OPTIMIZATION OF THE COST PRIORITY NUMBER (CPN) METHODOLOGY TO THE NEEDS OF A LARGE O&M OPERATOR

G. Oviedo Hernández[1]*, S. Lindig[2], D. Moser[2] and P. V. Chiantore[1]

[1]BayWa r.e. Operation Services S.r.l., Via di Settebagni 390, 00139 Rome, Italy
[2]Institute for Renewable Energy, EURAC Research, Viale Druso 1, 39100 Bolzano, Italy
*Phone: +39 346 1175 310; E-mail: guillermo.hernandez@baywa-re.it

INTRODUCTION

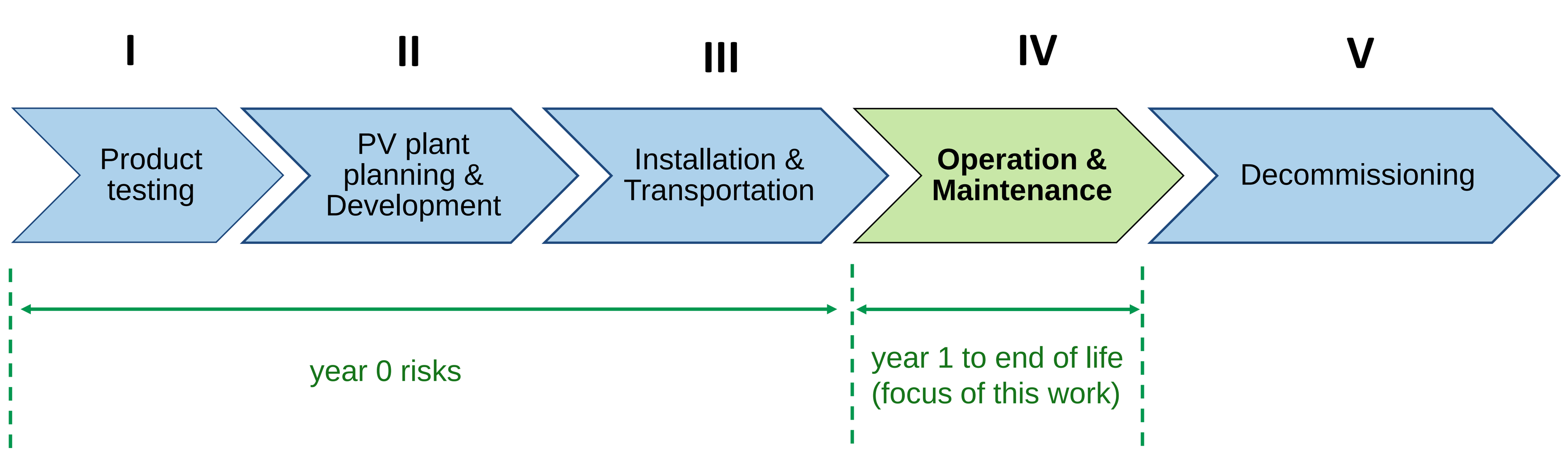
A methodology capable to assess the economic impact of failures in PV projects was one of the main outcomes of the H2020 project Solar Bankability. It was a first attempt to derive a cost-based FMEA (Failure Mode and Effect Analysis) methodology for the PV sector using the metric CPN (Cost Priority Number) instead of the RPN (Risk Priority Number) as typically used in classical FMEA. It was originally applied by developing theoretical scenarios to calculate extreme values for the CPN metric, expressed in €/kW$_p$/year. In this study, the methodology has been updated and adapted to the needs of a large O&M operator and applied manually to monitoring data and maintenance tickets of a fielded utility-scale PV plant. The main objective was to identify the adjustments needed to take the implementation of the methodology a step further towards a fully automatized approach. Additionally, the most relevant O&M contractor Key Performance Indicators (KPIs), such as detect, response and repair times, which are the cornerstone of the proposed economic analysis, were revisited and reformulated. Finally, the methodology was further improved by introducing more accurate calculations for Performance Ratio (PR), plant degradation and energy losses.

OBJECTIVES AND BACKGROUND

The CPN methodology was developed in the Solar-Bankability project [1] back in 2017, in which the risk assessment connected to investments in PV projects was studied. The methodology helps to identify and classify the technical risks and their economic impact due to downtime C_{down} and repair C_{fix}, by assigning a cost metric that supports preventive and corrective measures, which then would lower the impact of failures on the availability and performance of a PV plant.

