The performance of the proposed method will be thoroughly evaluated using these two types. Special consideration should be given in case of single-phase PV and ESS. Towards this objective, the following steps shall be implemented:

- Step 1: Model in NEPLAN and OpenDSS two benchmark networks (LV CIGRE European Configuration [1] and IEEE European Network [2]).
  Deadline: M04 (end of April 2020)
- Step 2: Develop the local decentralized controller (PV and ESS) in MATLAB (Chapter 2 of [1]).
  - Stage 1: BESS+PV: absorb reactive power
  - Stage 2: Reduce active power: a) curtailment, b) BESS
  - It is also important to clarify if the controller will be connected at the **DC** or the **AC** side of the inverter.

  Deadline: M05 (end of May 2020)
- Step 3: Perform one day analysis using consumption and generation data with one-minute resolution. More specifically, the data acquired from NREL and JRC will be used to model the consumption, while the data related to PV generation will be obtained from Ninja, JRC measurements, and INCREASE project.
  Deadline: M05 (end of May 2020)
- Step 4: Compare the results with other decentralized solutions proposed in the literature [17] – [20].
  Deadline: M06 (end of June 2020)

2.1.2. Voltage regulation in MV networks (Subtask 2.1.2)

- **Participants:** G. Kryonidis, A. Nousdilis.
- **Effort:** 3 months (M04 – M06)

Contrary to the LV networks, in MV networks large scale storage systems will be deployed which will be connected to specific nodes of the network. Scope of this task is to develop a local controller that can be applied not only to DRESs but also to large ESSs connected to the MV level. The local controller will control the active and reactive power output of the ESSs and the reactive power output of the DRESs to tackle both overvoltages and undervoltages. Towards this objective, the following steps shall be implemented:

- Step 1: Develop the local controller in MATLAB (MV benchmark networks have been already implemented in NEPLAN and OpenDSS). The MV CIGRE European Configuration [21] and the IEEE 33-bus network [22].
  Deadline: M05 (end of May 2020)
- Step 2: Perform one day analysis using consumption and generation data with one-minute resolution. The consumption data of the DUTH campus will be obtained. Similar to the LV voltage regulation method, the generation data will be acquired from Ninja, JRC, and INCREASE project.
  Deadline: M05 (end of May 2020)
- Step 3: Compare the results with other decentralized solutions proposed in the literature [17] - [20].

Deadline: M06 (end of June 2020)

2.1.3. Voltage unbalance mitigation in LV networks (Subtask 2.1.3)

- **Participants**: A. Nousdilis, G. Kryonidis., PhD candidate
- **Effort**: 4 months (M07-M10)

Update the local controller developed in Task "*Voltage regulation in LV networks*" to tackle network unbalances. The updated local controller will only employ the **reactive** power allocation among phases to tackle voltage unbalances using the "conductance" concept. In case of limited performance, the local controller can be revised to include also active power allocation among the phases. Once again, the ac-coupled and the dc-coupled type of connection of PV and ESSs will be considered. Towards, this objective the following steps shall be implemented:

- Step 1: Develop the updated version of the local controller in MATLAB.
  Deadline: M07 (July 2020)
- Step 2: Develop an algorithm for the derivation of the desired value of the conductance that should be applied to each PV and ESSs (e.g. using the equivalent Thevenin theory).
  Deadline: M08 (August 2020)
- Step 3: Compare the results with the corresponding from [23], [24].
  Deadline: M10 (October 2020)

2.1.4. Overloading of network equipment (Subtask 2.1.4)

- **Participants**: ALL
- **Effort**: 2 months (M11-M12)

Update the local controller developed for voltage regulation and voltage unbalance mitigation to tackle the problem of lines and transformer overloading (*additionally: temperature-dependent power flow may be also used here*). This work will be split in two separate subtasks. The first subtask is related to overloading in MV networks while the second in LV networks. As already mentioned, in the MV level the ESSs will be treated as large installations located at the HV/MV transformer or at critical nodes of the network (in terms of voltage and current violation). Contrary to MV level, in the LV level, an integrated PV and ESS will be assumed without, however, neglecting the possibility of examining separate installations of PVs and ESSs. Special consideration should be given in case of single-phase PV and ESS. The common characteristic of both methods will be the current measurement (possibly of the upstream line). Towards, this objective the following steps shall be implemented:

- Overloading in MV networks [A. Nousdilis, G. Kryonidis]
  - Step 1: Develop the updated version of the local controller in MATLAB. **Technique:** measure line current, compare with the thermal current and utilize BESS. Re-evaluation of the overvoltage control should be also checked.
    Deadline: M11 (end of November 2020)
  - Step 2: Evaluate the overall performance of the local controller to tackle voltage and current violations at the same time.

Deadline: M11 (end of November 2020)

  - Step 3: Compare the proposed method with other decentralized solutions in the literature (if exist).
    Deadline: M12 (end of December 2020)
- Overloading in LV networks [PhD candidate, G. Kryonidis]
  - Step 1: Develop the updated version of the local controller in MATLAB. **Technique:** measure line current, compare with the thermal current and utilize BESS. Re-evaluation of the overvoltage control should be also checked.
    Deadline: M11 (end of November 2020)
  - Step 2: Evaluate the overall performance of the local controller to tackle voltage violations, overloading, and voltage unbalances at the same time.
    Deadline: M11 (end of November 2020)
  - Step 3: Compare the proposed method with other decentralized solutions in the literature (if exist).
    Deadline: M12 (end of December 2020)

2.2. High level control strategies via optimization techniques (Task 2.2)

The main objective of this task is the development of high-level control strategies to maximize the effectiveness of the individual control schemes developed in Task 2.1.

