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EVIEW OF CONTROL AND MANAGEMENT OF RAILWAY SYSTEM CONNECTED TO MICROGRID STATIONS

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Abstract - The recent railway system is a huge micro grid assembling multiplex structure with distributed active loads, sources and storage devices. The active load represents the train. The sources are a micro grid based on renewable energies. The big problem of the most of electrical train is that they can't recover energy recovery during regenerative breaking phases. Another problem of the electrical train is the long charging time from the stations. This paper suggests a techno-economic process for the energy storage by using SCs in the train, with the aim to reduce the energy consumptions. The proposed design of railway station use PV and wind sources, and batteries for energy storage system (ESS). For the train, SCs are implemented to the ESS
Where they are alimented breaking phases and from stations by a pantograph installed in an air power line in each stop. SCs are distinguished by high characteristics power and a wide number of charge/discharge cycles, they provide low particular energy and a fast charging time. An energy management approach is suggested to control the DC bus by voltage and the buck-boost converter by current. The Sizing of PI controller used for the stabilization of the DC bus of train and station is given.

Index Terms: Energy management, railway system control, energy storage system, super capacitors.

I. INTRODUCTION

The consumption of energy is increasing constantly in the word. In the meantime, limited availability of conventional sources has encouraged a better use of available energy and to develop alternatives for generating power. Among others, the Braking Energy Recovery System (BERS) power is an important energy efficiency issue. During the last decade, considerable progress has been made of electric traction due to evolving of Power electronics. These innovations have made it possible a large range of regeneration of the train braking energy, and offer a very attractive way to reduce the energy consumption of urban railway stations. However, the electricity production from these sources is strongly variable with very high transients.

In the last few decades, generally there are growing in energy using and pollution. The growing number of citizen traveling between cities has implied the continuous development of mass transit systems as buses, taxies, and trains. However, the use of railway transportation systems other conventional means of transport is widely recognized due to the Carrying capacity of a large number of people. The development of rail transportation allows people to travel quickly. Thereby, growing environmental like climate change and CO_2 emissions change issues dictate the requisite for ameliorate the performance energy regulation of railway systems. For these raisons, the electrified railway traffic has become a principal development management of current public transportation networks.

The production of clean energy from renewable sources have become the hot topics of social development. However, railway system integrates different renewable energy sources, like photovoltaic (PV) and wind turbines. To ensure a continuous power supply and to respond to the charge power of train from station to the train, an energy storage system (ESS) is necessary. In order to manage the overload variation in railway power supply structure in the time of heights commuting hours, a wide number of ESS technologies are implemented in the railway system as a constructive means to improve load needs. The on-board storage augmented the weight and space of a vehicle that encourage the underground storage. SCs represent an appear energy storage devices characterized with a high power density, a long span life and a wide temperature range, has become the best appropriate storage element match with the functioning characteristics of train system. By comparing SCs to different energy storage devices like batteries and flywheels, SCs present fast charging and discharging time because of the high power density, and important potential of energy recovery. In general, ESS with SC is considered like energy buffer accelerating mode of train and recycles the excess of power during the braking mode, realizing a good balance of charge and discharge. SCs are considered a best solution in systems which characterized with different fluctuations. SCs are also used in interruptible power systems to stabilize the power and bus voltage.

The energy storage in railway system presents a challenge for researches. Energy management system (EMS) is currently a big challenge in large-scale complex energy distribution networks like railway structure. Most of EMS researches in railway structure interest on ameliorating the railway system technologically. EMS on the system level with an integrated strategy into the railway structure often is ignore. The optimal control theory for railway vehicle is presented in many articles. EMS is implemented to control and connect different devices in railway system, energy storage devices, sources and train.

II. LITERATURE SURVEY

In order to increase the utilization rate of regenerative braking energy (RBE), reduce the operation cost and improve the power quality of traction power supply system (TPSS) in high-speed railway, a super capacitor (SC) based energy storage system (SCESS) integrated railway static power conditioner (RPC) is presented in this paper. In this scheme, the SC is connected onto the dc-link of the RPC via a bidirectional dc-dc converter. A hierarchical control strategy, with an energy management layer and a converter control layer, is presented. Four operation modes and transition conditions of the SCESS-RPC are elaborated in detail in the energy management layer. To obtain rapid and stable control performance, in the converter control layer, a passivity-based control (PBC) based nonlinear controller is designed for the RPC, and an optimal control strategy based on linear quadratic regulator with integral action (LQRI) is adopted for the bidirectional dc-dc converter [1].

