European Commission

Project[1] Number: [675318]

Project Acronym: [INCITE]

Project title: [Innovative controls for renewable sources Integration into smart energy systems]

Mid-term report

Part B of the Periodic Report

Period covered by the report: from [01/12/2015] to [30/11/2017]

Periodic report: *[*1st*]*

[1] The term 'project' used in this template equates to an 'action' in certain other Horizon 2020 documentation

1. Explanation of the work carried out by the beneficiaries and overview of the progress

- Explain the work carried out during the reporting period in line with the Annex 1 to the Grant Agreement.

- Include an overview of the project results towards the objective of the action in line with the structure of the Annex 1 to the Grant Agreement including summary of deliverables and milestones, and a summary of exploitable results and an explanation about how they can/will be exploited[2].

  (No page limit per work package but report shall be concise and readable. Any duplication should be avoided).

1.1 Objectives

List the specific objectives for the project as described in the Description of Action (DoA) and describe the work carried out during the reporting period towards the achievement of each listed objective. Provide clear and measurable details.

The general objective of the research programme of INCITE is to propose innovative solutions for the challenging work of controlling and designing the future electrical networks. Another goal is to create a multidisciplinary research space with a complete view of the smart grids control where talented young researchers can be trained through research. In other words, INCITE aims to cover the existing gap between theory and smart grid real world applications, in order to ensure the proper understanding of the novel problems arising due to the implementation of such new technologies as well as provide tools that cope with such new requirements.

The specific objectives of the research plan proposed within INCITE framework are as follows:

- To provide ESRs with deep knowledge in control, optimisation, power electronics and power systems with a complete view of the real necessities of the main actors in the smart-grids sector.
- To establish a long-term collaboration network that allows the interaction of researchers from control and power systems.
- To create a multi-sectoral space where industry and academia can interact to find new and better control solutions for the future electrical networks.
- To develop high-quality tools and methodologies for the control, power management and monitoring for smart grids.
- To develop experimental test benches with the aim of testing and evaluating new ideas for the control of smart grids.

[2] Beneficiaries that have received Union funding, and that plan to exploit the results generated with such funding primarily in third countries not associated with Horizon 2020, should indicate how the Union funding will benefit Europe's overall competitiveness (reciprocity principle), as set out in the grant agreement.

To answer and achieve such complex objectives (both general and specific), the following work programme objectives have been detailed at each work package. It is worth noting that the work packages from 1 to 5 are the ones directly related with the research activities proposed within the project.

WP1 (Control Strategies for distributed power generation) objectives:

- Modelling of complex electrical networks with sources, demands and storage for control purposes.
- Development of decentralised control strategies for balancing generation and consumption.
- Development of energy management algorithms for improving efficiency and energy cost in grids with distributed generation.

WP2 (Control strategies for energy storage systems) objectives:

- Development of low-level control strategies for ESS in smart grid contexts.
- Exploitation of energy storage capabilities of buildings.
- Development of management algorithms to integrate ESS in smart grids.

WP3 (Control strategies for RES integration) objectives:

- Modelling of smart grids for stability analysis.
- Development of control strategies for integration of RES.
- Proposing distributed control strategies for grid support.

WP4 (Monitoring tools and secure operation of smart grids) objectives:

- Implementation of communications and other features required for control of smart grids.
- Development of monitoring schemes for electrical networks.
- Development of self-healing capabilities.

WP5 (Simulation and experimental validation) objectives:

- Select a set of benchmark grid models in order to have proper contexts and test cases for the evaluation of the control solutions produced in WP1-4
- Validate by simulation and experimental test the control solutions produced in WP1-4

Detailed information on the achievement of the 5 research-related WPs can be found in section 1.2 (Explanation of the work carried out per WP)

Additionally, there are other work packages (6 to 8) focused on more transversal activities and management of the project, but that are also of great relevance and have their own objectives as:

WP6 (Dissemination and results exploitation) objectives:

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- *Prepare all types of material to disseminate the project results.*
  This objective has been achieved. The following material has been created:
  The INCITE webpage (http://www.incite-itn.eu/) has been created. All relevant information regarding the project is published there (vacancies, news, blog, ESR personal pages, meetings, etc.)
  INCITE accounts on social media have been created: LinkedIn (https://www.linkedin.com/company/10432636/), Twitter (https://twitter.com/inciteitn) and ResearchGate (https://www.researchgate.net/project/INCITE-Innovative-controls-for-renewable-source-integration-into-smart-energy-systems), and are being updated regularly.
  Creation of INCITE flyers and INCITE business cards for all ESRs.

  All ESRs have been encouraged to create their own social media accounts to contribute to the dissemination of the project.

  The INCITE twitter account has 118 followers and is curated both by the CMO and the ESRs (on 2-month periods, following a dissemination schedule). The INCITE LinkedIn page has 103 followers.
  The INCITE blog embedded in the INCITE webpage, has a posting schedule were both ESRs and supervisors contribute with posts. Currently 19 contributions have been posted. The list of contributions can be found in section 1.2 (work carried out per WP).

- *Carry out activities and participate in specific forums to communicate project results.*
  Ongoing.
  ESRs and supervisors have presented results achieved within INCITE in a number of international conferences.

  First publications have been published:

Publications

☐ This project does not currently have any scientific publication

Suggested publications from OpenAIRE (1 publications)

No.	Type	Title	Authors	Title of the Journal/Proc./Book	Date of Acceptance	DOI	Repository Link	Actions
1	Article in J	Impact of Demand-Side Management on Thermal Comfo	Thibault Q. Péan; Joana Ortiz; Ja	Buildings, Vol 7, Iss 2, p 37 (2017)	09/05/2017	10.3390/buildings7020037		✕

Project publications (4 publications)

Manually add publication

No.	Type	Title	Authors	Title of the Journal/Proc./Book	Number, date or freq. of the Journal/Proc./Book	DOI	Repository Link	Actions
1	Article in J	Impact of Demand-Side Management on Thermal Comfo	Thibault Péan, Joana Ortiz, Jaum	Buildings	7/2	10.3390/buildings7020037		✕
2	Publication	An overview of micro-grid architecture with hybrid sto	Unnikrishnan Raveendran Nair, Ra	Proceedings of the XV Simposio CEA de Inge				✕
3	Article in J	Potential and optimization of a price-based control stra	Thibault Q. Péan, Jaume Salom, J	Energy Procedia	122	10.1016/j.egypro.2017.07.292		✕
4	Publication	Advanced functionalities for the future Smart Seconda	Konstantinos Kotsalos, Nuno Silva	Book of Abstracts of the 2nd Symposium on				✕

  Details of all the conferences attended and planned and of the publications in process can be found in the ESR CDP's included in D7.2 (due November 2017)

  At a local level, ESRs and supervisors have participated in outreach activities (Science Slams, Family Day)

- *Proper exploitation of the project outcomes.*

This objective will be addressed during the 2nd reporting period.