This Task is divided into the following STs**.**

- ST 2.2.1: Optimal voltage regulation in MV networks
- ST 2.2.2: Optimal voltage regulation in LV networks
- ST 2.2.3: Optimal voltage unbalance mitigation
- ST 2.2.4: Optimal overloading mitigation

Table 10: Task 2.2 schedule.

	2020	2021										
	D	J	F	M	A	M	J	J	A	S	O	N	D
Month	12	13	14	15	16	17	18	19	20	21	22	23	24
WP2				MS2								MS3	
Task2.2												D2.2	

2.2.1. Optimal voltage regulation in MV networks (Subtask 2.2.1)

- **Participants:** G. Kryonidis, A. Nousdilis
- **Effort:** 4 months (M12-M15)

Scope of the developed methodology is to properly coordinate the response of DRESs and ESSs to regulate network voltages, while also maximizing the energy yield to the transmission system. Additional objectives can be added to the optimization problem. The proposed method will be also capable of providing voltage support to the transmission system. The developed methodology will use the available reactive power of DRESs and the flexibility added by the ESSs in terms of controllable active and reactive power output. Towards this objective, the following steps will be implemented:

- Step 1: Develop and implement the high-level control strategy in MATLAB. The decentralized operation developed in Subtask 2 of Task 2.1 will be capable of maintaining network voltages within permissible limits but in an uncoordinated way. Scope of the high-level control strategy is to coordinate them to meet the above-mentioned optimization/operation objectives. The high-level control strategy will adopt a rule-based approach, meaning that the coordination process will be centrally managed by a central controller located at the DSO level. Scope of ACTIVATE to maintain as low as possible the information exchange between the DRESs, ESSs, and of central controller.
  Deadline: M13 (end of January 2021)
- Step 2: Evaluate its performance against optimization-based centralized solutions [25], [26].
  Deadline: M15 (end of March 2021)
- Step 3: Evaluate its performance against decentralized solutions [17]-[19].
  Deadline: M15 (end of March 2021)

2.2.2. Optimal voltage regulation in LV networks (Subtask 2.2.2)

- **Participants:** PhD candidate, G. Kryonidis
- **Effort:** 4 months (M13-M16)

The developed methodology will be implemented using the following concept: A central controller will be used to acquire the network voltages at the PCC of the PV and ESSs. Afterwards, the central controller will prioritize the response of each PV and ESS based on the PCC voltage. A similar concept to the following publication will be adopted [27]:

Additionally, a coordinated LV/MV voltage regulation solution will be developed (from sub-tasks 2.1.1 and 2.1.2). This will be achieved by adding reactive power support capability (to the upstream MV network in terms of regulating the MV voltage at the PCC with the MV/LV transformer) in the developed LV voltage regulation method. The performance of the developed control scheme will be evaluated against decentralized (e.g., maximize SCR) and optimization-based methods in terms of:

- Voltage regulation capability
- Computational complexity
- ESS sizing requirements
- Energy losses

The following steps will be implemented:

- Step 1: Develop the high-level control strategy in MATLAB. Similar to Subtask 1, scope of the high-level control strategy is to coordinate the decentralized operation of the ESSs, DRESs to meet the above-mentioned operation/optimization objectives. This will be attained by developing a rule-based approach (if possible) to coordinate the response of DRESs, ESSs, presenting thus small computational complexity, which allows the implementation of the proposed method under real field conditions.

Deadline: M13 (end of January 2021)

- Step 2: Evaluate its performance against optimization-based centralized solutions.
  Deadline: M15 (end of March 2021)
- Step 3: Evaluate its performance against decentralized solutions [28]-[29].
  Deadline: M16 (end of April 2021)

2.2.3. Optimal voltage unbalance mitigation (Subtask 2.2.3)

- **Participants:** A. Nousdilis, G. Kryonidis, PhD candidate
- **Effort:** 5 months (M13-M17)

Scope of this task is to determine the optimal “conductance” allocation among the PVs and ESSs in LV network. This can be implemented by adopting one of the following solutions. In the first solution, an optimization problem with reduced computational complexity will be solved (using GAMS or MATLAB). The network asymmetric will be modelled in detailed, while the “conductance” at each PV and ESS node will be the only control variable. Scope of the optimization problem will to define the allocation of the “conductance” among the phases to minimization a specific optimization objective, e.g., the sum of the VUF_0 and VUF_2 of all the network nodes. Possible linearization techniques will be employed to reduce the computational complexity of the optimization problem. The second solution involves the development of a rule-based solution for the reactive power allocation. This will be attained by analytically deriving the sensitivity of voltage unbalance factors (VUF_0, VUF_2) at a specific node with respect to the reactive power allocation among the phases of this node. This analysis will give a better insight of the mechanism that affects the voltage unbalance in a distribution network, towards the development of the rule-based solution. These solutions will be compared in terms of applicability, performance, and computational complexity. The adopted solution will be compared against other solutions in the literature (if exist). Towards this objective, the following steps will be implemented:

- Step 1: Develop an optimization-based solution for the optimal allocation of “conductance” among the PV units.
  Deadline: M13 (end of January 2021)
- Step 2: Develop a rule-based solution for the optimal allocation of “conductance” among the PV units.
  Deadline: M14 (end of February 2021)
- Step 3: Compare the developed solutions (Step 1 and Step 2) in terms of applicability, performance, and computational complexity to be adopted by ACTIVATE.
  Deadline: M15 (end of March 2021)
- Step 4: Compare the adopted solution with other methods presented in the literature (feedback from Task 1.1.).
  Deadline: M17 (end of May 2021)

