Scopus

Documents

Chowdhury, I.J.[a] , Yusoff, S.H.[a] , Gunawan, T.S.[a] , Zabidi, S.A.[a] , Hanifah, M.S.B.A.[a] , Sapihie, S.N.M.[b] , Pranggono, B.[c]

Analysis of Model Predictive Control-Based Energy Management System Performance to Enhance Energy Transmission

(2024) *Energies*, 17 (11), art. no. 2595, .

DOI: 10.3390/en17112595

[a] Department of Electrical and Computer Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia

[b] Petronas Sdn Bhd, Bandar Baru Bangi, Kajang, 43000, Malaysia

[c] School of Computing and Information Science, Anglia Ruskin University, Cambridge, CB1 1PT, United Kingdom

Abstract

A supervisory control system using Model Predictive Control (MPC) has been designed to evaluate the efficiency of wind and solar power and is consistent with the cost function in the supervisory MPC optimization problem. A two-layer Economic Model Predictive Control (EMPC) framework has been developed and has improved results such as cost reductions compared to recent advanced methods. A speed Generalized Predictive Control (GPC) scheme intended for wind energy conversion systems was developed last year, with simulation results indicating superior performance over previous models. A Hierarchical Distributed Model Predictive Control (HDMPC) can work under different weather conditions with improved economic performance and keep a good balance between power delivery and load demand. An energy management system (EMS), built on the basis of MPC, can be quite lucrative for the sphere in the present climate scenario, with the selection and testing of suitable algorithms, controlled processes, cost functions, and a set of constraints as well as with proper optimizations carried out. Previous research indicates that an MPC-based EMS has the potential to be a good solution to manage energy well and also introduced it to the world experimentally. The key intention of this research study is to explore the existing advances that have been introduced and to analyze their performance in terms of cost function, different sets of constraints, variant conversion processes, and scalability to achieve more optimized operation of MPC-based EMS. © 2024 by the authors.

Author Keywords

energy management system; energy storage system; Model Predictive Control; renewable energy sources

Index Keywords

Cost functions, Cost reduction, Electric power transmission, Energy conversion, Energy efficiency, Energy management, Energy management systems, Predictive control systems, Solar energy, Well testing, Wind power; Cost-function, Energy storage system, Energy transmission, Model-predictive control, Performance, Renewable energy source, Storage systems, Supervisory control systems, Systems performance, Wind and solar power; Model predictive control

References

- Available online
- Available online
- Available online
- Available online
- Available online

- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Available online
- Katkar, R.A., Bhosale, N.V., Bhange, D.S., Phutane, P.S.
  Supervisory predictive control of standalone wind/solar energy generation systems
  (2015) *Int. J. Innov. Eng. Res. Technol*, 2, pp. 1-5.
- Qi, W., Liu, J., Chen, X., Christofides, P.D.
  Supervisory predictive control of standalone wind/solar energy generation systems
  (2011) *IEEE Trans. Control. Syst. Technol*, 19, pp. 199-207.
- Qi, W., Liu, J., Christofides, P.D.
  Distributed Supervisory Predictive Control of Distributed Wind and Solar Energy Systems
  (2013) *IEEE Trans. Control. Syst. Technol*, 21, pp. 504-512.
- Hure, N.
  Model Predictive Control of a Wind Turbine
  (2012) *Master's Thesis*,
  University of Zagreb, Zagreb, Croatia

- Lio, W.H., Rossiter, J.A., Jones, B.L.
  A Review on Applications of Model Predictive Control to Wind Turbines
  Proceedings of the 10th International Conference on Control (UKACC), pp. 8-11.
  Loughborough, UK, 9–11 July 2014

- Shiravani, F., Cortajarena, J.A., Alkorta, P., Barambones, O.
  Generalized Predictive Control Scheme for a Wind Turbine System
  (2022) *Sustainability*, 14.

- Kong, X., Liu, X., Ma, L., Lee, K.Y.
  Hierarchical Distributed Model Predictive Control of Standalone Wind/Solar/Battery Power System
  (2019) *IEEE Trans. Syst. Man Cybern. Syst*, 49, pp. 2168-2216.

