Scientific Report

First name / Family name	Hector Eloy / Sanchez Sardi
Nationality	Italy
Name of the *Host Organisation*	Fraunhofer SCAI
First Name / family name of the *Scientific Coordinator*	Jochen / Garcke
Period of the fellowship	01/09/2017 to 31/12/2018

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

- Research on the State of The Art of Data-Driven, Machine Learning Techniques for Wind Turbines Fault/Anomaly Detection and Prognostics. Assessment of the high fidelity wind turbine simulator FAST v8 for wind turbine numerical simulations and wind turbine blades ice accretion.

- Collaboration in the writing of a research proposal with the host group for the research project MADESI. The funding for the research project was granted on date May 2, 2018.

- Within the Vavid project the research fellow collaborated in the tasks of flutter phenomena investigation, analysis of wind turbine SCADA data for flutter detection from the company General Electric. State of the art research in flutter control and the design of a supervisory control scheme integrating a lower level adaptive controller and a flutter detection scheme in collaboration with engineers from General Electric.

- Within the Vavid project the research fellow collaborated in the tasks

of literature research for rotor imbalance detection, analysis of documentation on gitlab and support on the analysis of mass changes and aging datasets from the industrial partner of the project Weidmueller.

- Collaboration in the internal API design for the host group. Report on the experience from project requirements on the data format and output from simulated data from FAST simulator.

- Collaboration in the supervision of a master thesis with applications of wind turbine systems numerical simulations. Name of the student: Alex Dick. Master Thesis Tittle: "Subspace Identification and Koopman Theory for Modal Analysis of Linear Dynamical Systems" presented at Bonn University. Date of defense: October 24th, 2018.

- Research and feedback to the host group in the topic of wind turbines Campbell Diagrams interpretation.

- Learning and usage of a software called Mlife for fatigue damage analysis of wind turbine time-series. Application of the software for Damage Equivalent Loads (DELs) calculation on time-series resulting of different power production rates and wind speed scenarios of the NREL 5MW reference wind turbine.

- Numerical simulations of blade mass changes in the wind turbine FAST simulator. Research on experimental design and simulation of mass changes on wind turbine blades. Implementation of mass changes at blades and simulation with FAST v8.

- Training of industrial partners in MADESI project and colleagues of the host group in wind turbine numerical simulations, blade mass changes, rotor imbalance and assessment of the state of the art in blades anomaly simulation with FAST simulator.

- Investigation and collaboration on the integration of control schemes to reduce power production and blade loads in wind turbines with optimization strategies. Research on static and dynamic optimization strategies, e.g. dynamic strategies in the framework of a Markov decision process.

- Supervision of an internship at the host group in the topic of model predictive control of wind turbines. Name of the student: Fran Medjurecan.

- Online lessons of Machine Learning Course on the platform Coursera. Online lessons of German Language provided by the host group with the platform Berlitz and Linguarama.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Journal Paper:
Authors: Hector Eloy Sanchez Sardi, Helene Seyr, Michael Muskulus and Jochen Garcke.
Title: Wind Turbine Scheduled Maintenance Optimization based on Control Strategies for Generator Derating.
Journal: Wind Energy
Status: Submission

III – ATTENDED SEMINARS, WORKSHOPS, CONFERENCES

Conferences Attended:
- **Fourth European Conference of the Prognostics and Health Management Society - PHME18** in Utrecht, The Netherlands, 3-6 July 2018.

- **Wind Europe Conference / Wind Energy Hamburg Expo** in Hamburg, Germany, 25-28 September 2018.

Short Courses:
- **Analytics for Prognostics and Health Management (PHM)**
Place: Utrecht, The Netherlands
Dates: 2-3 July 2018. Length: Two, eight hour days.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

The Research Exchange Programme (REP) took place at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway, from 12-03-2018 to 23-03-2018 with the Host Contact Person: Prof. Michael Muskulus. The tasks and research exchange performed can be summarized in the following points:
- Research on the state of the art of wind turbine maintenance and optimization most recent published works of the group.
- Exchange with PhD students from the Host Professor in the topics of Machine Learning application to the impact of waves at wind turbine structures, Markov decision processes applied to wind turbine maintenance assessment. Exchange from part of the research fellow on the topic of Model Predictive Control and the trade-off between remaining useful life extension or damage reduction and power production at wind turbines.
- Ideas on the integration of generator derating strategies of a wind turbine and optimization of power production subject to damage accumulation constraints were discussed.