2.2.4. Optimal overloading mitigation (Subtask 2.2.4)

- Participants: ALL
- Effort: 6 PMs (M17-M23)

The above-mentioned high-level control strategies will be integrated in this subtask into a high-level control strategy which will be updated to include the optimal overloading mitigation of lines and transformer. Two high-level control strategies will be considered. The first one will be applied to MV networks while the second one to LV networks. Apart from tackling all the above-mentioned issues that may occur in MV and LV networks, scope of the high-level control strategy will be to include some optimization criteria, e.g., minimization of the energy losses, or maximization of the energy yield to the transmission system. Ambition of ACTIVATE is to implement a rule-based approach that presents a reduced-computational complexity and can be applied under real-field conditions. Towards this objective, the following steps will be implemented:

- Overloading in MV networks [A. Nousdilis, G. Kryonidis]
    - Step 1: Develop the updated version of the high-level control strategy in MATLAB.
      Deadline: M19 (July 2021)
    - Step 2: Evaluate the overall performance of the high-level control strategy against centralized, optimization-based methods.
      Deadline: M21 (September 2021)
- Overloading in LV networks [PhD cadidate, G. Kryonidis]
    - Step 1: Develop the updated version of the high-level control strategy in MATLAB.
      Deadline: M19 (July 2021)
    - Step 2: Evaluate the overall performance of the control strategy against centralize, optimization-based methods.
      Deadline: M21 (September 2021)
- MV/LV interaction [ALL]
    - Improve the overloading method developed for LV networks to participate in the congestion management of MV grids.
      Deadline: M23 (November 2021)

2.3. Development of control strategies to optimize network frequency responses (Task 2.3)

Scope of this task (M10 – M18) is to integrate real-time control strategies to the DRESs to ensure optimal frequency responses. The following real-time control strategies are considered:

- Inertia response
- Power smoothing operation
- Frequency response

This Task is divided into the following STs.

- ST 2.3.1: Inertia response
- ST 2.3.2: Power smoothing operation
- ST 2.3.3: Frequency response

Table 11: Task 2.3 schedule.

	2020						2021					
	J	A	S	O	N	D	J	F	M	A	M	J
Month	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
WP2									MS2			
Task2.1												
Task2.2												
Task2.3												

2.3.1. Inertia response (Subtask 2.3.1)

- **Participants:** G. Kryonidis, PhD candidate
- **Effort:** 3 months (M10-M12)

The inertia response functionality will be integrated in the operation of the DRESs. The solutions proposed in the literature will be thoroughly assessed and a new inertia response control scheme will be developed [30]-[32].

Towards this objective, the following steps will be implemented:

- Step 1: Develop a new inertia control scheme that will be integrated in DRES operation. The outcome of the WP3, e.g. modes estimation, will be used as an input for the development of the proposed inertia control scheme.
  Deadline: M10 (October 2020)
- Step 2: Determine the optimal size of the required ESS to provide inertia response.
  Deadline: M11 (November 2020)
- Step 3: Evaluate the performance of the proposed scheme against other solutions presented in the literature (literature review feedback from Task 1.1).
  Deadline: M12 (December 2020)

2.3.2. Power smoothing operation (Subtask 2.3.2)

- **Participants:** A. Nousdilis, G. Kryonidis
- **Effort:** 3 months (M13-M15)

A new power smoothing control scheme will be integrated in the operation of the ESS. Towards this objective, the following steps will be implemented:

- Step 1: Develop a new power smoothing (e.g., ramp-rate control, low-pass filter, etc.) that will be integrated in ESSs operation.
  Deadline: M13 (January 2021)
- Step 2: Determine the required size of the required ESS to provide the power smoothing functionality.
  Deadline: M14 (February 2021)

- Step 3: Evaluate the performance of the proposed scheme against other solutions presented in the literature.
  Deadline: M15 (March 2021)

2.3.3. Frequency response (Subtask 2.3.3)

- **Participants:** ALL
- **Effort:** 3 months (M16-M18)

The frequency response functionality will be integrated in the operation of both DRESs and ESSs. The frequency response parameters will be calculated based using an optimization-based method to ensure the equal participation of DRESs and ESSs in the frequency regulation:

- Step 1: Incorporate the frequency response functionality in the DRES, ESSs operation. The outcome of the WP3 (dynamic equivalent) will be used as an input for the frequency response functionality.
  Deadline: M16 (April 2021)
- Step 2: Develop an optimization-based method (possibly GAMS) for the optimal allocation of the frequency response among the DRESs and ESSs (both in MV and LV networks).
  Deadline: M17 (May 2021)
- Step 3: Evaluate the performance of the proposed scheme against other solutions presented in the literature.
  Deadline: M18 (June 2021)

2.4. WP Outputs

- **Participants:** ALL
- **Effort:** 2 months (M23-M24)

The research outcomes will be published to **at least** one international peer-reviewed journal and one international peer-reviewed conference.

Table 12: WP2 outputs.

• **Output 1 (D2.1):** A unified control strategy for optimal voltage regulation and congestion management in ADNs (IJ). Write and submit a journal paper on the unified control strategy that will be developed in Task 2.2. [G. Kryonidis, A. Nousdilis, PhD candidate, PI] **(M23)**. • **Output 2 (D2.2)**: Power smoothing control strategies using ESSs (IC). Write and submit a conference paper regarding the developed power smoothing control strategy using ESSs [G. Kryonidis, A. Nousdilis, PhD candidate, PI] **(M23)**. • **Output 3 (MS2)**: Initial control strategies framework. **(M15)**. • **Output 4 (MS3)**: Fined tuned control strategies. **(M23)**.