WP7 (Training) objectives:

- *Coordinate courses, events and workshops with the aim of ensuring a proper training of ESRs.*
  Ongoing objective. At the beginning of the project, the training available at each partner's premises was put together and that information was used to plan the network-wide training at workshops and summer schools (details available in D7.1). Each workshop and summer school addresses different scientific training (the first summer school was devoted to "Smart Energy Systems: Advanced Control and Safety Capabilities") and also the complementary skills training in each workshop is selected to complement what has already been done and what is offered locally by each beneficiary.

  Summary of the network-wide training activities provided in the 1st Workshop and the 1st Summer School:

Network-wide Training Activities SAVE

Add Training Activity

	Organiser Name	Organiser Sector	Training Module Title	Skills/Knowledge Acquired	Duration (days)	ETCS Points (if applicable	Number of Early Stage Researche	Number of External Trainees	Actions
1	VLAAMSE INSTELLING VOOR TECHNOLOGISCI	Academic	Smart Grids and Energy Markets	General knowledge in a research field	0.12		11	0	
2	VLAAMSE INSTELLING VOOR TECHNOLOGISCI	Academic	Redesigning the decision chain for managin	General knowledge in a research field	0.12		11	0	
3	VLAAMSE INSTELLING VOOR TECHNOLOGISCI	Academic	Project Management	Project management	1.00	1	11	0	
4	UNIVERSITAT POLITECNICA DE CATALUNYA	Academic	Effective Communication	Scientific communication (e.g. oral presentation, publication)	1.00		13	14	
5	UNIVERSITAT POLITECNICA DE CATALUNYA	Academic	Virtual Labs Course	Other	1.00		13	10	
6	UNIVERSITAT POLITECNICA DE CATALUNYA	Academic	Smart Energy Systems: Advanced Control an	General knowledge in a research field	2.00		13	12	
7	VLAAMSE INSTELLING VOOR TECHNOLOGISCI	Academic	Introduction to the publication review pro	Scientific communication (e.g. oral presentation, publication)	0.12		11	0	

  The TSC also evaluates all CDPs and their yearly assessment to ensure that each ESR receives training adjusting to their needs and interests. All CDPs with the detailed information can be found in D7.2 (due November 2017).

- *Organisation of seminars and talks given by visiting experts*.
  Ongoing objective. Achieved partially by the training and talks given by international experts at the workshops and summer school.
  Co-organization of workshops with other international networks (for example, IEA EB Annex67, IEA HEV Task28 and Comunitat RIS3CAT Energia) is also planned.

- *Define complementary skill courses and seminars*.
  The offer of complementary skill courses available at each beneficiary was collected and, based on that, a tentative training schedule was defined in D7.1 – (First) annual training report

WP8 (Network Management) objectives:

- *Ensure an efficient and transparent management system for INCITE.*
  Signature of the Consortium Agreement, creation of the Management committees (Supervisory Board, Training Steering Committee, Dissemination and Exploitation Committee and Administrative Committee), creation of the Central Management

Office (CMO) in charge of management of the project. Launching and maintenance of the INCITE Intranet using Microsoft online (i.e. Office365). Design and creation of the INCITE webpage.
Preparation of best practice guidelines for the consortium: guidelines for hiring ESR and best financial practices.

- *Ensure a proper development of project objectives.*
  Supervisory Board (SB meetings) carried out regularly –in person at workshops and summer school plus email voting and discussion whenever needed.
  WP meetings (supervisor + ESRs) to coordinate the progress at WP level.

- *Ensure a suitable communication channels among partners.*
  Project workshops and summer schools have proven an optimum platform for networking and communication between partners. ESR collaboration has flourished there as well as via secondments.
  Additionally, the Microsoft online platform provides all ESRs and partners with Skype for Business accounts and a Sharepoint platform to make communication and sharing of information easier.

1.2 Explanation of the work carried per WP

1.2.1 Work Package 1 - Control Strategies for distributed power generation

Work Package 1 is leaded by TU Delft, namely by Zofia Lukszo. This work package encompasses four (4) Individual Research Projects (IRPs). During the first 24 months the following work has been carried out:

- *IRP 1.1 – Partitioning and non-centralized optimization-based control of dynamical energy grids (Project responsible: UPC)*

During this report period, the following tasks in IRP1.1 have been accomplished:

- A literature survey on system partitioning methods. Various partitioning methods that have been proposed are reviewed. In most of the papers, large-scale systems are represented as a graph and the methods proposed in those papers are developed by considering the graph partitioning problem. Furthermore, currently system partitioning is carried out prior to designing the controller. However, when the controlled large-scale system has time-varying behavior, e.g., time-varying topology, the system needs to be repartitioned during the operation. In this regard, only one paper has discussed a time-varying partitioning method.
- Proposing a partitioning approach that is suitable for systems with time-varying topology. As the first step toward online dynamic partitioning, it has been proposed that in order to deal with time-varying topology, a library of partitions is constructed offline. Each partition corresponds to a topology thus when the topology switches, the controller also immediately switches the partition and its control structure. Moreover,

in this work, a decentralized state-feedback control method is applied. In accordance with the partitioning approach, a library of state-feedback gains is also calculated offline. Furthermore, a stability analysis of this approach is also carried out.

- A study on the impact of time-varying communication network in distributed model predictive control (DMPC) schemes. Specifically, the impact of communication failures, in which some of the communication links in the network are broken, is investigated. Based on this study, communication failures may result in infeasibility and suboptimality for DMPC controllers. Therefore, two communication protocols that are resilient to some extent of communication failures have been proposed. One protocol is a practical application of the standard distributed consensus approach while the other one is based on a mean dynamic, namely distributed projection dynamic.
- A review on non-centralized MPC methods, in particular DMPC methods that are based on evolutionary game theory (EGT). DMPC strategies can be classified into cooperative and non-cooperative methods, depending whether the objective of each local controller is local or global. Furthermore, some DMPC strategies employ a distributed optimization method, which is convenient when the goal of the controller is to obtain an optimal performance. EGT-based DMPC methods that are recently developed in our group belong the latter group. Currently, these methods are able to deal with nominal systems and therefore it is interesting to extend it such that it is able to deal with uncertain systems.
- A review on DMPC and distributed optimization methods for energy management problems in power network. During this work, the dynamic optimal power flow problem is reviewed. Furthermore, some DMPC and distributed optimization methods that have been proposed to solve optimal power flow problems are also surveyed.

