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Manual on Energy Management for Public Transport Companies

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Executive Summary

This deliverable refers to a manual on energy management for public transport (PT) companies realised based on the experience of the EfficienCE project partner Leipzig Transport Company.

1. Introduction

This manual has been prepared on the basis of the general scope of action specified in EN ISO 50001:2018.

As energy costs are one of the highest costs in public transport (PT), public transport companies have to dive in, plan and find solutions related to reducing energy consumption. Earlier projects of LVB dealt with the main energy sources, i.e. electrical energy and diesel fuel, and went into detail with the most important resources and control reserves, which emerge through the efficient operation of public transport vehicles. Now external factors and legal requirements have made it necessary to look into processes leading to the efficient use of energy.

This manual describes examples from LVB practical operations. It explains the requirements in the valid standards in consideration of the operation and deals with their practical realisation in public transport companies. This manual is putting an emphasis on practical experience and is intended to become a procedural guideline for other public transport companies.



2. Reasons for Setting up an Energy Management System

1. Legal Reason

The German Act on Energy Services and other Energy Efficiency Measures was published in April 2015. With this act, Germany converted Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency into national law, which determines that enterprises that are not classified as small or medium-sized enterprises (SMEs), i.e. enterprises with more than 250 employees and annual turnovers of more than 50 million euros, as well as municipal companies shall be subjected to energy audits pursuant to EN 16247 as from 05.12.2015. This Directive only allowed the postponement of the obligation of these companies to bindingly introduce an energy management system (EnMS) pursuant to EN ISO 50001 to the end of 2016.

In fact, Germany did not have enough qualified auditors by the end of 2015. Consequently, the audit duty or the duty to introduce certification pursuant to EN ISO 50001 was not implemented in time, which was regarded as a regulatory offence, which could in turn be sanctioned. However, Leipziger Verkehrsbetriebe (LVB) GmbH severely intended to efficiently control the energy resources and had already dealt intensively with the main energy sources, for which reason the company decided to introduce an EnMS pursuant to EN ISO 50001.

2. Entrepreneurial Reason

Energy costs are the biggest expense item for public transport companies after staff costs. Therefore, special attention should be paid to these costs. In principle, each employee is integrated into the EnMS and has the right and obligation to avoid unnecessary energy consumption and thus unnecessary costs. The energy consumption and energy costs are monitored by way of regular energetic assessments and analyses of defined energy performance indicators (EnPI).

It is only possible to integrate all employees into the EnMS if there are suitable possibilities for assessing and evaluating energy consumption. Consequently, the LVB informs its employees about energy management via its internal newsletter and its intranet at regular intervals. A central e-mail address has also been set up, via which the employees can contact the energy management team if they have tips, questions or suggestions for improvement.

3. Social Reason

Public transport contributes essentially to the protection of the environment and the climate. Thus, it contributes much to reducing greenhouse gases by handling fossil and non-regenerative energy sources mindfully. Public transport companies aim to minimise their energy consumption and emission in all fields, i.e. in the operation of the vehicles, in the workshops and in the technical and administrative fields.

3. Procedures

Introduction of the basic procedure in the company. Comparison of the likely effects in relation to the personnel and financial resources and in consideration of the necessary administrative services

To begin with, the pros and cons of introducing an energy audit pursuant to EN 16247 or an EnMS pursuant to EN ISO 50001 should be compared. Which advantages do the systems have and which possibilities arise with continuous energy management?



If an energy audit pursuant to EN 16247 is introduced, there are often very long intervals between the collection, assessment and analysis of the energy consumption data. Often, they are only collected, assessed and analysed shortly before the audit.

Regular and continual dealing with energy consumption is a good reason for certifying an EnMS pursuant to EN ISO 50001. In this connection, it is important to set energy goals and embody them in the planning. Moreover, it is important to document the efficiency measures to be able to prove them. Thus, at least an annual internal audit, a management review and a review/recertification audit are needed for the certification. The expenditure of time and personnel resources depends on the size of the company and the energy consumption.

The issued certificate is a good advertisement for a public transport company.

4. The decision-making process in favour of a system pursuant to EN ISO 50001

Having compared the expenditure and effort and the available services necessary for the audits and in consideration of the energy management services that had already been performed, the LVB decided that the best solution to ensure sustainable economic use of energy was the certification of an EnMS pursuant to EN ISO 50001.

It was also taken into consideration that the sustainable effect achieved with continual energy management does not only reduce energy costs, but also other costs.