- Clarke, W.C.
  Hierarchical Economic Model Predictive Control of an Isolated Microgrid
  (2020) *Doctoral Thesis*,
  The University of Melbourne, Victoria, Australia

- Gangatharan, S., Rengasamy, M., Elavarasan, R.M., Das, E., Hossain, N.E., Sundaram, V.M.
  A Novel Battery Supported Energy Management System for the Effective Handling of Feeble Power in Hybrid Microgrid Environment
  (2020) *IEEE Access*, 8, pp. 217391-217415.

- Eini, R., Abdelwahed, S.
  Learning-based Model Predictive Control for Smart Building Thermal Management
  Proceedings of the IEEE 16th International Conference on Smart Cities: Improving Quality of Life Using ICT & IoT and AI (HONET-ICT),
  Charlotte, NC, USA, 6–9 October, 2019

- Chen, Z., Zhang, Y., Zhang, T.
  An Intelligent Control Approach to Home Energy Management under Forecast Uncertainties
  Proceedings of the IEEE 5th International Conference on Power Engineering, Energy and Electrical Drives (POWERENG), pp. 657-662.
  Riga, Latvia, 11–13 May 2015

- Sai, W., Sawant, S., Reinhardt, D., Rastegarpour, S., Gros, S.
  Learning-Based Model Predictive Control Strategy for Home Energy Management Systems
  (2023) *IEEE Access*, 11, pp. 145264-145280.

- Novak, H., Lešic, V., Vašak, M.
  Hierarchical Model Predictive Control for Coordinated Electric Railway Traction System Energy Management
  (2019) *IEEE Trans. Intell. Transp. Syst*, 20, pp. 2715-2727.

- Tumeran, N.L., Yusoff, S.H., Gunawan, T.S., Hanifah, M.S.A., Zabidi, S.A., Pranggono, B., Yunus, M.S.F.M., Halbouni, A.H.
  Model Predictive Control Based Energy Management System Literature Assessment for RES Integration
  (2023) *Energies*, 16.

- Abidin, S.A.Z., Yusoff, S.H., Mansor, H., Sapihie, S.N.M., Fahmi, M.A.M.M.
Scheduling of the Battery for Peak Shaving Using Model Predictive Control (MPC)
Proceedings of the IEEE 9th International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA),
Kuala Lumpur, Malaysia, 17–18 October 2023

- Zhai, M., Liu, Y., Zhang, T., Zhang, Y.
Robust Model Predictive Control for Energy Management of Isolated Microgrids
Proceedings of the IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), pp. 2049-2053.
Singapore, 10–13 December 2017

- Novickij, I., Joos, G.
Model Predictive Control Based Approach for Microgrid Energy Management
Proceedings of the IEEE Canadian Conference of Electrical and Computer Engineering (CCECE),
Edmonton, AB, Canada, 5–8 May 2019

- Boralessa, M.A.K.S., Hovden, S., Wickramarathna, A.V.U.A., Hemapala, K.T.M.U.
Effect of Renewable Energy Forecasting Error on Model Predictive Control Based Microgrid Energy Management System
Proceedings of the IEEE IAS Global Conference on Emerging Technologies (GlobConET), pp. 959-962.
Arad, Romania, 20–22 May 2022

- Bordons, C., Teno, G., Quintero, J.J.M., Ridao, M.A.
Effect of the Integration of Disturbances Prediction in Energy Management Systems for Microgrids
Proceedings of the International Conference on Smart Energy Systems and Technologies (SEST),
Porto, Portugal, 9–11 September 2019

- Yan, H., Zhuo, F., Lv, N., Yi, H., Wang, Z., Liu, C.
Model Predictive Control Based Energy Management of a Household Microgrid
Proceedings of the IEEE 10th International Symposium on Power Electronics for Distributed Generation Systems (PEDG), pp. 365-369.
Xi'an, China, 3–6 June 2019

- Freire, V.A., Arruda, L.V.R.D., Bordons, C., Quintero, J.J.M.
Optimal Demand Response Management of a Residential Microgrid Using Model Predictive Control
(2020) *IEEE Access*, 8, pp. 228264-228276.