Table 13: WP2 schedule.

	2020												2021											
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
WP2															MS2								MS3	
Task2.1																							D2.1	
Task2.2																							D2.2	
Task2.3																								

3. WP3 – Network monitoring technologies and techniques

3.1. Converter-level identification methods (Task 3.1)

- **Participants:** E. Kontis, PhD candidate, PhD candidate
- **Effort:** 8 months (M04 – M11)

Scope of this task is to develop real-time measurement-based identification techniques, which can be applied on a local level to estimate network modal parameters and inertia time constants

This Task is divided into the following STs:

- ST 3.1.1: Evaluation of well-established identification methods for real-time estimation of poorly-damped and undamped modes
- ST 3.1.2: Evaluation of conventional methods for the real-time estimation of inertia time constants
- ST 3.1.3: Development of a new method for the simultaneous modal analysis and inertia estimation

Table 14: Subtask 3.1 schedule.

	2020											
	J	F	M	A	M	J	J	A	S	O	N	D
WP3									MS4			
Task3.1												

3.1.1. Evaluation of well-established identification methods under specific conditions (Subtask 3.1.1)

- **Participants:** PhD candidate, E. Kontis, MSc student
- **Effort:** 4 months (M04 – M7)

The evaluation of the identification methods will be performed both for ringdown and ambient data responses, according to the following steps:

- Step 1: Model in NEPLAN a HV-MV-LV network (LV CIGRE European Configuration and IEEE European Network).
  Deadline: M04 (End of March 2020)
- Step 2: Performance evaluation using ringdown data acquired from simulation models and measurements. The following tests will be performed:
  - Immunity to noise
  - Identification of well-damped modes
  - Identification of closed spaced modes
  - Identification of poorly-damped modes
  - Identification of undamped modes

Deadline: M05 (End of April 2020)

- Step 3: Performance evaluation using ambient data:
  - Immunity to noise
  - Identification of well-damped modes
  - Identification of poorly-damped modes

  Deadline: M07 (End of July 2020)

3.1.2. Evaluation of conventional methods for the real-time estimation of inertia time constants (Subtask 3.1.2)

- **Participants:** E. Kontis, PhD candidate
- **Effort:** 6 months (M04 – M9)

The evaluation of methods for the estimation of inertia will be performed both for ringdown and ambient data responses, according to the following steps:

- Step 1: Implementation of conventional approaches.

  Deadline: M07 (End of July 2020)
  - Step 2: Testing the performance of the conventional methods under both ambient and ringdown data to determine potential limitations. For this purpose, Artificially created data andsimulated responses from the developed power system models in 3.1.1 will be used. The following factors will be tested:
  - Immunity to noise
  - Impact of time of disturbance (event detection) on the accuracy of the methods
  - Impact of model order on the accuracy of the methods

  Deadline: M09 (End of September 2020)

3.1.3. Simultaneous modal analysis and inertia estimation (Subtask 3.1.3)

- **Participants:** PhD candidate, E. Kontis
- **Effort:** 3 months (M09 – M11)
  - A method for the simultaneous estimation of modal parameters and inertia time constants will be developed. The method can use both ambient and ringdown data, and model parameters will be updated using the sliding window technique.

  Deadline: M11 (End of November 2020)

3.2. DSO-level multi-channel identification methods (Task 3.2)

- **Participants:** L. Kontis, PhD candidate, PhD candidate
- **Effort:** 8 months (M10-M17)

The main objective of this task is to develop **multi-channel measurement-based identification methods** at the DSO level. These methods will be used to derive network modal parameters (on a DSO level) and to develop static and dynamic equivalent models (on a DSO level)

This Task is divided into the following STs:

- ST 3.2.1: Development of multi-channel identification methods
- ST 3.2.2: Development of static equivalent models
- ST 3.2.3: Development of dynamic equivalent models

Table 15: Subtask 3.2 schedule.

	2020												2021					
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**
WP3									MS4									TM2
Task3.2																		

3.2.1. Development of multi-channel identification methods (Subtask 3.2.1)

- **Participants:** PhD candidate, L. Konits
- **Effort:** 2 months (M10-M11)

The multi-channel identification method will be developed, according to the following steps:

- Step 1: Extend conventional single-input single-output (SISO) methods to multi-input multi-outputs MIMO.
  - Methods such as the Matrix Pencil, Eigenvalue Realization Algorithm, Vector Fitting, and Prony will be used
  - The developed MIMO methods will be evaluated using artificially created signals and simulated responses from multi-modal power systems

  Deadline: M10 (End of October 2020)
- Step 2: Pre-processing of the measurements. A pre-processing method will be developed to facilitate the application of the proposed MIMO model to real-field conditions. The pre-processing method should perform:
  - Filtering, outlier removal
  - Time alignment
  - Measurement synchronization (due to communication delays, different reporting times or different acquisition rates)
  - Reconstruct missing data

  Deadline: M11 (End of November 2020)

Table 16: Subtask 3.2.1 outputs.

Output (George B., Lefteris K., PhD candidate, PI): Results of this task will be used for D3.1 (International conference).