To be in conformity with the law, the following conditions have to be fulfilled:

- an energy team has to be established and an energy management representative (EMR) might have to be appointed;
- documentation on energy management has to be prepared; if relevant, in the form of a manual;
- data concerning the total energy consumption in one year have to be collected and assessed for all energy sources (for public transport: traction current, generally electrical energy, diesel fuel, heating oil, district heating and gas);
- the energy policy, the energy goals and the EnPIs have to be specified.

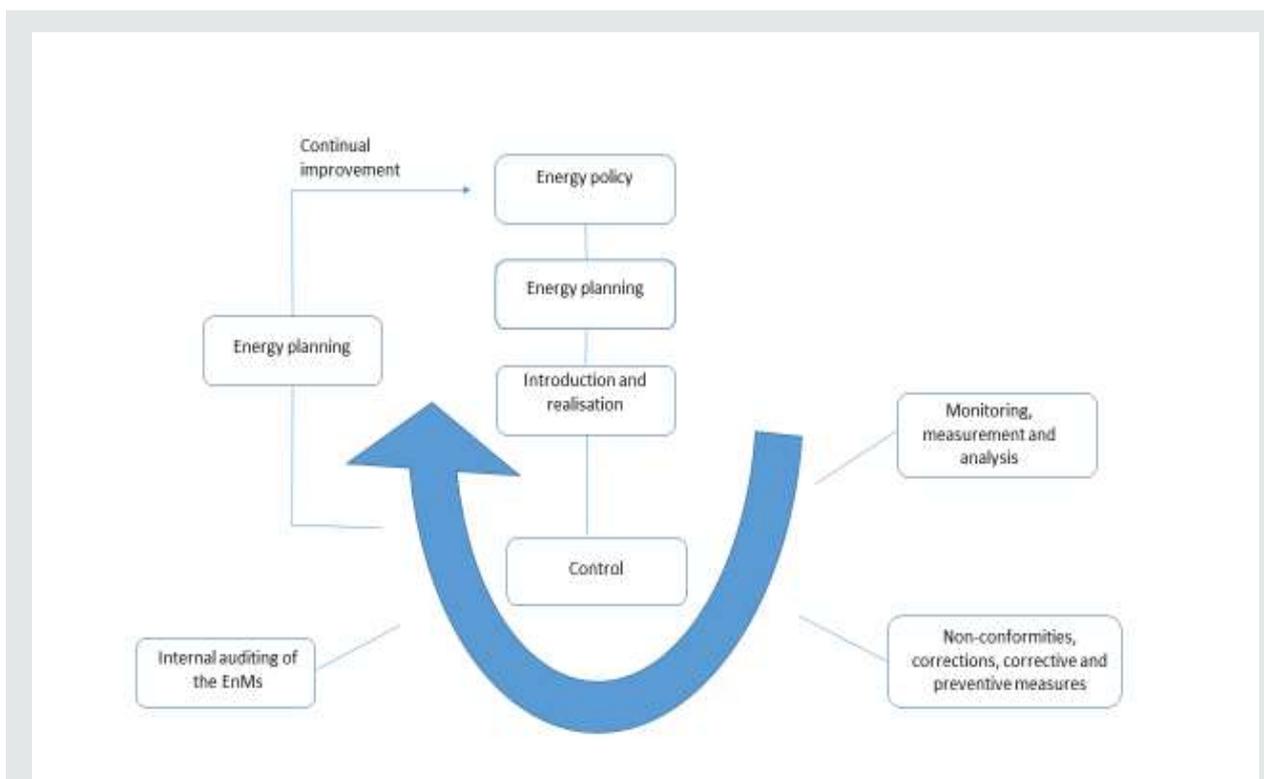
The energy consumption, i.e. mainly the significant energy use (SEU), is checked in the form of monthly monitoring.

In this connection, it is important to name the persons responsible for reporting and management in the respective fields.

5. The basic procedures in accordance with the normative rules

5.1. Context analysis

A company has to fulfil several conditions for the certification pursuant to EN ISO 50001, which ensures active integration of the EnMS into the operational processes. The EnMS model according to EN ISO 50001 is shown in the following figure:



Scope

The EnMS includes all fields of the LVB (and its subsidiaries) as well as all sites, infrastructure, vehicles and service processes. It does not include energy supply systems for which third parties are mainly responsible.