- *IRP 1.2 – Decentralized Control for RES by Fast Market-based MAS (Project Responsible: TU Delft)*

During the first year, a generalized model for the problem of optimal device-level decision making and planning under dynamic pricing has been formulated using Markov Decision Processes. The generalized model applies to different types of flexible distributed energy resources, and takes into account the uncertainty in real-time prices and the operational, comfort constraints. Algorithms are being developed for different types of distributed energy resources based on the model. These algorithms can be easily implemented using embedded systems with small computational power.

- *IRP 1.3 – Hybrid agent-based optimisation model for self-scheduling generators in a market environment (Project Responsible: TU Delft)*

During the first year the focus was on the aspect of modelling low voltage DC distribution networks and account for power losses in it. For this, I collaborated with another Ph.D. and M.Sc. student in developing an Exact Optimal Power Flow algorithm which is an innovative and novel approach to performed distributed optimization within a DC distribution system.

The model is built upon the Consensus + Innovation approach and helps to achieve optimal solutions while considering congestion and network line losses. Earlier research available in literature dealt with an approximated DC OPF model for an AC distributed system. Also, the research did not consider losses in the distribution lines. This violates how a practical power grid would function, as transmission and distribution cables in general encounter power losses. The algorithm developed is a non-complex procedure of update equations for the various primal and dual variables of the DC system. The only exchange of information between physically connected nodes was the nodal voltage magnitudes and the LMP values. Also, the model considers network practicalities like line losses and thus, is able to obtain a more exact solution as compared to model which did not consider network losses.

- *IRP 1.4 – Development of intrusive and non-intrusive control algorithms for the electricity market (Project Responsible: VITO)*

During the first year of the PhD, the research goal was to improve the state-of-the-art results in electricity price forecasting. This goal was achieved by exploiting DL models and market integration. During this report period, the following tasks in IRP1.4 have been accomplished:

- During this first year of the PhD, the work has focused on the first research step, i.e. forecasting techniques for the electricity market. In detail, new forecasting techniques based on deep learning algorithms have been developed and tested. These techniques were also shown to improve the state of-the-art accuracy. In parallel with this research, we also focused on setting up a large benchmark to compare the different models from the literature. The outcome of this work is, first, to obtain a better insight in the variations and predictability of these markets, and second, to have a clear understanding of the performance of difference methods.
- In addition to that, the relation between market integration and forecasting accuracy has been explored. Focusing on the day-ahead market in Belgium and the relation with neighbouring markets, we have proven that significant gains can be obtained by considering different phenomena from neighbouring markets.
- The performed research has led to two journal papers. The first paper treats the interaction between the energy prices in Belgium and France and the way these relations can be exploited. The second paper deals with a comparison between different forecast techniques and the performance of the developed of the deep learning algorithm.
- To give a brief idea about the quality of the results when combining all the different improvements, current commercial forecasts have an accuracy of typically 14 % sMAPE and the developed techniques reach 11.5 % sMAPE.

1.2.2 Work package 2 – Control strategies for ESS

Work Package 2 is led by UPC, namely Carlos Ocampo-Martínez. This work package has three (3) Individual Research Projects (IRPs). The general progress of the work package is satisfactory. It is worth noting that almost the whole first year of this work package was mainly dedicated to the recruitment of the ESRs; consequently, the first period of time of the IRPs have been used for reviewing and understanding and discovering the existing gaps to focus the work to be done.

- *IRP 2.1 – Energy flexible and smartgrid/enery ready buildings (Partner Responsible: IREC)*

The progress of the IRP is in good track. During the first year, a review of the state-of-the-art has been completed, as well as has been working on several aspects as model predictive control of buildings for increasing its flexibility. Additionally, some preliminary experimental tests have been carried out at SEILAB facilities of IREC.

- *IRP 2.2 – Control and management of storage elements in microgrids (Partner Responsible: UPC)*

This project has been going on for less than a year. However, a review of different control methods applied at different levels of energy storages has been carried out, detecting that there are different options to be applied at the primary level controls for the low level (as Classic PI and more advanced as Sliding Mode, H-infinity, ..) and high level controls (Gain Scheduling, Voltage Scheduling, Static Droop,…). This controller has focused on the DCDC converter for integrating Fuel Cells which can be treated as a switched and hybrid system (depending on the switch status). Thus, up to now a Reset Controller (PI + CI-Clegg Integrator) has been investigated and implemented in lab for continuous mode, and currently the expansion to discontinuous mode is ongoing.

- *IRP 2.3 – Robust Management and control of smart multi-carrier energy systems (Partner Responsible: TU Deft)*

In the first year of the project, an extensive literature survey has been carried out related to topics such as model predictive control, distributed control, large-scale systems, hybrid systems, smart grids and energy storage systems. It is now focusing on the power networks, mainly on the extension of tube-based model predictive control to hybrid systems and distributed model predictive control for dynamic partitioning of large-scale systems.

1.2.3 Work package 3 – Control Strategies for RES Integration

Work Package 3 is leaded by IREC, namely by Jose Luis Domínguez-García. This work package encompasses three (3) Individual Research Projects (IRPs). The general progress of the work package is fully satisfactory. Almost the whole first year of this work package was mainly dedicated to the recruitment of the ESRs; thus from the 24 months, about 15 had been used for the discovery of the project objectives and workplan of each Individual Research Project.

During such period of time, all positions has been successfully assigned and the ESRs are working hard to complete and achieve all expected objectives within their tasks as well as maximize their impact. It is worth noting that according to the original plan all the ESRs had to be currently on their secondment, but due to the delay on the recruitment and the current status of their work, two of them has been shifted and coordinated to maximize their collaboration except for the ESR33 which is at TU Delft, working together with the group of TU Delft on the project and others key persons on the same institution.

In order to give some overview of the ongoing work carried out up to now, detailed explanation of the progress of each ESR and their individual projects is given.

- *IRP 3.1 – Control strategies for hybrid AC-DC grids (Partner Responsible: IREC)*

As expected within the first year, the main tasks for the IRP included, modelling of hybrid AC/DC grids for control design purposes, detecting interactions among AC and DC systems, designing control systems for DC grids to support AC power systems, amongst others. This required a literature review to get an insight into the problems and find gaps in literature considering the topic in question. An extensive review showed there were several gaps. Particularly was the issue of complexity in modelling both AC and DC grids together. Most authors either simplified the AC side for studies where the DC was the major consideration; or simplified the DC grid where the AC grid was the major consideration. Very few cases where both grids were considered in detail. In the same vein, there were gaps in modelling methodology that could combine both grids, whilst also permitting to study one, while simplifying the other. The first year work was devoted to developing a suitable methodology or combination of methodologies that met the discussed criteria, validate it for simple cases, and in a typical fashion, extend to more complex cases. It is expected, that at the end of the second year, a realistic hybrid AC/DC grid model or models for various studies (particularly, meshed AC/DC hybrid grid with as much complexity as possible) would have been developed and important results and insights from studies published.

