O&M Optimisation

Ruizi Wang*, Giovanni Picotti†, Pietro Borghesani*, Michael Cholette*, Lin Ma*, Ted Steinberg*
* School of Chemistry, Physics and Mechanical Engineering, Science and Engineering Faculty, Queensland University of Technology
† School of Industrial and Information Engineering, Department of Energy, Politecnico di Milano

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This project aims to reduce the O&M component of LCOE for the solar tower CSP plant through productivity maximization and optimization of O&M tasks and schedules. An overall approach has been proposed, including reliability and degradation models, condition monitoring and O&M optimization. With an initial focus on mirror cleaning, a soiling model has been developed for the prediction of reflectivity losses. A camera-based method for mirror reflectivity assessment has been preliminary validated. By integrating the two approaches, optimization strategy for mirror cleaning can be further derived.

Project overview and approach

Industry gap

- O&M represent a significant component of LCOE (10-15%)
- IRENA identifies O&M as a key area for feasible cost reduction (~23% in tower CSP)
- 38% O&M cost reduction obtained by Sandia NL on trough plant
- 0.2-0.25 c/kWh reduction with an absolute improvement of 2% in mirror cleanliness from studies by Sandia and NREL

Goal

- Increase the productivity of the plant by reducing reflectivity losses due to soiling of heliostats
- Reduce the O&M component of LCOE by optimizing O&M tasks and schedules in CSP power plant

Approach

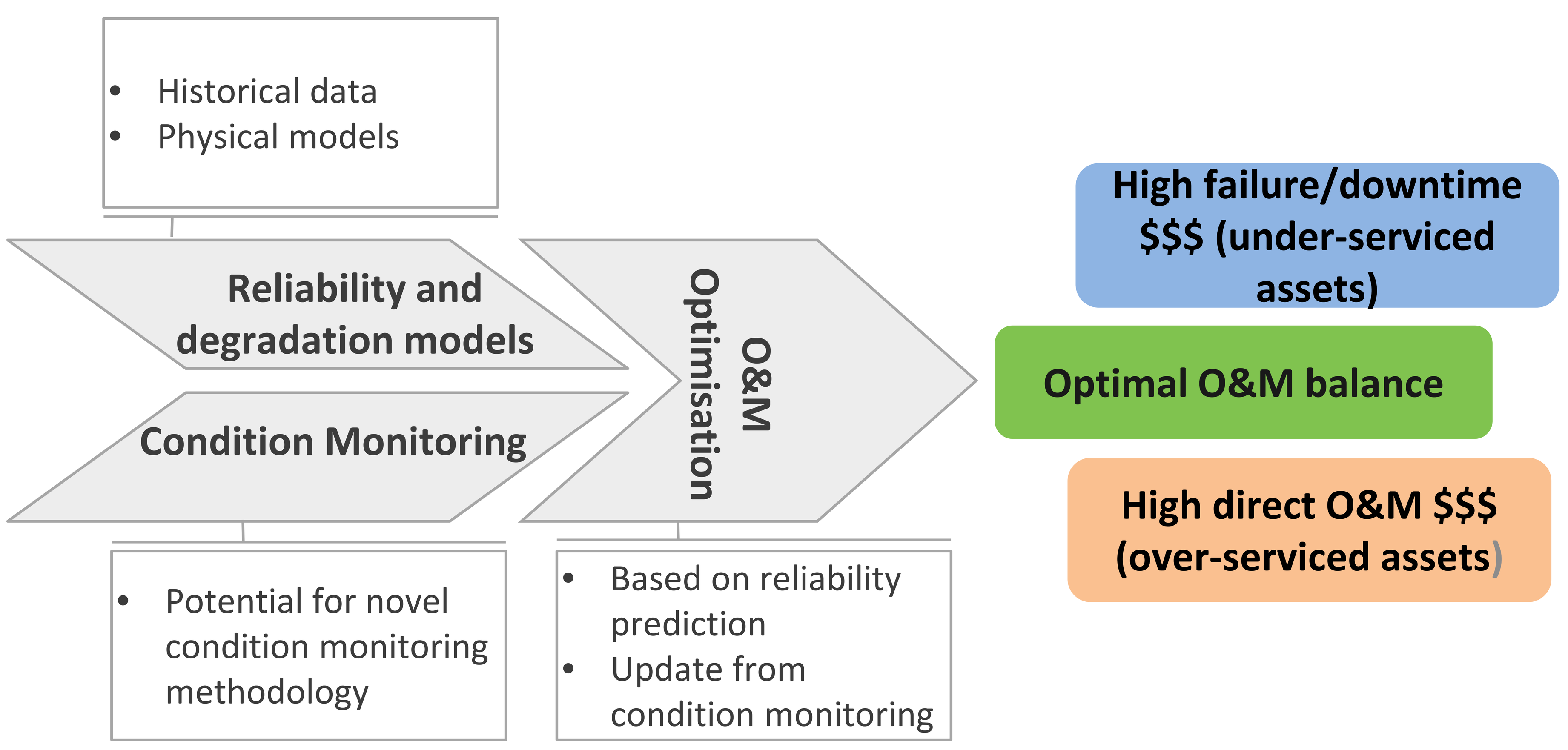

Figure 1: The overall approach for optimal O&M strategy.