In the case of multifunctional companies, all sections involved in the public transport process are to be integrated into the EnMS because:

- technological processes and energetic process workflows cannot be split into single organisational and structural fields;
- monitoring (evaluation and assessment) is only meaningful for the complete system, e.g. because:
 - real estate and the infrastructure are used by several parties;
 - the rail network is used by several parties;
 - drivers are employed by several subsidiaries;
 - service staff are employed by several subsidiaries;

whereas the end customers consider the services as one overall service, i.e. the transport of passengers.

The City of Leipzig and the surrounding counties have entrusted the LVB with the performance of public transport in Leipzig and its surroundings, which is possible because the LVB has been granted a licence to perform public transport by the City of Leipzig and the surrounding counties. The LVB owns the rail network and the vehicles that it operates. As the LVB is the parent company and thus the party with the overall responsibility, the LVB also managed the installation of the EnMS. All subsidiaries of the LVB are integrated into the certified EnMS. Concretely, the following companies participate in the EnMS:



- Leipziger Verkehrsbetriebe (LVB) GmbH
- IFTEC GmbH & Co. KG
- LAB Leipziger Aus- und Weiterbildungsbetriebe GmbH
- Leipziger Servicebetriebe (LSB) GmbH
- Leipziger Stadtverkehrsbetriebe (LSVB) GmbH
- LeoBus GmbH
- LTB Leipziger Transport und Logistik Betriebe GmbH

The division managers of the LVB manage the subsidiaries.

Energy types

The following types of energy can be monitored as part of the audit:

Electric energy

- Electric energy for the operation of tramcars and electric buses
- Electricity for the real estate and the facilities

Fuel

- Diesel for the bus line service
- Diesel for other vehicles and construction machines
- Petrol for other vehicles

Heat energy

- Heating oil
- Gas
- District heating and local heat

Technical gases

Requirements of interested parties

The following parties are parties interested in a public transport company:

- *customers*: They expect a reliable and relatively comfortable transport offer at reasonable prices;
- *the customers' representation of interests*: It passes on the customers' suggestions, wishes and criticism to the public transport company;
- *residents of the city and its surroundings*: They are interested in the transport offer and do not want to be bothered more than absolutely necessary with building sites, transport noise, emissions or occupation of buildings and sites;
- *shareholders of the company*: They are interested in economic handling of the company and require that public transport contributes to the protection of the environment and the climate;
- *supervisory board*: The company shall meet its obligation to report to the supervisory board, above all in respect of financial subjects;



- *network operator*: Plannable use of the available infrastructure is of particular importance;
- *public authorities*: They fulfil the duty of supervision in respect of the energy law and the tax law.

5.2. Management and commitment

The contractor and his top management are responsible for the process in its entirety according to the requirements in EN ISO 50001. The management of the company can commit all employees who have considerable influence on the use and consumption of energy to act in accordance with these requirements. It is the objective of an EnMS to prove continual improvement of energy-related performance. The suitability and efficiency of the EnMS are examined at regular intervals by assessing the results, performing internal audits and reporting about the use and consumption of the energy by the company.

5.3. Energy policy

It is the objective of a public transport company to offer an attractive mobility alternative to private transport and thus to contribute to society's environment-friendly overall transport concept. Therefore, the LVB commits itself to continually improve its energy-related performance and particularly to minimise its specific use of energy and the emitted greenhouse gases within the scope of its economic and technical possibilities. For this purpose, the major consumers of energy are to be specified and assessed and the defined energy goals and energy programmes are to be fulfilled.

5.4. Tasks, responsibilities and powers

Energy management is a comprehensive management task. The managers are responsible for the performance of tasks in relation to energy management. The reporting chain appears from the organisation chart of the company. The duties and powers for certain tasks have to be determined to be able to meet the responsibility. The managers can always delegate the performance of tasks and some responsibilities to the employees, but they can never delegate the overall responsibility.

According to the organisation chart, the managers have to adequately inform the employees about the requirements resulting from the certification and they have to ensure that these requirements are considered in the performance of the tasks.

The company can appoint an energy management representative (EMR), who takes care of the energy management. This EMR is responsible for the introduction and continual improvement of the EnMS. The EMR bundles the single responsibilities for which the energy team is responsible in the various production and action fields of the company. The tasks, rights and duties are to be documented in the appointment letter.