- *IRP 3.2 – A new modelling approach for stabilisation of smart grids (Partner responsible: UGA)*

During the first year, the ESR focused mainly on scientific progress. At first, a rigorous and comprehensive literature review about stability and synchronization in power systems was carried out. The models most commonly used in the study of synchronization were identified and the scientific results were understood. Some computer experiments were performed to reproduce the analytical results from literature. The next important step was to identify weaknesses in the models studied before. It was necessary to consider which simplifications had an impact in the properties of synchronization of the network. Using this, an extension of the model was formulated. Just after this, we stated the open questions regarding the extended model and to derive strategies on how to answer this questions. The project was designed to be explorational work. During this fundamental work, the ESR was able to improve his knowledge of power systems, smart grids and electrical engineering. This knowledge will be helpful in the further work expected within the INCITE project.

- *IRP 3.3 – Distributed control strategies for wind farms for grid support (Partner Responsible: IREC)*

As it was expected within this Individual Research Plan, the main objective of the project is to propose distributed control strategies for wind farms aimed to regulate both the active and reactive power injected into the grid in order to provide ancillary services (i.e. frequency support and voltage stability) and thus to fulfil the TSO’s demands. Accordingly, a comprehensive literature review on the state of the art of the Grid Code requirements related to ancillary services and an extensive technology review of control strategies to be applied by the wind power plants have been carried out. Then, with the aim of improving the participation of wind power in ancillary services, a centralized control strategy has been proposed in order to maximize the active power delivered to the grid after a frequency event. Initially, a Model predictive control strategy has been cast as a multi-objective optimization problem and evaluated for a low number of wind turbines facing only one wind profile. Then, the scheduling of power generation for wind power plants has been provided to optimize primary frequency response. This optimization problem has been tested for a wind power plant of twelve wind turbines and several wind profiles.

1.2.4 Work package 4 - Monitoring tools and secure operation of smart grids

Work Package 4 is leaded by UGA, namely by Nicolas Retiere. This work package encompasses four (4) Individual Research Projects (IRPs). The general progress of WP4 is fully satisfactory. For the recruited ESRs, the first year was dedicated to discover the INCITE project objectives and workplan, take in charge their own Individual Research Project and develop mutually beneficial interactions inside the WP.IRP 4.1 – Integrated simulation and design optimisation tools (Responsible Partner: UniBo)

After the resignation of the candidates selected for the 2016 call, a new call has been organized in 2017. The vacancy has been opened in the INCITE web (http://www.incite-itn.eu/vacancies/) and posted in our social media with deadline 1 October 2017. 12 applications have been received. The selection procedure will be completed by the end of October 2017.

- *IRP 4.2 – Fault detection and isolation for renewable sources (Responsible Partner: UGA)*

The main goal of this project is to develop fault detection and isolation methods for renewable energy sources (mostly wind and solar plants) connected to grids (through AC or DC links) and to ensure high level of availability of renewable power plans in order to reduce the impact of outages. After the 2nd INCITE workshop in Universitat Politècnica de Catalunya (UPC), Barcelona, it was decided that two more cases will be studied during the secondments: a) the case of grid faults at Efacec and b) the case of fuel cells as a renewable source at UPC.

After a literature review on fault detection and isolation in power systems, the photovoltaic (PV) system was selected as the first test case.

In order to design the model of a PV array, 3 steps were necessary: 1) extraction of the basic parameters from the equations describing the equivalent circuit of a PV cell, using only the available data from the manufacturer's datasheet, 2) usage of the known parameters to solve the transcendental current-voltage characteristic equation (using Newton-Raphson method or Lambert-W functions) and obtain the current-voltage characteristic curve and 3) synthesis of several elements in series and in parallel to construct the PV array. The Bishop's model for PV cells was selected as the most appropriate model for fault detection and isolation on PVs.

Among the various available topologies of connecting PV arrays to the grid, the two-stage conversion through a DC-DC boost converter connected in series with an inverter, was selected. Furthermore, the most popular maximum power point tracking technique (MPPT), perturb and observe (P&O) was implemented. As a first step in designing and testing the model of the system, the averaged model was used for both the boost converter and the inverter. A preliminary attempt to introduce faults in the system such as shading was successful. After verifying that the averaged model responds accurately to simple faults, the exact models of the converter and the inverter were developed and tested separately. Their successful implementation into a complete system followed.

At the moment, the various effects that different faults (e.g. shade, IGBT open circuit etc.) have on the system are being studied. The AC variables (V, I, P, Q) are being monitored in order to determine which faults can be detected from the AC side and which from the DC side. The symptoms of the grid are assigned to the corresponding faults thus creating the fault signature.

The following steps include: a) further analysis of how different faults affect the plant, b) extension of the fault signature table with more symptoms and faults and c) development of a fault detection and isolation algorithm for the PV test case. After this process is completed, the test case of wind farms will be examined.

- *IRP 4.3 – Advanced Monitoring and Controls of the Electrical Distribution Grid (Partner Responsible: GE-GR)*

In distribution networks, only a very limited number of measurements are available and installing the required quantity to make the system fully observable would be economically prohibitive. However, to include distributed generation such as solar panels or electrical vehicles, and implement demand response programs, it is required to monitor the network to determine the needs at every moment.

For that purpose, a Distribution System State Estimator (DSSE) has been developed that considers the few measurements deployed and the previous knowledge and assumptions about the network structure and loads, to determine an accurate estimation of the network state. This method can include all sorts of measurements, voltage, current, loads, synchronous or asynchronous. Additionally, it is computationally highly efficient, which allows for fast computations every few seconds and thus to monitor the network continuously. It could be therefore used for a continuous security analysis and for control purpose such as curtailing generations, voltage control, connecting and disconnecting loads, etc.

At the same time, different approximation algorithms for the optimal placement of new measurements have been developed together with guarantees of their accuracy. This problem is intractable for large networks, since all combinations of sensors need to be tested in order to determine the optimal placement. However, with our methodology, it is possible to decide where to allocate the measurements to maximize the information gained about the network and minimize the uncertainty caused by fast-changing loads.

Both methodologies have been tested on standard distribution feeders provided by the IEEE Power & Energy Systems Society. First, it has been shown that the method developed for State Estimation performs as well as standard methods, but reduces significantly the computation time compared to them, thus enabling its use to real-time monitoring of these networks. Secondly, it has been observed that the algorithms developed for optimal measurements placement are approximately as good as the possible optimal solution, while being having a reasonable computing time.