an energy management control strategy of wayside Li-ion capacitor (LiC) based energy storage for light railway vehicles (LRV). The installation of wayside supercapacitor (SC) storage devices, as widely recognized, allows the recovery of the braking energy for increasing the system efficiency as well as a better pantograph voltage profile. A new type of SC, LiC, interfaced with dc-interleaved converter has been presented. This technology has an energy density comparable to batteries and power density much higher than the batteries. The authors propose a control strategy based on the maximum kinetic energy recovery throughout braking operations of the running vehicles. The stored energy comes back to the vehicles during the accelerations. The strategy stays on the knowledge of the state of charge of LiC device and the actual vehicle speeds. In particular, the control algorithm evaluates, in real time, the actual value of LiC voltage and current references on the basis of the vehicles inertial forces and acceleration estimations, taking into account the power losses of the system. Experimental tests made on electromechanical simulator, equipped with a 136-V, 30.5-F LiC module, fully confirm the validity of the suggested control [2].

Growing concerns about environmental issues dictate the necessity for improving the energy efficiency and total performance of metro railway systems. Proper management of the regenerative energy is a key element in this direction and several strategies, like timetable optimization, use of reversible substations and installation of storage devices, have been proposed. This paper focuses on optimal control of reversible substations and wayside storage devices for energy savings and voltage stabilization [3].

The recent application of energy storage devices in electrified railways, especially batteries, flywheels, electric double layer capacitors and hybrid energy storage devices. The storage and reuse of regenerative braking energy is managed by energy storage devices depending on the purpose of each system. The advantages resulting from the use of energy storage devices are presented by observing the results of both verification tests and practical applications in passenger services. Several real installations of energy storage for railways are shown and compared by using the Rag one plot. The effect of the use of energy storage devices on electrified railways of the future is discussed. Finally, a discussion on the recent applications and developments of energy storage devices is presented in this study. The effective use of energy storage devices is characterized on the basis of the specific applications and current trends of the research undertaken by public bodies and manufacturers [4].

Electric trains typically travel across the railway networks in an inter-provincial, inter-city and intra-city manner. The electric train generally serves as a load/source in tractive/ brake mode, through which power networks and railway networks are closely coupled and mutually influenced. Based on the operational mode of rail trains and the characteristics of their load power, this paper proposes a coordinated optimal decision-making method of demand response for controllable load of rail trains and energy storage systems. First, a coordinated approach of dynamically adjusting the load of the controllable rail train in considering the driving comfort and energy storage battery is designed. Secondly, under the time conditions that satisfy the train's operational diagram, the functional relationship between the train speed and the load power is presented [5].

A practical pricing scheme is proposed to encourage different consumers to participate in demand response by providing them with a list of price plans. Firstly, a classification algorithm is employed to divide consumers into different categories based on their individual information, such as marginal cost, upper limit of load adjustment, and elasticity coefficient. Afterwards, from the perspective of load service entity (LSE), a pricing model is formulated as a nonlinear programming problem, aiming to minimize the overall operation cost. Moreover, the Bayesian discrete probability distribution function (PDF) is adopted to tackle the uncertainty of consumers' choosing behavior [6].

Standalone operation of a photovoltaic generating system under fluctuating solar irradiance and variable load conditions necessitates a storage energy unit. The energy storage system by using battery super capacitor combination is an interesting solution. However, batteries have a high energy storage ratio but are limited in the power. In the other hand, super capacitors can provide high levels of power while they have a much lower energy storage ratio. Moreover, the SC can act as a buffer against large magnitudes and rapid fluctuations in power. In super capacitors are used to reduce stresses on batteries and improve their life cycle. In this context, the performance of the RMS current gain in battery, the gain in energy losses, the total energy efficiency and the elimination rate of surge load power are explored, in different operating state conditions [7].

The photovoltaic energy enables a variable power generation that is influenced by uncertain fluctuations caused by the weather change (temperature and solar irradiation). Hence, the requirement for an energy storage system is essential to address this major issue. The use of only one energy storage element, such as battery, is insufficient. For this purpose, super capacitors (SCs) can also be introduced as a power storage device. The combination of batteries and SCs is a viable solution that requires an appropriate energy management strategy. The previous studies are focused on the designing and modeling. In this study, a photovoltaic system with a hybrid energy storage system (HESS) was developed by using batteries and super capacitors [8].

With the increasing penetration of renewable energy, it becomes challenging to smoothen highly fluctuant and intermittent power output only through the conventional thermal units. In this paper, by exploiting the dynamic regulating ability of hydropower and energy intensive controllable load to reduce the power output uncertainties, an optimal wind-solar capacity allocation method is proposed. The power regulation characteristics of hydropower stations based on hydraulic head and energy intensive controllable load based on complex production process are modelled. A bi-level (including planning and operation layers) optimization model for wind-solar capacity allocation is proposed, which is subject to the system dynamic regulation constraints. In the planning layer, a cost function model is constructed to minimize the investment and operational cost of the hybrid system with wind-solar, hydropower and energy intensive load. In the operation layer, a coordinated optimal dispatching scheme is proposed to minimize the dynamic source-load tracking coefficient [8].