Energy team

An energy team is appointed for the realisation of the energy policy goals and the regular recording, analysis and control of data within the manifold processes and structures of the company group. The members of the energy team organise and manage the realisation of the energy goals in their respective sphere of responsibility. They act as multipliers of the energy



management by influencing the action of the employees in their respective process area and initiate technical or organisational efficiency measures. Moreover, the energy team discusses possible solutions for more efficient energy processes at regular intervals.



5.5. Organisation within the public transport company: the case of LVB

To be able to operate an EnMS in accordance with the requirement of EN ISO 50001 (in its valid issue), its efficiency should be continuously documented, fulfilled, adapted and improved.

The energy policy and its energy-related overall goals and principles of action are specified for the company within the scope of the entrepreneurial duty of care. The legal requirements are to be fulfilled and all organisational, commercial and technical activities that influence energy consumption are to be planned, controlled and monitored.

To realise permanent control of the responsibility, it should be laid down in the process landscape of the company that deals with the energetic resources. In this way, the regular data recording and data analysis as well as the continuous dealing with energy consumption become an integral part of the work of the energy team and the work in the line structure.

5.6. Planning

Planning of energy consumption on the basis of the energy policy and the results of the energetic assessment (see 5.9 Energetic assessment) and the general corporate planning

The strategic and operative energy goals are considered on the basis of management assessments and further inputs.

The energy-related performance shall be examined and assessed at regular intervals and continuously updated to make the information needed to reach the goals transparent and to report about the energetic performance at regular intervals. There shall be so many personnel and financial resources that the energy goal can be reached. The purchase of energy-efficient



products and services that influence energy consumption significantly is to be supported. This aspect is of great importance by the purchase of new vehicles.

5.7. Opportunities and risks

Determination of the optimisation potentials for reduction of energy consumption and assessment of the effect on the process

Reference to legal requirements

Making use of financial reliefs

Deadlines for filing applications and for realisation of the project, including formalities

Such a project is the ideal opportunity to make out energy potentials to reduce energy consumption to sustainably pursue both corporate and social interests. Moreover, the certification strengthens the positive image of the company.

The bureaucratic, technical and organisational effort by e.g. concretely registering measurements for assessment and control might be disadvantageous. Rights of determination might also be affected. Due to the complicated energy law, some rules might be overlooked or misinterpreted, which can lead to loss of privileges or breach of the law.

5.8. Goals

Efficiency benefits that can be realised by way of the intended measures from operative and strategic points of view

The energy goals are specified in consideration of the results of the following:

- the analysis of chances and risks;
- the management assessment;
- energy policy requirements and requirements based on the guidelines for sustainability;
- the assessment of the energy-related performance;
- the assessment concerning the observance of legal obligations and other requirements;
- the specification and assessment of the major energy consumption sources;
- the specification of the financial, operational and commercial conditions;
- preventive and corrective measures.

The energy goals are documented and the various departments are informed accordingly. The employees responsible for the various projects and processes are familiar with and realise the goals of relevance to them. At regular intervals, the management examines whether the goals are fulfilled.

5.9. Energetic assessment

Consumption of the various energy types

Analysis of the performance

Analysis of the potential

To begin with, an energetic balance is to be prepared, which documents the various energy types and sources of energy that are used. Such a starting basis makes it possible to estimate potential efficiency gains.



The energetic starting basis can be determined by registering the accounting of the various consumptions and by making internal measurements of the consumers of all relevant energy types.

Thus, the introduction of an EnMS enabled the LVB to sum up and evaluate the energy consumption for the complete company group for the first time.

Concretely, the LVB was able to define its SEUs and got starting points for achieving the best possible results and for reducing the energy consumption of the major consumers of energy by taking many simple steps.

Spread of sources of energy in 2020



5.10. Energy performance indicators, starting basis

Definition of scalable indicators for assessment of the energetic performance and efficiency in consideration of frequent variables

Normalisation as regards the major influencing factors

If the consumption data are known, it is possible to refer them to operational production indicators and to derive relevant indicators on this basis. It is important to use indicators that are reproducible and to relate them directly and nearly proportionally to energy consumption.

In the case of public transport by bus and rail, which is performed by a public transport company, the transport performance is measured by way of the kilometres operated pursuant to the timetables and the number of passengers.

As regards the tramway operation, the energy consumption of the tramcars is assessed on the basis of the transport performance so that an EnPI results for the energy consumption per



kilometre of operation. To be able to refer the relative consumption to the offered performance, the seat kilometres performed according to the timetable can be referred to the energy consumption in kWh. Increase in the seat offer relative to the purposive measures for energetic improvement reflects the efficiency of the measures concerning the transport offer. To be able to relate the relative consumption to the transport performance, the passenger kilometres can be put in relation to the energy consumption in kWh. If the passenger figures are increased continuously and if purposive measures for energetic improvement are taken, the relations shown by the EnPI can be significantly improved. This EnPI reflects the production success.