In next steps, we will consider the operation and control of these networks using the State Estimator and considering its uncertainty. We will use this estimation to control the integration of renewable energies, the level of the tap voltage change in the transformers, the charge and discharge of batteries along the networks, etc.

- *IRP 4.4 – Advanced functionalities for the future smart secondary substation (Partner Responsible: EFACEC)*

The increasing integration of Renewable Energy Resources (RES) as well as several Distributed Energy Resources (DER), pose several challenges on the planning and operation of the networks. The conventional electricity sector presently transits to a major shift in its design; thus, planning and operation of distribution networks are foreseen to follow novel trends beyond the so far centralized and "fit-and-forget" approach.

The main goal of this research project is to develop control and management functionalities, which will take advantage of the Distributed Energy Resources (DER) such as Battery Storage Systems, controllable loads and Electric Vehicles, to optimize the operation of Low Voltage (LV) networks. These control functionalities will be accommodated within a top-level centralized architecture, since a Distribution Transformer Controller (DTC) is envisaged to be placed at the Secondary Substation. The proposed control algorithms will manage the flexibilities of the integrated Distributed Energy Resources (DER) along the grid; thus, any technical challenges provoked by them, will be efficiently mitigated.

The overall control strategy will be organized in a multi-temporal scheme, that follows a preventive and predictive nature, in the sense that any technical problem might be anticipated and resolved, allocating properly the DER resources. In day-ahead scale, the available flexibility services will be communicated to the DTC, where the underdeveloped optimization problem will aim at scheduling (i.e. sequence and allocation) the coordination of these flexible assets, in such way that the LV operation is optimized from technical and economic viewpoint. Therefore, the scheme relies on short-term demand and renewable generation forecasting, so as to define the control actions (i.e. set-points for the operating mode of DER) for the following day. Besides, the contingency of uncertainties of forecasted net-load demand is meant to be addressed with corrective control actions, closer to the time of the delivery.

The first year, covered an extended literature exploration on control strategies related to different types of DER -controllable loads, Electric Vehicle and Battery Storage System-, integrated in the LV network so as to accomplish techno-economic objectives. The impact of extended DER integration was studied and simulated by using simulation tools as OpenDSS and Simulink. Additionally, the DER and LV grids were integrated in OpenDSS (which was selected to be the simulation tool for the developments). A unified simulation framework in MATLAB-OpenDSS together with a graphic user interface was created in order to ease the process of any ongoing simulations.

Improvements are made in the models of the DER components that are being within MATLAB and OpenDSS framework. Concurrently, probabilistic analysis is being held so as to assess the potential flexibility capacity for different levels of DER penetration, at the level of the LV grid.

Following this analysis, the focal point will be the formulation of the day-ahead optimization scheme, which will be responsible to allocate the DER flexibility resources. Inputs for this tool will be initially, the flexibility (in the sense of availability) curve-profiles by the end-users as well as the operating constraints for the DER units. In the frame of formulating the day-ahead operation tool, it is meant to further explore the methodology of optimization technique, depending on the technical details such as time resolution (e.g. intervals of subdividing the day-ahead optimization), as well as the feasibility of setting different techno-economic objectives for the LV network operation. In the 1st mobility-secondment, the proposed scheme will be verified and tested using the test bed of IREC microgrid and emulators.

1.2.5 Work package 5 - - Simulation and Experimental validation

Work Package 5 is leaded by IREC, namely by Jose Luis Domínguez-García. This work package does not have any specific IRP but it is expected that it will make all the IRP and WPs to converge and will keep them in the same track.

The general progress of this project is quite dependent on the status of the projects of all the IRPs and ESRs, since the definition of case studies to be applied or potential data bases, etc. have to be selected when better knowledge of the potential impacts is known.

In order to start to define such common work environments, a questionnaire was shared among the ESR supervisors. This form asked for descriptive details about the research infrastructures (experimental labs), simulation software, and benchmark test cases available and proposed to be used within the INCITE project.

The template of the questionnaire shared with the participants can be seen in the following figure:

INCITE WP5 "Simulation and Experimental Validation"

COPY THIS TABLE AS MANY TIMES AS NEEDED

Experimental validation (LABS)	**Short Description of Available Facilities**	Please, indicate the name and type of facilities which may be used by different ESR students within the INCITE project framework (i.e. to be used during secondments, common publications, etc) -
	Main tests and capabilities of the facilities	

COPY THIS TABLE AS MANY TIMES AS NEEDED

Simulation Software	**Short Description of Available Software**	Please, indicate the name and type of software (and toolboxes) do you have and believe can be used by different ESR students.
	Main capabilities and functionalities	

COPY THIS TABLE AS MANY TIMES AS NEEDED

Model Benchmarks	**Short Description of Proposed Model Benchmark to be used**	Please, indicate and propose Model/Benchmarks that can be used in common to compare and validate the outcomes of the different Individual Research Projects within INCITE project. **Remind that to show interaction among the different WPs, is a contractual obligation according to GA.**

D5.4. Project No. : H2020-MSCA-ITN-2015 675318

Another action taken has been to highlight the potential interactions among the ESRs at each presentation within the project Workshops as well as to propose the work package leaders and ESRs to have a work package telco periodically.

Short in time, it is planned to create a new form for the ESRs, taking advantage of the increased knowledge and the advancement of the Individual Research Projects. In order to update, the benchmark, test cases and software to be used.

One key step forward is to take advantage of the secondments of the ESRs to enhance such collaborations and interactions among partners, work packages and tasks.

Additionally, the idea is to use the online tool (intranet) used within the project i.e. Office365 in this case, in order to share the available documentation, data, models, etc. to be used in the project for ensuring that any other ESR may utilize it for their own developments and allow worth comparisons.

1.2.6 Work package 6 – Dissemination and exploitation of results

The main objective of this WP is to spread out the project results among different groups of audiences. As the project is developed by different entities, the dissemination plan has defined a common framework for all the project partners, in order to coordinate the different actions to be performed by each one.