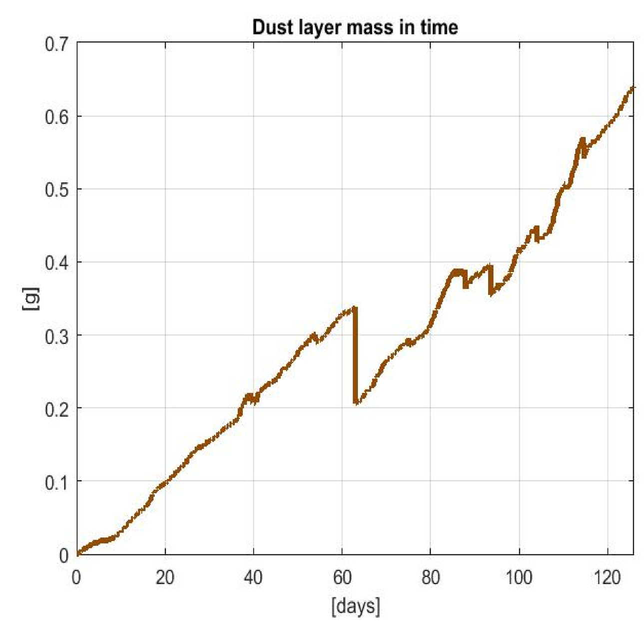

Figure 3: Simulated dust layer over time based on data from Collinsville[1].

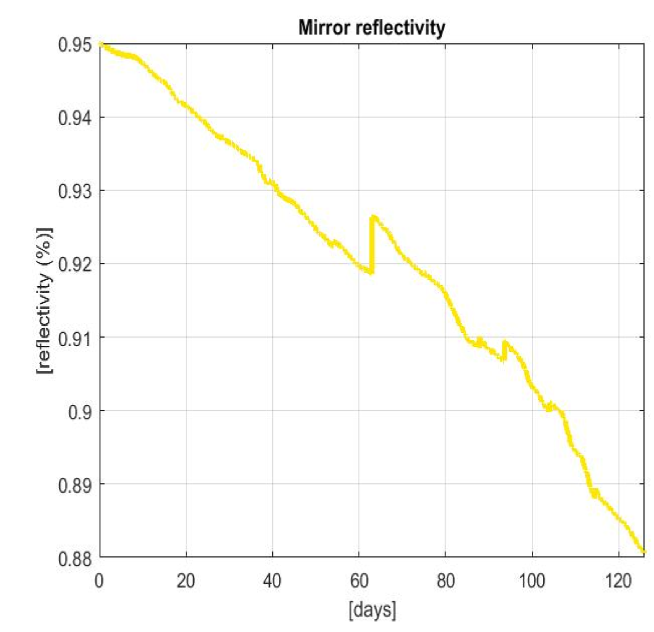

Figure 4: Simulated mirror reflectivity loss over time based on data from Collinsville[1].

Reflectivity assessment with calibration camera

Figure 5: Comparison of reflectivity measurements from clean mirror and dirty mirror

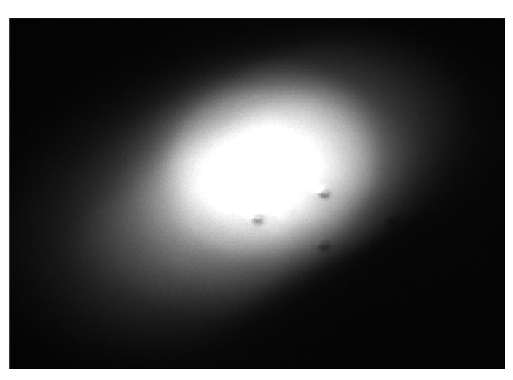

Figure 6: Image of calibration target reflected by clean mirror with 100ms exposure time and 820W/m^2

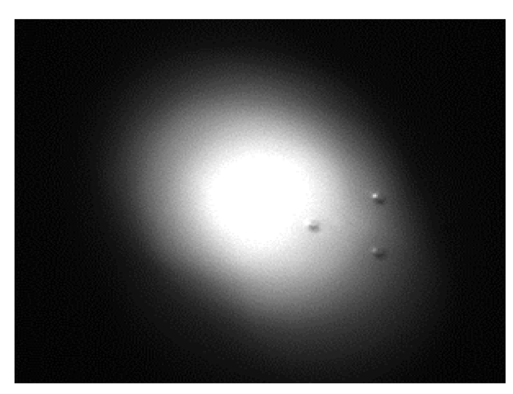

Figure 7: Image of calibration target reflected by dirty mirror with 100ms exposure time and 820 W/m^2