3.2.2. Development of grey-box static equivalent models (Subtask 3.2.2)

- **Participants:** PhD candidate, L. Kontis
- **Effort:** 3 months (M12-M14)

A grey-box static equivalent model will be developed Scope of the model is determine equivalent *P-f* and *Q-V* droop curves at PCC with the transmission grid Measurements for the derivation of the model will be acquired using the proposed monitoring scheme.

Deadline: M14 (End of February 2021)

3.2.3. Development of grey-box dynamic equivalent models (Subtask 3.2.3)

- **Participants:** PhD candidate, L. Kontis
- **Effort:** 3 months (M15-M17)

A grey-box dynamic equivalent model will be developed. Scope of the model is to analyze the dynamic behavior of ADNs. Measurements for the derivation of the model will be acquired using the proposed monitoring scheme.

Deadline: M17 (End of May 2021)

3.3. Network dynamic performance evaluation on a CMU-level (Task 3.3)

- **Participants:** PhD candidate, L. Kontis
- **Effort:** 7 months (M18-M24)

On this level, modal estimates and reduced order equivalent models, derived at the DSO level, are transferred to the TSO. Modal estimates are used to evaluate in real-time the stability margins of the overall grid, while reduced order equivalents are used to assess the dynamic behavior of the grid under several contingencies. This way, close to real-time dynamic stability assessment is performed. Specifically, the objectives are:

- Modal estimates (on a TSO level)
- Dynamic performance (on a TSO level)

This Task is divided into the following STs**.**

- ST 3.3.1: Development of a network monitoring architecture
- ST 3.3.2: Impact of equivalent models on system stability studies

Table 17: Task 3.3 schedule.

	2021											
	J	F	M	A	M	J	J	A	S	O	N	D
WP3						TM2						MS5
Task3.1												
Task3.2												
Task3.3								D3.1				D3.2

3.3.1. Development of a network monitoring architecture (Subtask 3.3.1)

- **Participants:** PhD candidate, L. Kontis
- **Effort:** 7 months (M18-M24)

A network monitoring architecture will be developed, according to the following steps:

- Step 1: The main characteristics of the architecture will include the following estimations: dominant modes, mode shapes, participation factors, coherent generator groups, center of inertia (COI), overall system inertia, reduced order equivalents
  - Identification method: Based on the results of ST3.2.1 (proposed identification method and processing procedure)

  Deadline: M21 (End of September 2021)
- Step 2: D3.2 should be written

  Deadline: M24 (End of December 2021)

Table 18: Subtask 3.3 output.

Output (PhD candidate, L. Kontis, PI): A three-level distributed architecture for the real-time monitoring of ADNs (International Journal).

3.3.2. Impact of equivalent models on system stability studies (Subtask 3.2.2)

- **Participants:** L. Kontis, PhD candidate, P. Papadopoulos
- **Effort:** 3motnhs (M22-M24)

A comprehensive study for the impact of equivalent models in stability studies will be performed, according to the following steps:

- Step 1: Testing of different equivalent models. ()
- Step 2: Incorporation into NEPLAN software
- Step 3: Impact on:
  - Rotor angle stability (small-disturbance, large disturbance)
  - Voltage stability (small-disturbance, large disturbance)

- Frequency stability
- System modes
- Power flow results (voltages at transmission level, system losses)

Deadline: M24 (End of December 2021)

3.4. WP Outputs

- **Participants:** All

The research outcomes will be published to at least one international peer-reviewed journal and one international peer-reviewed conference.

Table 19: WP outputs.

- **Output 1 (D3.1):** Multi-channel measurement-based identification methods for the analysis of ADNs (IC). **[George B., Lefteris K. PI] (M20)**.
- **Output 2 (D3.2)**: A three-level distributed architecture for the real-time monitoring of ADNs (IJ) **[George B., Lefteris K. PI] (M24)**.
- **Output 3 (MS4)**: Decentralized monitoring techniques **(M09)**.
- **Output 4 (MS5)**: Network monitoring architecture. **(M24)**.

Table 20: WP schedule.

	2020												2021											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
WP3									MS4									TM2						MS5
Task3.1																								
Task3.2																								
Task3.3																				D3.1				D3.2

4. WP4 – Development of converter

4.1. Development of control strategies to tackle network operational issues (Task 4.1)

- **Participants:** PhD candidate, N. Papanikolaou
- **Effort:** 2 months (M20 – M21)

Scope of this task is to determine the technical specifications of the proposed power converter.

- Step 1: All required activities to design and manufacture the converter will be determined, based on the summary and findings of Task 1.3. Then, the technical specifications and requirements of the converter (power rating, hardware, and software) will be explicitly defined.
  Deadline: M21 (End of September 2021)
- Step 2: The technical specifications and requirements of the converter (power rating, hardware, and software) will be explicitly defined.
  Deadline: M21 (End of September 2021)

Table 21: Task 4.1 schedule.

	2021												2022					
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Month	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
WP4												MS6			MS7			
Task4.1																		

4.2. Development of a prototype converter equipped with the proposed control strategies (Task 4.2)

- **Participants:** PhD candidate, N. Papanikolaou
- **Effort:** 6 months (M22 – M27)

This task aims at the development of the prototype converter, which will be used to test the proposed control strategies. The converter will be developed in the Electrical Machines Laboratory of DUTH and will be three-phase four-wire (3 phases and neutral).

Table 22: Task 4.2 schedule.