Tasks that fall within this WP are as follows:

- Coordination of dissemination activities at the general public level (UPC)
- Coordination of dissemination activities at the scientific level (TUDelft)
- Analysis of possible exploitation of results (Efacec)
- Keep up-dated the contents of the website (IREC)

During the reported period, relevant dissemination activity has been done. Most relevant work is described below:

- **INCITE Webpage**: The project has launched the webpage http://www.incite-itn.eu/, which is being permanently updated with different information from the project. The webpage contains several sections (news, blog, training, ESR personal pages, etc.) that help to maintain information sorted.
- **Blog inputs**: Within the INCITE webpage, there is a blog (http://www.incite-itn.eu/blog/) that allows ESR and supervisors to explain their ideas about different topics. According to internal agreements at consortium level, at least a blog input per month should exist, fact that not only disseminate the internal advances of the project but also allows the general public to keep updated about the progress of the related scientific topics. So far, the following blog inputs have been produced:

Contributor	***Post Title***
Nuno Silva (Sup ESR44)	Tracing the transition from Passive to Active

	Distribution Networks
Fernando Bianchi (Sup ESR33)	Towards distributed control of wind energy
Fjo De Ridder (Sup ESR14)	Large scale thermal energy storage systems: Ecovat
Jesus Lago (ESR14)	Introduction to electricity markets, its balancing mechanism and the role of renewable sources
Adolfo Anta (Sup ESR43)	On Low Inertia Grids
Thibault Péan (ESR21)	Why do we need to make our buildings more “energy-flexible”?
Nicolas Retiere (Sup ESR32)	Complexity paves the path to smart electrical systems
Adedotun Agbemuko (ESR31)	The Dynamics of Future Power Grids: What Should We Expect?
Ramon Costa Castelló (Sup ESR22)	The role of hydrogen in the energy system
Konstantinos Kotsalos (ESR44)	The role of Demand Response
Zofia Lukszo (Sup ESR13)	Electric vehicles and microgrids: they need each other
Hazem Abdelghany (ESR12)	Demand-side management by real-time market-based control
Bertrand Raison (Sup ESR42)	Faults and power grids
Unnikrishnan Raveendran Nair (ESR22)	The role of Electrical storage systems in future grids
José Luis Domínguez-García (Sup ESR31)	Microgrids, a game changer
Felix Koeth (ESR32)	Synchronization in dynamical systems and power systems
Jaume Salom (Sup ESR21)	Thermal inertia in buildings: An opportunity to increase the share of renewables in the European energy system
Nikolaos Sapounzoglou (ESR 4.2)	Solar energy: the once and future king

- **Project ambassador**: Project members (ESR and supervisors) have attended different conferences, seminars and workshops around the world. During these occasions, INCITE members take the opportunity to explain the activities of the project to the attendees of the congress. Also, people interested in the research developed into INCITE has the opportunity of contacting to the project ESRs and supervisors, fact that motivates the networking with exogenous scientists and encourage future collaborations with external people (academia and industry).

  An INCITE flyer has been printed as dissemination material and used by the project ambassadors to inform those interested in INCITE.

  The attendance of INCITE ambassadors to conferences, workshops and meetings is advertised before the event using the project webpage (within the news section, http://www.incite-itn.eu/news/) and the project social networks (Twitter and LinkedIn)

- **Twitter:** The project has a twitter account (@inciteitn) that is being used to disseminate particular project activities and other issues of transversal interest. So far, the account has made almost 400 tweets. By using this dissemination tool, the followers are aware of activities related to INCITE Ambassadors, awards received by INCITE members, accepted and published papers, etc. ESRs also contribute as curators to the project Twitter feed, taking charge of part of its contents for a couple of months at a time

- **Linkedin:** The project has a LinkedIn page (https://www.linkedin.com/company/10432636/), where blog post, project publications and other worth-disseminating news are posted.

- **ResearchGate:** The project has created a ResearchGate project (https://www.researchgate.net/project/INCITE-Innovative-controls-for-renewable-source-integration-into-smart-energy-systems). The project contains information about the project's publications and other relevant news.

- **Outreach activities:** During this period, members of the project have participated in different outreach events that have taken place mainly on a local level:
  - Barcelona Science Slam – On March 3rd 2017, the Barcelona-based ESRs (IREC & UPC) took part in the ITN Barcelona Science Slam, that brought together ESRs of a number of ITNs coordinated from institutions located in the Barcelona area.
  - IREC Family Day – On September 1st 2017, INCITE coordinator Jose Luis Domínguez participated in IREC's first family day, where children of IREC's employees learnt about the investigation carried out there (including that covered by INCITE).

- Researchers Night Science Slam – On September 29th 2017, Konstantinos Kotsalos, ESR at EFACEC in Porto, took part in the Science Slam organised within the European Researchers Night 2017.

Submitted deliverables:

- D6.1 – Dissemination plan report
- D6.3 – First workshop proceedings
- D6.4 – Second workshop proceedings

1.2.7 Work package 7 - Training

The aim of the INCITE training program is to prepare and support top young researchers in proposing innovative control solutions for the future electrical networks. One of the objectives is to provide the young researchers with the necessary knowledge in control theory, optimization techniques, instrumentation, power electronics, power systems and energy markets to face the challenging problem of shaping the future electric networks. Another key point in the training program will be the cross-sectoral interaction aimed to provide the ESRs with a wide view in methods and approaches for the control of smart grids. Moreover, all the ESRs are enrolled in a PhD program offered by their (academic) host institution.

The INCITE training program will not only provide the ESRs with a solid preparation in technical aspects of control, design and operation of smart grids, but also with a training in other complementary skills that will contribute to improve their R&D career perspectives.

The INCITE training program consists both of locally organized activities and courses (e.g., within the framework of the Participants' local graduate school programs) and network-wide INCITE activities (INCITE Workshops and INCITE Summer Schools). Two main lines are covered: technical skills and complementary skills, as detailed next.

a. Technical skills

For the technical skills, the following main topics have been planned:

- Automatic control
- Power systems
- Smart grids
- Related subjects

Topics not provided locally will be covered at network level in the INCITE Workshops and the INCITE Summer Schools. The current idea is to include one or more subtopics for each of the main topics at each event, e.g. through tutorials (in the first years of the project) and advanced seminars (later on), by the Participants as well as top international experts. The goal of these tutorials and seminars is to ensure all ESRs have a general knowledge about techniques and tools used in all the Individual Research Projects. This aims to fulfil the main project objective of training experts on a particular aspect of control of smart grid with general awareness of all issues and requirements in the control of the future electrical networks.

The following list indicates a tentative set of tutorials/seminars for the network-wide events:

- Automatic control
  - Model predictive control
  - Distributed control
  - Multivariable control
  - Optimization
  - Fault detection and isolation; fault-tolerant control
  - Multi-agent systems and large-scale systems
- Power systems
  - Power transmission technologies
  - Power system stability
  - Renewal Energy Sources (RES) integration
  - Wind power plant control
  - Power converters
  - Grid code
  - Types of power generation
  - Dynamics and basics of power generators
- Smart grids
  - Smart grids and machine learning
  - Smart grids and energy markets
  - Smart grids, dynamics and complexity
  - Failures and attacks in electricity system
  - Electric power grids control
  - Power dispatch in energy networks: practical cases and smart solutions
  - Power system operation and planning, microgrids and energy hubs, sustainable energy integration
- Related subjects
  - State estimation of electrical grids
  - Information and Communication Technology (ICT)

b. Complementary skills

For the complementary skills, the following main topics are planned:

- Communication skills
- Organization skills
- Project management & funding
- Result exploitation & scientific business
- Language

These skills can be detailed as follows, where we also indicate the (intended) source of the courses or seminars.