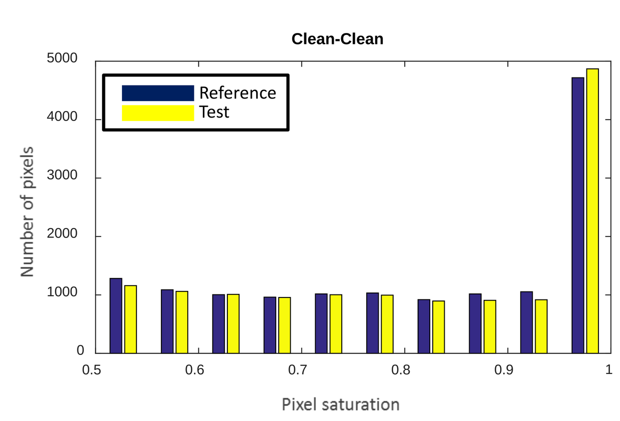

Figure 8: Comparison of images between two clean mirrors

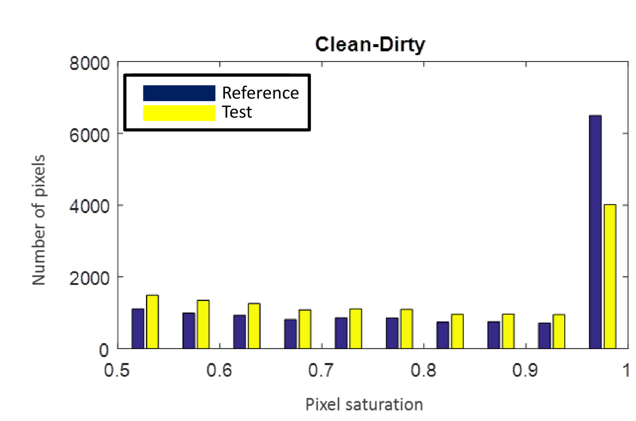

Figure 9: Comparison of images between clean and dirty mirrors

Optimization of mirror cleaning operation

Reasons for initial focus

- Typical and specific of the industry
- Cleaning not covered by OEM instructions
- Plant owners interested in "insights" on appropriate scheduling

Modelling steps

- Prediction of reflectivity with soiling model
- Continuous update of model prediction with automated reflectivity monitoring
- Evaluation of economic impact of sector degradation with Modelica software integration
- Optimisation of cleaning resources, schedule and sector priority

Mirror soiling model and results

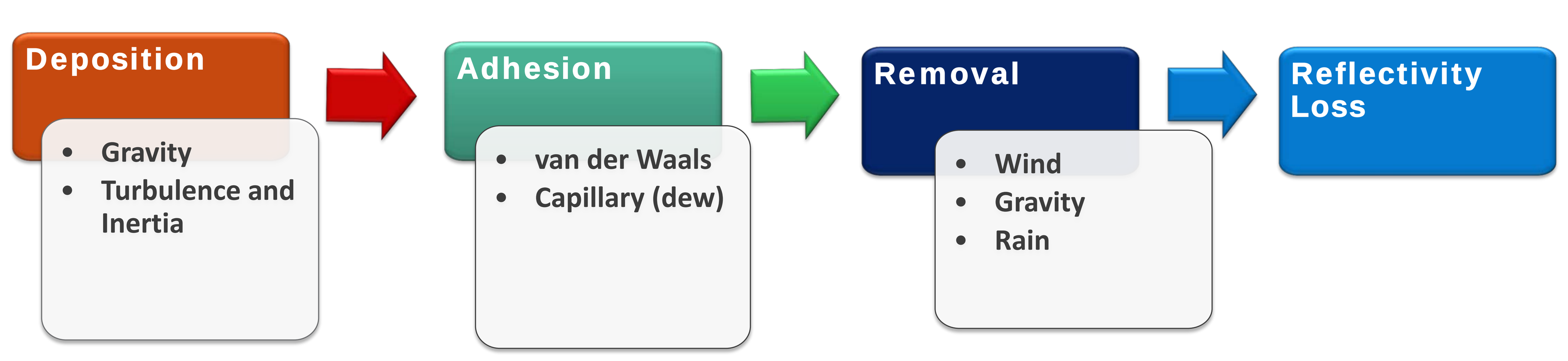

Figure 2: Modelling steps for mirror dust soiling

Optimisation strategy

- Cleaning optimisation as a time-varying balance between loss of productivity and direct cleaning costs;
- Best schedule identification regarding priority and clustering for cleaning activities across solar field sectors;
- Time-varying soiling rates based on soiling model and camera-based reflectivity assessment.

Summary and future directions

- Complete development of soiling model for solar field sectors and further refinement with experimental data;
- Experimental activity with calibration cameras and preliminary validation for further development of condition monitoring methodology;
- Further optimization of mirror cleaning schedule and practice;
- Ongoing and future engagement of CSP industry partner.

QUT

AUTHOR CONTACT
Ruizi (Norman) Wang
e r9.wang@qut.edu.au
w www.astri.org.au

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