- Freire, V.A., Quintero, J.J.M., Bordons, C., Cabeza, A.Z., Arruda, L.
Energy Management System for Microgrid Considering Operational Faults in Power Supply
Proceedings of the International Conference on Smart Energy Systems and Technologies (SEST),
Istanbul, Turkey, 7–9 September 2020

- Rosli, A.N., Yusoff, S.H., Mansor, H., Sapihie, S.N.M., Fahmi, M.A.M.M.
Using Model Predictive Control in Renewable Energy Sources
Proceedings of the IEEE 9th International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA),

Kuala Lumpur, Malaysia, 17–18 October 2023

- Zhang, T., Xiang, Y., Yang, J., Zang, T.
Energy Management Optimization Strategy of User Side in Smart Grid Based on Model Predictive Control
Proceedings of the IEEE Innovative Smart Grid Technologies—Asia (ISGT Asia), pp. 1479-1484.
Chengdu, China, 21–24 May 2019

- Alrumayh, O., Bhattacharya, K.
Model Predictive Control Based Home Energy Management System in Smart Grid
Proceedings of the IEEE Electrical Power and Energy Conference (EPEC), pp. 152-157.
London, ON, Canada, 26–28 October 2015

- Bolotnyi, N.P., Karmazin, O.O., Ostapchuk, O.V.
Analysis of Prospects for Electrical Energy Storage Application in Power Supply Systems of Ukraine
Proceedings of the IEEE 8th International Conference on Energy Smart Systems (ESS),
Kyiv, Ukraine, 12–14 October 2022

- Kryvonos, K., Pyrogov, D., Shevchuk, Y.
Modern Aspects of Alternative Energy in Ukraine
Proceedings of the IEEE International Conference on Modern Electrical and Energy Systems (MEES),
Kremenchuk, Ukraine, 23–25 September 2019

- Available online

- Available online

- Pryakhina, K., Usanova, O., Skrebcova, K.
State and Prospects for the Development of Energy Management Systems in Ukraine and the EU
Proceedings of the IEEE 5th International Conference on Modern Electrical and Energy System (MEES),
Kremenchuk, Ukraine, 27–30 September 2023

- He, K., Yu, L., Lai, K.K.
Crude oil price analysis and forecasting using wavelet decomposed ensemble model
(2012) *Energy*, 46, pp. 564-574.

- Zhang, Q., Hu, Y., Jiao, J., Wang, S.
The impact of Russia–Ukraine war on crude oil prices: An EMC framework
(2024) *Nat. Humanit. Soc. Sci. Commun*, 11, p. 8.

- Vaidya, S., Ambad, P., Bhosle, S.
Industry 4.0—A Glimpse
(2018) *Procedia Manuf*, 20, pp. 233-238.

- Sakun, L., Viedienina, Y., Khomenko, M., Rieznik, D., Kovalenko, M.
Introduction of Energy Storage Facilities as an Element of Industry 4.0 of the Energy Sector of Ukraine

Proceedings of the IEEE 4th International Conference on Modern Electrical and Energy System (MEES),
Kremenchuk, Ukraine, 20–23 October 2022

Correspondence Address
Yusoff S.H.; Department of Electrical and Computer Engineering, Malaysia; email: sitiyusoff@iium.edu.my
Gunawan T.S.; Department of Electrical and Computer Engineering, Malaysia; email: tsgunawan@iium.edu.my
Pranggono B.; School of Computing and Information Science, United Kingdom; email: bernardi.pranggono@aru.ac.uk

Publisher: Multidisciplinary Digital Publishing Institute (MDPI)

ISSN: 19961073
Language of Original Document: English
Abbreviated Source Title: Energies
2-s2.0-85195784814
Document Type: Review
Publication Stage: Final
Source: Scopus