- Communication skills
    - Managing the academic publication review process – network-wide (Workshop 1)
    - Scientific writing (article/dissertation) – local
    - Popular scientific writing – local
    - Presenting scientific research/self-presentation – local
    - Tools for scientific dissemination/attractive presentations – network-wide (School 1)
    - Search and management of bibliographical data – local
- Organization skills
    - Assertiveness/teamwork/cooperation – local
    - Self-organization/time management – local
    - Career management and career development – local
    - Different options for a career in research – local & network-wide
    - Team activities – local & network-wide
    - Involvement in the organization of network activities – local & network-wide
- Project management & funding opportunities
    - Funding opportunities – network-wide (School 2)
    - Writing funding applications – network-wide (School 2)
    - Project management – network-wide (School 2)
    - Engineering ethics – local
- Exploitation of results & scientific business
    - Technology transfer – network-wide (School 3)
    - Management of Intellectual Property Rights (IPR) – network-wide (School 3)

    - Entrepreneurship – network-wide (School 3)
    - Start-up creation – network-wide (School 3)
    - Product commercialisation – network-wide (School 3)
    - Business strategy/finance management – network-wide (School 3)
    - Marketing for start-ups – network-wide (School 3)
    - Innovation/creativity – network-wide (School 3)

- Language

    - Local language – local
    - English – local

- Others

    - Gender issues – network-wide

All ESRs have been admitted to a PhD program and nine of them have started with the local training on technical skills necessary to carry out their IRP. Table lists the PhD program in which each ESR is enrolled.

Researcher	Host institution	PhD program	Status	Starting date
ESR11	UPC	UPC	Admitted	Dec 2016
ESR12	TU Delft	TU Delft	Admitted	Oct 2016
ESR13	TU Delft	TU Delft	Admitted	Oct 2016
ESR14	VITO	TU Delft	Admitted	Sep 2016
ESR21	IREC	UPC	Admitted	Jun 2016
ESR22	UPC	UPC	Admitted	Dec 2016
ESR23	TU Delft	TU Delft	Admitted	Jun 2016
ESR31	IREC	UPC	Admitted	Sep 2016
ESR32	UGA	UGA	Admitted	Sep 2016
ESR33	IREC	UPC	Admitted	Sep 2016
ESR41	UniBo	UniBo		
ESR42	UGA	UGA	Admitted	Sep 2016
ESR43	GE-GR	TU Delft	Admitted	Jul 2016
ESR44	Efacec	University of Porto	Admitted	Aug 2016

Career Development Plans (CDP)

To tailor each ESRs training to their IRP, needs and requirements, a Career Development Plan was set during the first month of recruitment. Both general goals for the whole IRP as well as detailed goals for the first year of the ESR are defined there. Once ESR and supervisor have agreed on a CDP, the TSC first and the SB later evaluate and approve the plan.

The CDP is revised and updated yearly, to evaluate the progress of ESR, set the goals for the following year and update the general goals for the IRP.

Secondments

Each ESR will spend at least six months in partner institutions with complementary research profiles (see Table 1). All ESRs hosted by academic partners will spend time at non-academic partners, and vice versa. Therefore, through secondments and interactions with other partners, the ESRs will be exposed to different views and they will learn to work with people from different professional fields.

Researcher	Recruiting Beneficiary	Secondments	
		1st stay	2nd stay
ESR1.1	UPC	UniBo	GE-GR
ESR1.2	TU Delft	UPC	IREC
ESR1.3	TU Delft	IREC	VITO
ESR1.4	VITO	TU Delft	3E
ESR2.1	IREC	3E (11/09/2017 - 24/11/2017)	VITO
ESR2.2	UPC	Efacec	UniBo
ESR2.3	TU Delft	UPC (13/03/2017 - 14/07/2017)	3E
ESR3.1	IREC	UGA	GE-GR
ESR3.2	UGA	IREC	VITO
ESR3.3	IREC	TU Delft (01/09/2017 - 23/12/2017)	GE-GR
ESR4.1	UniBo	UPC	Efacec
ESR4.2	UGA	UPC	Efacec
ESR4.3	GE-GR	IREC	TU Delft
ESR4.4	Efacec	IREC	UGA

Network-wide training

The following network-wide courses and seminars have been provided during the 1st INCITE Workshop (November 23-25, 2016, Genk, Belgium), the 1st INCITE Summer School (June 26-28, 2017, Barcelona, Spain), and the 2nd INCITE Workshop (June 29-30, 2017, Barcelona, Spain):

- 1st INCITE Workshop - Genk:

  Courses on scientific skills:

  - Smart Grids and Energy Markets – Ronnie Belmans (1h)

- The GREDOR project. Redesigning the decision chain for managing distribution networks – Damien Ernst (1h)

Courses on transferable skills:

- Project Management – Propellor (8h)
- Introduction to the publication review process – Bart De Schutter (1h)

- 1st INCITE Summer School - Barcelona

  Courses on scientific skills:

  - Smart Energy Systems: Advanced Control and Safety Capabilities (2 days)
  - The Role of Population Games and Evolutionary Dynamics in Distributed Control Systems – Nicanor Quijano (1.5h)
  - Understanding natural, accidental and malicious threats against secure operation of power systems – Tao Huang (2h)
  - Enhancement for the security of power system operation – Tao Huang (1.5h)
  - Fault Diagnosis of Complex Systems – Vicenç Puig (1.5h)
  - Distributed Control and Optimization in Smart Power Distribution Grids – Florian Dörfler (1.5h)
  - Control of Low-Inertia Systems: Naive and Foundational Approaches - Florian Dörfler (1.5h)
  - Adaptive Parameter Estimation and Control: Introduction and Application – N. Jing (1.5h)

  Courses on transferable skills:

  - Virtual Labs Course – F. Esquembre (3h)
  - Effective Communication –Servei de Llengües UPC (6h)
  - Resources for scientific writing – Alan Lounds (2h)
  - The external peer review process, including point-by-point replies – Mary Ellen Kerans (2h)
  - The internal peer review process - Mary Ellen Kerans (2h)

- 2nd INCITE Workshop – Barcelona
  - Courses on scientific skills:
  - Grids in transition: the evolution of DSOs - Miguel Pardo (1.25h)
  - StoreAge: the flexibility game changer for distribution networks - Nuno Silva (1.25h)
  - Von Neumann meets Le Corbusier: From Game Theory to Smart Cities – Nicanor Quijano (1.25h)

Submitted deliverables:

- D7.1 – Annual training report
- D7.2 – Annual training report (due Nov 2017)

1.2.8 Work package 8 – Network management

WP8, leaded by IREC, aims at ensuring a smooth management of the Project. Its goals comprise ensuring an efficient and transparent management system for INCITE ensuring the proper development of the project objectives and ensuring suitable communication channels among partners.