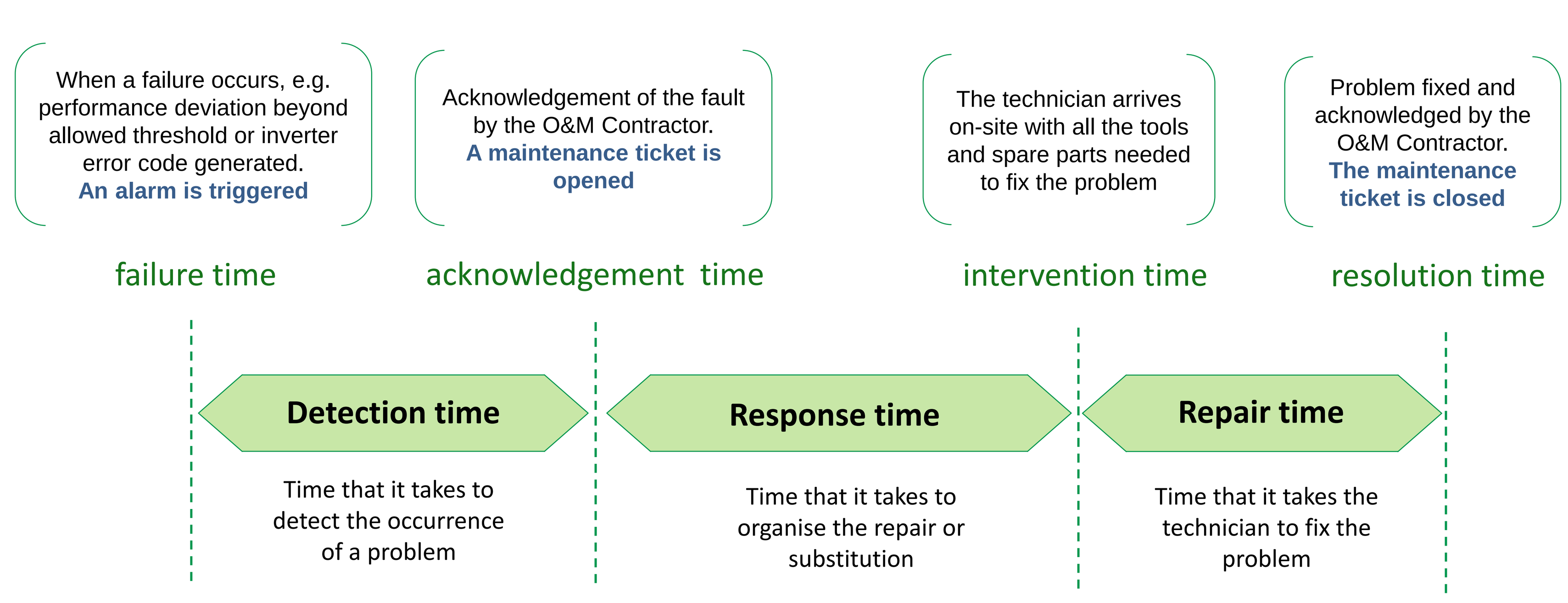
$$\mathbf{CPN} = C_{down} + C_{fix} \quad [€/kW_p/year]$$

This work is only focused on the O&M phase, which is by far the longest in the life cycle of a PV plant (20-25 years). Real monitoring data were used and key information was extracted from maintenance tickets in order to improve the accuracy of the methodology by stepping away from theoretical assumptions. This approach will help to standardize the methodology further and to acquire more applicable results for the solar industry.



IMPROVEMENTS OF THE CPN METHODOLOGY

- Reformulation of O&M contractor KPIs [2]



- Optimization of equations [3]