	2021												2022					
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
Month	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
WP4												MS6			MS7			
Task4.2															D4.1			

This Task will be implemented according to the following steps:

Step 1: Develop of the prototype converter with the following properties:

- Integrate the control strategies, designed and developed in Tasks 2.1, 2.2, 3.1, and 3.2.
- The DC side of the converter will be able to be connected either to a DC source, or to an ESS (or both forming a hybrid unit).
- A user-friendly interface will be developed allowing the researcher to easily implement and test the developed strategies.
  Deadline: M27 (End of March 2022)

Step 2: Develop of the prototype converter with the following properties:

- A patent will be submitted describing in detail the implementation of the power electronics converter.
  Deadline: M27 (End of March 2022)

4.3. WP Outputs

- **Participants:** PhD candidate, N. Papanikolaou, PI

The research outcome is a patent, describing in detail the implementation of the power electronics converter.

Table 23: WP outputs.

- **Output 1:** Development of the converter **[PhD candidate, N. Papanikolaou, PI] (M27)**.
- **Output 2 (D4.1):** A patent will be submitted describing in detail the implementation of the power electronics converter **[PhD candidate, N. Papanikolaou, PI] (M27)**.
- **Output 3 (MS6)**: Implementation of converter - beta release.
- **Output 4 (MS7)**: Tested and fine-tuned converter - final release.

Table 24: WP 4 schedule.

	2021												**2022**					
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**
Month	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
WP4												MS6			MS7			
Task4.1																		
Task4.2															D4.1			

5. WP5 – Validation of the proposed holistic approach

The proposed control strategies, the monitoring architecture and the prototype converter developed in WP2, WP3 and WP4, respectively, will be validated in this WP by means of simulation and laboratory tests via power hardware-in-the loop experiments (PHIL).

5.1. Evaluation using simulations (Task 5.1)

- **Participants:** All
- **Effort:** 8 months (M22 – M30)

Scope of this task is.

- To test by means of simulations the performance of the control strategies, developed in the framework of WP2
- To test the performance of the proposed three-level monitoring scheme, by means of simulations

This Task is divided into the following STs:

- ST 5.1.1: Develop benchmark networks and base case scenarios
- ST 5.1.2: Simulation results using the holistic approach
- ST 5.1.3: Final evaluation of the proposed control strategies and monitoring architecture
- ST 5.1.4: Overall evaluation

5.1.1. Develop benchmark networks and base case scenarios (Subtask 5.1.1)

- **Participants:** All
- **Effort:** 2 months (M22-M24)

The following steps will be followed:

- Step 1: implementation of benchmark MV and LV grids for steady-state simulations (see Table 8 this manuscript) and base case scenarios.
  Deadline: M23 (End of November 2021)
- Step 2: implementation of benchmark HV, MV and LV grids for dynamics simulations (see Table 8 this manuscript).
  Deadline: M23 (End of November 2021)
- Step 3: Derivation of the HV-MV-LV network, that used to evaluate the holistic approach (see 1.5 of this manuscript).
  Deadline: M24 (End of December 2021)

5.1.2. Simulation results using the holistic approach (Subtask 5.1.2)

- **Participants:** All
- **Effort:** 2 months (M24-M25)

The following steps will be followed:

- Step 1: Simulations in the HV-MV-LV network, assuming conventional control strategies.

Deadline: M24 (End of December 2022)

- Step 2: Technical problems such as overvoltages, overloading and frequency deviations will be recorded and analyzed.
Deadline: M24 (End of December 2022)
- Step 3: Integrate proposed control strategies.
Deadline: M25 (End of January 2022)

5.1.3. Final evaluation of the proposed control strategies and monitoring architecture (Subtask 5.1.3)

- **Participants:** All
- **Effort:** 2 months (M25-M29)

The following steps will be followed:

- Step 1: Final evaluation of the proposed control strategies.
Deadline: M29 (End of May 2022)
- Step 1: Final evaluation and calibration of the proposed network monitoring architecture.
Deadline: M29 (End of May 2022)

5.1.4. Overall evaluation architecture (Subtask 5.1.4)

- **Participants:** All
- **Effort:** 1 month (M29-M30)

The following steps will be followed:

- Step 1: Holistic evaluation and calibration of the proposed control strategies and network architecture.
Deadline: M30 (End of June 2022)

5.2. Validation through lab tests (Task 5.2)

- **Participants:** All
- **Effort:** 6 months (M29 – M34)

Simulations conducted in Task 5.1 will be used to prepare a detailed test plan of lab test scenarios. The performance and the functionalities of the proposed converter will be tested at the dynamic power system laboratory (D-NAP) of the University of Strathclyde via PHIL experiments. Scope of this task is to evaluate the proposed holistic approach by means of laboratory tests via PHIL.

This Task is divided into the following STs:

- ST 5.2.1: Design scenarios and benchmark grid
- ST 5.2.2: Perform laboratory experiments
- ST 5.2.3: Evaluation of the experiments

5.2.1. Design scenarios and benchmark grid (Subtask 5.2.1)

- **Participants:** All

➢ **Effort:** 3 months (M29-M31)

The following steps will be followed:

- Step 1: benchmark low-voltage grid will be modeled on a digital real time simulator (DRTS) from RTDS Technologies. Virtual converters, such the proposed one, will be connected in several nodes of this model.
  Deadline: M30 (End of June 2022)
- Step 2: scenarios based on the results of Task 5.1 will be designed.
  Deadline: M31 (End of July 2022)

5.2.2. Perform laboratory experiments (Subtask 5.2.2)

➢ **Participants:** L. Kontis, PhD candidate, P. Papadopoulos, PI
➢ **Effort:** 1 month (M32)

The following steps will be followed:

- Step 1: a real converter will be installed in the actual laboratory environment.
  Deadline: M32 (End of August 2022)
- Step 2: Several scenarios will be examined to test the foreseen functionalities of the proposed converter, while its monitoring functions will be evaluated using power loggers.
  Deadline: M32 (End of August 2022)
- Step 3: derive reduced order equivalents for medium and low voltage grids.
  Deadline: M32 (End of August 2022)
- Step 4: the equivalents will be integrated into the existing DRTS to evaluate their accuracy and applicability range.
  Deadline: M32 (End of August 2022)

5.2.3. Evaluate of the experiments (Subtask 5.2.3)

➢ **Participants:** All
➢ **Effort:** 2 months (M33-M34)

The following steps will be followed:

- Step 1: evaluation of experimental results
  Deadline: M32 (End of October 2022)
- Step 2: paper writing.
  Deadline: M32 (End of October 2022)

5.3. WP Outputs

➢ **Participants:** All

The proposed holistic approach will be validated by means of simulation results and lab tests. The findings will be submitted on an international peer-reviewed journal (IJ)

Table 25: WP outputs.

- **Output 1:** Paper regarding the validation of the proposed approach (IJ) **[All, PI]** **(M34)**.
- **Output 2** **(MS8)**: Definition of lab experiments.
- **Output 3** **(MS9)**: Validation of the holistic approach.

Table 26: WP 5 schedule.

	2021											2022					
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Month	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
WP5										MS8						MS9		
Task5.1																		
Task5.2																D5.1		

6. WP6 – Dissemination of results and exploitation

The horizontal activities for dissemination and exploitation are intended to be active throughout the project's lifetime. A continuous monitoring of the advances, outcomes, achievements and conclusions is considered crucial for raising maximum external awareness as well as defining a realistic and viable exploitation plan. Updated/revised versions of the defined reports will also be delivered publicly to increase project's awareness and activity sense to external end-points.

6.1. Setting up the dissemination plan (Task 6.1)

- **Participants:** All
- **Effort:** 3 months (M01-M03)

Disseminating ACTIVATE's goals, achievements and final results will be one of the tools to attract stakeholders, getting into contact with the core group and joining information. The dissemination plan describes which specific tools will be developed to reach specific target groups and when and where actions will be taken. ACTIVATE will draw up and follow systematically a concrete dissemination policy to raise awareness, highlighting the opportunities of ancillary services in ADNs.

Table 27: Task 6.1 output.

• **Output 1:** List of target groups (TSOs and DSOs, partners in academia, research centers, industry, students, trainers, teachers, policy makers, wider public). **[A. Nousdilis., L. Kontis, G. Kryonidis, PI]** **(M03)**.

6.2. Designing and maintaining the ACTIVATE website (Task 6.2)

- **Participants:** PI
- **Effort:** 36 months (M01-M36)

This task aims to increase public awareness and communicate the project advances and outcomes through the project web-site accompanied and interlinked with its respective social media accounts: Researchgate and Facebook Page. The project website alongside with the social media profiles and channels will be launched early in the project and will continuously be updated and refined to ensure maximized exploitation of web-based communication possibilities. All relative activities will be reported and demonstrated in D6.3 newsletters. This newsletter will be periodically updated (every 6 months) with any additional material generated in-between its delivery dates.
Moreover, this task includes the design and development of project material used for dissemination purposes, such as: project logo, project leaflet, project banners, project posters and multimedia content (mainly videos) for YouTube. Finally, a standalone annual report monitoring the scientific peer-reviewed publications as well as the participation in two (2) international conferences.

Table 28: Task 6.2 output.

• **Output 2:** Project website and facebook, researchgate, linkedin pages. As well as logo, etc **[PI]** **(M02)**. • **Output 3** **(D6.3)**: Newsletter **(M36)**

6.3. Organizing international workshop (Task 6.3)

- **Participants:** All
- **Effort:** 2 months (M35-M36)

The dissemination of the project results includes also a scientific international workshop that will be take place in DUTH facilities located in the campus of Kimmeria, Xanthi, including presentations to selected group of enterprises and organizations followed by discussions and demonstration of case studies. Therefore, potential end users, participating in the workshop will have the opportunity to experience the **ACTIVATE** functionality and review application prototypes in selected case studies. All members of the research team of DUTH will participate in the international workshop, as well as three members of AUTH.

Table 29: Task 6.3 output.

• **Output 4:** International workshop **[All]** **(M36)**.

6.4. Deployment of project results (Task 6.4)

- **Participants:** All
- **Effort:** 4 months (M33-M36)

The current task considers activities focusing on the design of the potential exploitation strategy related to the outcomes of the project. Scope of this task is to ensure a successful commercialisation of the project results and the continuation of the research after the end of this project. The following activities will minimally be performed: A) discussion of future research publications, B) collaborations in projects, C) organisation of further dissemination and exploitation activities and D) exploitation plans alongside with identified future work steps will be presented in the closing event (D6.4).

6.5. WP Outputs

Table 30: WP outputs.

• **Output 1:** List of target groups (TSOs and DSOs, partners in academia, research centers, industry, students, trainers, teachers, policy makers, wider public). **[A. Nousdilis., L. Kontis, G. Kryonidis, PI] (M03)**. **Output 1 (D6.1):** First accessible version of social media accounts. **[PI] (M02)** • **Output 2 (D6.2)**: List of published scientific papers **[ALL] (M36)** • **Output 3 (D6.3)**: Newsletter **[ALL] (M36)** • **Output 4 (D6.4)**: Closing event. International workshop **[ALL] (M36)**

7. Project management

This WP is related to managerial and coordination activities throughout the project's lifetime. The PI will continuously monitor the outcomes' quality from a technical perspective, the on-time achievements, the on-time delivery of the material as well as the smooth evolution of the project financial resources. Quality management and Risks mitigation plans will be established at early stage in the framework of this WP, as a roadmap for ensuring high quality project outcomes.