Main tasks in WP8:

- Prepare and sign a Consortium Agreement (IREC)
- Organise a kick-off meeting and first meeting (IREC)
- Create and maintain the project website (IREC)
- Organise and carry out the recruitment process (TU Delft)
- Carry out the financial management of the network (IREC)
- Coordinate the use of partner infrastructures

Work carried out:

The Consortium Agreement was prepared before the signature of the GA and signed by all project beneficiaries in M1 (December 2015).

INCITE's kick-off meeting was held at IREC premises in Barcelona (Spain), January 14th 2016, where the implementation of the project was discussed, the governance bodies (SB and project committees) were elected and the recruitment process was put into place. Further discussion regarding the training and dissemination and exploitation plans together with the approval of ESR candidates took place during the SB meeting in Grenoble (France), April 25th 2016.

The INCITE webpage was designed and implemented (the process summarized in D8.1) and is being maintained up to date by the CMO (www.incite-itn.eu).

The methodology developed by the Consortium for the recruitment process was to implement an effective centralized recruitment strategy. Details on the recruitment process can be found in D8.3 (recruitment completion report) and D8.8 (Progress Report). The starting date of the different ESRs extended over a period of time ranging from M7 to M13, depending on the personal status of each selected ESR and the bureaucratic procedures required. Additionally, ESR4.1 position is undergoing a new recruitment process at the moment following the resignation of the previous ESRs.

The CMO is also responsible for the financial management of the network (pre-financing payment to partners took place in a timely manner) and of ensuring a smooth communication among partners and within the different internal processes (for example, the follow-up of evaluation and approval of the CDPs and the organization of the network-wide events)

Submitted deliverables:

- D8.1 – Project website completion
- D8.2 – Consortium Agreement
- D8.3 – Recruitment completion report
- D8.4 – Annual Financial report
- D8.5 – Annual Financial report (due Nov 2017)
- D8.8 – Progress Report
- D8.11 – Supervisory Board of the network

1.3 Impact

Include in this section whether the information in the DoA (how your project will contribute to the expected impacts) is still relevant or needs to be updated. Include further details in the latter case.

INCITE is a training network aimed to provide the ESRs with the necessary skills to become attractive candidates for top universities, research centres and industry in the field of electrical and control engineering and/or to start their own companies.

At this point the information in the DoA regarding impact is still relevant.

2. Update of the plan for exploitation and dissemination of result (if applicable)

Include in this section whether the plan for exploitation and dissemination of results as described in the DoA needs to be updated and give details.

NOT APPLICABLE

3. Update of the data management plan (if applicable)

Include in this section whether the data management plan as described in the DoA needs to be updated and give details.

NOT APPLICABLE

4. Follow-up of recommendations and comments from previous review(s) (if applicable)

Include in this section the list of recommendations and comments from previous reviews and give information on how they have been followed up.

NOT APPLICABLE

5. Deviations from Annex 1 (if applicable)

Explain the reasons for deviations from the DoA, the consequences and the proposed corrective actions.

IRP4.1 is delayed due to resignation of the recruited candidates. The initially selected candidate (Natalia Theologou) resigned one week before starting in M11 due to family issues. The second candidate in the pre-approved list was then contacted and started his IRP in M12, but he resigned two months after. The third candidate in the pre-approved list was then recruited. She didn't start until May 2017, due to bureaucratic issues –getting her visa-, but resigned in July 2017. As there was no one else in the pre-approved list, a new recruitment process has been started and the new ESR will be expected to start during M24 (November 2017). The main objectives of IRP4.1 will be covered, but some of the scope might be tuned.

The 3rd INCITE workshop, initially planned by November 2017, has been postponed to early 2018 due to some internal restructuring going on at GE, the partner in charge of its organization.

Risk assessment update:

European Commission

1.3.5. WT5 Critical Implementation risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
R1	ESR resignation before 18 months	WP8	With the proper authorization of the EU Commission, a new ESR will be recruited to take over the research activities corresponding to the IRP.
R2	ESR resignation after 18 months	WP8	The TSC will evaluate the possibility that the research objectives are covered by other IRPs
R3	Unavailability of laboratory equipment at the expected project stage	WP8	The AC will ask another partner for similar equipment and its availability. In case of negative answer, the TSC will reconsider the objectives
R4	Problems in event organisation	WP7	In case some partner is not capable of organising the planned event, the AC will ask one of the other partners to take over of the event organisation.

New risks have been identified:

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
R1/R2 update	ESR resignation	WP8	1- Go through the rest of pre-approved candidates to recruit a new ESR. 2- Open a new recruitment process. 3- Evaluate the possibility that the research objectives not achieved are covered by other IRPs from the same WP.
R5	A partner leaves the Action	WP8	1- Look for a new partner. 2- Another partner assumes the IRP from the leaving part
R6	Visa issues delaying ESR incorporation	WP7 and WP8	The ESR will receive locally the network-wide training missed.
R7	New opportunities	WP7	Include the new

	for secondments outside INCITE due to new collaborations		secondment hosts as Partner Organizations
R8	Scientist in Charge / Supervisors resignation	WP1,2,3,4,5	The responsibility will be taken over by someone from the same institution after approval by the PO.

5.1 Tasks

Include explanations for tasks not fully implemented, critical objectives not fully achieved and/or not being on schedule. Explain also the impact on other tasks on the available resources and the planning.

IRP4.1 is not fully implemented due to the resignation of the previous ESRs. Recruitment process to hire a new ESR4.1is ongoing and the new person is expected to join UniBo late M24 or early M25. The ESR substitution has caused a delay in the progress of IRP4.1. Once the new person has started, the workplan will be adapted to fulfil all objectives by the end of the project.

The delay in IRP4.1 might have a slight impact in the achievement of WP4 objectives, but the coordination among all supervisors and ESRs in the WP meetings has minimized such impact. Also, the delay of IRP4.1 will have no effect on the secondments planned at UniBo, as to maximize networking and collaboration among ESRs, those are planned for 2018.