The power conversion system architectures to interface a stationary electrochemical storage installation with the network. Theoretical justifications about the conversion system layouts and control, used for actual Italian installations, are given. This paper aims at giving the power energy society an overview of actual possibilities of static conversion of d.c. battery sources [9].

III. CONCLUSION

The proposes techno-economic method for the energy storage by using SCs in the train was presented in this paper. The studied system is devised on two parts: station and train. The design of railway station is presented by using PV and wind as principal sources, and batteries for ESS. The train is composed by engine and SCs. SCs are implemented to the ESS of the train, where they are alimented from the breaking phases and the stations by a pantograph installed in an air power line in each stop. SCs are used for their fast charge and discharge. An EMS is given in order to stabilize the DC bus. The calculation of parameters of the buck-boost converter are given. The Sizing of the integral and proportional gain controller used for the stabilization of the DC bus of train and station is given. A simulation test was proposed with one station and two trains. The trains recharge from the station in different times.

REFERENCES

[1] G. Cui, L. Luo, C. Liang, S. Hu, Y. Li, Y. Cao, B. Xie, J. Xu, Z. Zhang, Y. Liu, and T. Wang, ``Supercapacitor integrated railway static power conditioner for regenerative braking energy recycling and power quality improvement of high-speed railway system," IEEE Trans. Transport. Electric., vol. 5, no. 3, pp. 702 714, Sep. 2019.

[2] F. Ciccarelli, A. Del Pizzo, and D. Iannuzzi, ``Improvement of energy ef ciency in light railway vehicles based on power management control of

wayside lithium-ion capacitor storage," IEEE Trans. Power Electron., vol. 29, no. 1, pp. 275 286, Jan. 2014.

[3] V. A. Kleftakis and N. D. Hatziargyriou, ``Optimal control of reversible substations and wayside storage devices for voltage stabilization and energy savings in metro railway networks," IEEE Trans. Transport. Electri c., vol. 5, no. 2, pp. 515 523, Jun. 2019.

[4] T. Ratniyomchai, S. Hillmansen, and P. Tricoli, ``Recent developments and applications of energy storage devices in electri ed railways," IET Elect. Syst. Transp., vol. 4, no. 1, pp. 9 20, Mar. 2014.

[5] H. Yang, W. Shen, Q. Yu, J. Liu, Y. Jiang, E. Ackom, and Z. Y. Dong, ``Coordinated demand response of rail transit load and energy storage system considering driving comfort," CSEE J. Power Energy Syst., vol. 6, no. 4, pp: 749-759, Dec. 2020.

[6] H. Yang, J. Zhang, J. Qiu, S. Zhang, M. Lai, and Z. Y. Dong, ``A practical pricing approach to smart grid demand response based on load classi cation," IEEE Trans. Smart Grid, vol. 9, no. 1, pp. 179 190, Jan. 2018.

[7] Z. Cabrane, M. Ouassaid, and M. Maarou , ``Analysis and evaluation of battery-supercapacitor hybrid energy storage system for photovoltaic installation," Int. J. Hydrogen Energy, vol. 41, no. 45, pp. 20897 20907, Dec. 2016.

[8] Z. Cabrane, J. Kim, K. Yoo, and M. Ouassaid, ``HESS-based photovoltaic/ batteries/supercapacitors: Energy management strategy andDCbus voltage stabilization," Sol. Energy, vol. 216, pp. 551 563, Mar. 2021.

[9] Q. Z. Li, X. J. Wang, X. H. Huang, Y. Zhao, Y. W. Liu, and S. F. Zhao,``Research on ywheel energy storage technology for electri ed railway," Proc. CSEE, vol. 39, no. 7, pp. 2025 2033, Apr. 2019.

[10] H. Yang, Q. Yu, J. Liu, Y. Jia, G. Yang, E. Ackom, and Z. Y. Dong, ``Optimal wind-solar capacity allocation with coordination of dynamic regulation of hydropower and energy intensive controllable load," IEEE Access, vol. 8, pp. 110129 110139, 2020.

[11] M. Andriollo, R. Benato, M. Bressan, S. Sessa, F. Palone, and R. Polito, ``Review of power conversion and conditioning systems for stationary electrochemical storage," Energies, vol. 8, no. 2, pp. 960 975, Jan. 2015.