Table 31: WP outputs.

- **Output 1 (D7.1):** Establishment of the project handbook **[PI]** **(M02)**
- **Output 2 (D7.2)**: Project final report **[ALL]** **(M36)**

Appendix A. List of Deliverables

Table 32: List of Deliverables.

Deliverable Number	Deliverable Name	Related WP	Dissemination Level	Delivery Date
D7.1	Establishment of the project handbook	WP7	R (PR)	M02
D6.1	First accessible version of social media accounts	WP6	P (media)	M02
D1.1	Review of state-of-the-art and technical solutions	WP1	R (PR)	M03
D2.1	A unified control strategy for optimal voltage regulation and congestion management in ADNs	WP2	R (IJ)	M20
D3.1	Multi-channel measurement-based identification methods for the analysis of ADNs	WP3	R (IC)	M20
D2.2	Power smoothing control strategies using ESSs	WP2	R (IC)	M24
D4.1	Patent of the developed converter for voltage and frequency regulation of ADNs	WP4	(P)	M27
D3.2	A three-level distributed architecture for the real-time monitoring of ADNs	WP3	R (IJ)	M24
D5.1	Validation of the proposed holistic approach	WP5	R (IJ)	M34
D6.2	List of published scientific papers published	WP6	R (PR)	M36
D6.3	Newsletters	WP6	P (media)	M36
D6.4	Closing event. International workshop	WP6	Workshop	M36
D7.2	Project final release	WP7	R (PR)	M36

Appendix B. List of Milestones

Table 33: List of Milestones.

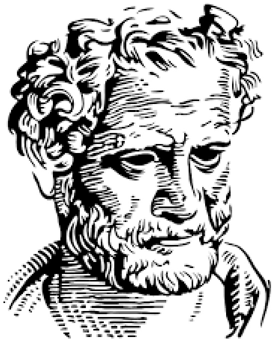
Milestone Number	Milestone Name	Related WP	Delivery Date	Means of Verification
MS10	Set up the website of the project	WP6	M02	Web site is online
MS1	Literature review – State-of-the-art	WP1	M03	The literature review will be published to the web site
MS4	Decentralized monitoring techniques	WP3	M09	Models of monitoring algorithms
MS2	Initial control strategies framework	WP2	M15	Models of the control strategies
MS3	Fined tuned control strategies	WP2	M23	The control strategy will be implemented and tested by means of the prototype inverter
MS5	Network monitoring architecture	WP3	M24	Model of the ADN monitoring architecture
MS6	Implementation of converter (beta release)	WP4	M24	Success of preliminary operational tests
MS7	Tested and fine-tuned converter (final release)	WP4	M27	Prototype which can be tested
MS8	Definition of lab experiments	WP5	M28	Lab experiments plan will be available to all research members
MS9	Validation of the holistic approach	WP5	M34	Results of the simulation of selected test cases, compared with lab tests

Appendix C. Risks and contingency plans (mitigation measures)

Table 34: Risks and contingency plans.

Description of risk (indicate level of likelihood: Low/Medium/High)	**WPs involved**	**Proposed risk – Mitigation measures**
No suitability of available tools (Low)	**WP2, WP3**	Research group and project external collaborators have the necessary skills to adapt available tools for the needs of ACTIVATE project. Some of the available tools to be used in ACTIVATE have also been developed by the research group members.
Difficulties for engaging the providers of necessary hardware components (Low)	**WP4**	Mapping of available related providers will be conducted. Various hardware providers will be reached to offer their solutions to the research team.
Dependency on systems of external laboratories (Low)	**WP5**	PHIL experiments will be conducted to UoS. NTNU will serve as a back-up lab. Both labs are external collaborators of ACTIVATE.
Safety conditions during converter development and laboratory tests (Low)	**WP4, WP5**	PI and research group members are experienced on laboratory experiments related to power systems. Safety and security plans of the involved laboratories will be strictly adopted by the research team.
Challenges during lab tests validation for the applicability of the developed prototype converter (Low)	**WP5**	Converter development will be closely monitored and validated through regular lab tests, during the whole period of development, so that problems are identified and tackled at early stage, while in this way future incompliances will be prevented.
Unrealistic effort estimates (Low)	**All WPs**	PI is experienced in managing research projects and estimates have been made based on projects of similar complexity. Mitigation measures are: • Research group members provide the extra effort required to ensure objectives are met. • Task reallocation amongst partners. • Later time delivery, provided that overall plan delivery is not seriously affected.
Research team member leaves the project (Low)	**All WPs**	PI will ensure appropriate management of the work in progress, so that the remaining members can complete the work, until a new member is found from the host institution or the external collaborations (in case that this is considered necessary).
Project objectives become obsolete (No risk)	**All WPs**	The project deals with emerging research topics.

Appendix C. Project template



Ancillary services in aCTIVe distribution networks bAsed on moniToring and control tEchniques

Project: **ACTIVATE**

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List of Acronyms

Acronym	Meaning
AB	Advisory board
WP	Work Package

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Executive summary

This is a brief summary describing the scope of the deliverable.

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8.1.1 Header 3

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