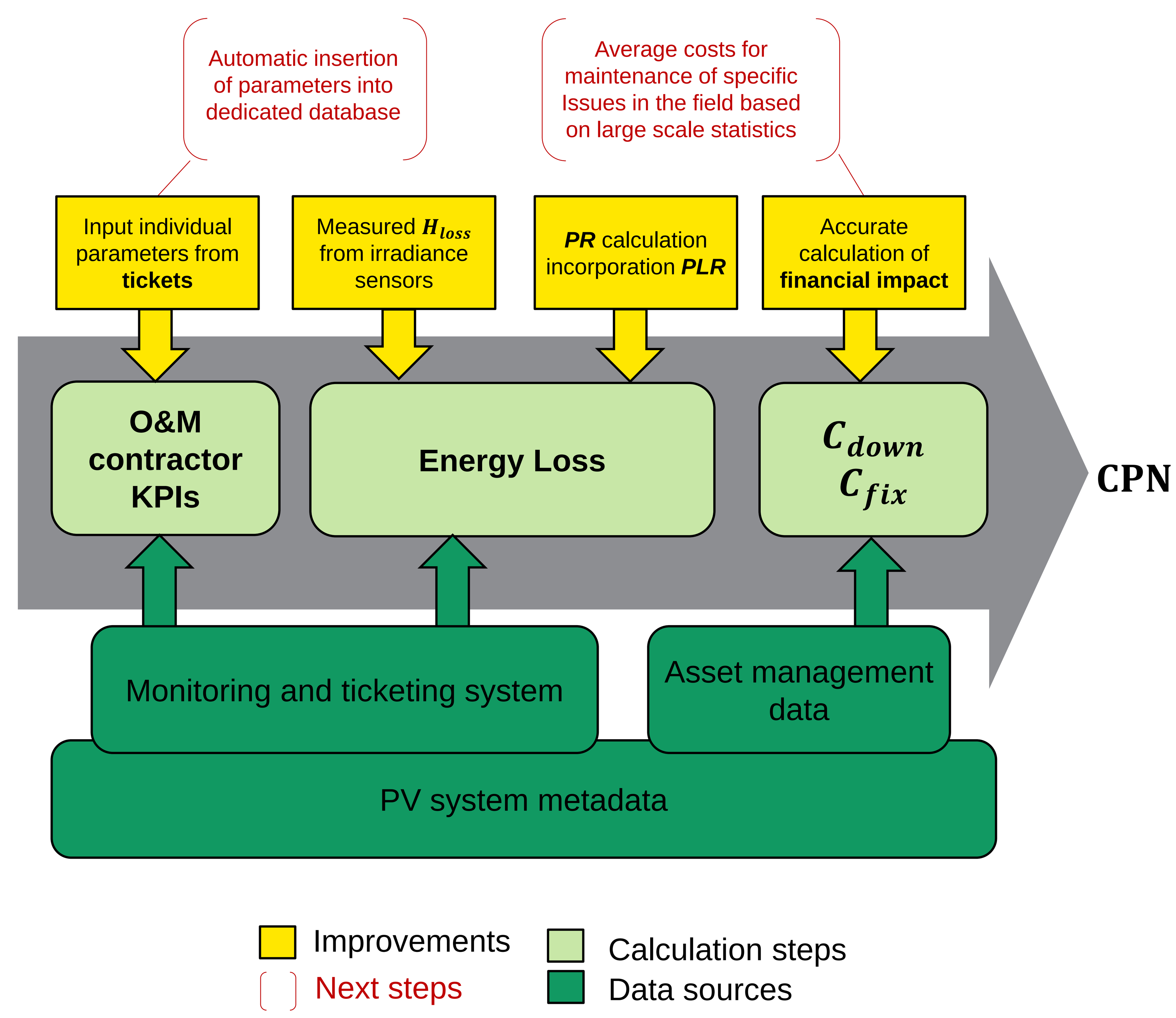
$$PR_{fail} = PR_{start_{monitoring}} - PLR \cdot (year_{fail} - year_{start_{monitoring}})$$

$$Y_{loss} = H_{loss} \cdot PR_{fail}$$

$$E_{loss} = Y_{loss} \cdot P_0 \cdot (n_{fail}/n_{total}) \cdot CPL \cdot M$$

PLR	Performance Loss Rate [%/a]	Y_{loss}	Specific yield loss [kWh/kW$_p$]
H_{loss}	Irradiation loss [kWh/m²]	E_{loss}	Overall power loss [kWh]
P_0	Total installed capacity of the PV plant [kW$_p$]	CPL	Component Power Loss [%]
n_{fail}	Number of components affected	M	Multiplier to consider failures that cause problems at higher component level
n_{total}	Total number of components		

- Improvement of CPN calculations



CONCLUSIONS

- The development of an automated and therefore time-efficient solution for extracting key parameters from maintenance tickets is of vital importance for the implementation of the methodology at portfolio level, and thus, to gain statistical insights from a large number of PV plants.

- The development of a software tool for field technicians that would allow the precise and error-free recording of standardised parameters for the calculation of the O&M contractors KPIs is necessary for an efficient implementation of the methodology, which has been proven to be highly dependent on how the data is structured inside the ticketing system.

- The O&M field practices must definitely move away from a manual input of tickets in text format and adopt a more standardised approach when human intervention is limited to choosing the category and failure type from a pre-defined selection list (in line with the nomenclature already developed by the Solar Bankability project [4]).

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