As regards the bus operation, the diesel consumption of the buses is assessed on the basis of the transport performance so that an EnPI results for the energy consumption per kilometre of operation. To be able to refer to the relative consumption to the offered performance, the seat kilometres performed according to the timetable can be referred to as the energy consumption in kWh (by calculating the diesel consumption with factor of 9.925). An increase in the seat offer relative to the purposive measures for energetic improvement reflects the efficiency of the measures concerning the transport offer. To be able to relate the relative consumption to the transport performance, the passenger kilometres can be put in relation to the energy consumption in kWh (by calculating the diesel consumption with factor of 9.925). If the passenger figures are increased continuously and if purposive measures for energetic improvement are taken, the relations shown by the EnPI can be significantly improved. This EnPI reflects the production success.

As regards the bus operation, the consumption of electric energy is assessed on the basis of the transport performance so that an EnPI results for the energy consumption per kilometre of operation. To be able to refer to the relative consumption to the offered performance, the seat kilometres performed according to the timetable can be referred to as the energy consumption in kWh. An increase in the seat offer relative to the purposive measures for energetic improvement reflects the efficiency of the measures concerning the transport offer. To be able to relate the relative consumption to the transport performance, the passenger kilometres can be put in relation to the energy consumption in kWh. If the passenger figures are increased continuously and if purposive measures for energetic improvement are taken, the relations shown by the EnPI can be significantly improved. This EnPI reflects the production success.

It is recommended to sum up the energy consumption of the buses, i.e. the consumption of diesel and electric energy, for the demonstration of energy efficiency. The energy consumption of electric buses is added to the energy consumption of diesel-powered buses. Then, the complete energy consumption is compared with the kilometres operated, the seat kilometres and the passenger kilometres.

It becomes obvious that electric buses consume far less energy than diesel-powered buses.

5.11. Collection of energy data

Measurement concept

Data collection

Data storage

To be able to correctly prepare the collection of energy data, a measurement concept is needed. It is to be recorded how the consumption data are accumulated for the single energy types. It is important that the delimitation of the various consumer groups is accepted pursuant to the calibration regulations to be able to observe rules for due taxes and other legal provisions. Moreover, it is important that the delimitation can be proved in reliable documents.

The measurement plane depth according to the measurement concept is examined at regular intervals in consideration of the required consumption data to purposively assign measures for improving the efficiency of consumers or consumer groups.

If metered values from billing measurements for consumption bills are used to determine the consumption, they have to be documented within the scope of the invoice control and assigned to the consumption statistics.

To demonstrate the energy data history, the measurement data and the consumption statistics have to be securely stored and remain specifiable at least in the certification period, which is also a requirement for further proofs in audits.

5.12. Support

Resources

Determination and provision of time, personnel and financial resources
Reference to LVB's resource concept and measures realised

To be able to realise, keep up and continually improve the EnMS and to fulfil the single operational goals, financial, technical, personnel and other resources are needed. It is important to ensure that these resources are available in all fields to be able to realise, keep up, improve and extend the EnMS. To ensure that the energy management tasks can be realised, it is recommended to always consider these resources in economic planning.

Competence

Determination of competencies, gaining competence (training, services)
LVB's measures to achieve competencies by employing qualified staff, training and exchanging experiences (energy efficiency networks)

To fulfil the condition that energetic and economic contexts are to be understood, comprehensive professional training is needed. Moreover, methodological expertise is important to gather, structure, evaluate, reuse and represent information and to correctly interpret and suitably present the results of the processes. To be qualified to do so, e.g. training, exchange of experiences and practical experience are needed.



To be able to realise the principles of the EnMS, it is important that all employees know the energy policy requirements. Training is important at all employment levels to achieve this competence and to create the necessary awareness.

Awareness

*Strengthening the awareness of individual responsibility and influence of persons who have a particular effect on the energetic performance
(Assignment of the energy team members' particular responsibility)*

The employees learn about energy management from publications, which are prepared by the energy team at regular intervals. If requested, the energy team informs the various departments about its work, advises them and receives tips from them.

The drivers are frequently sensitised to drive in an energy-saving way and trained at suitable intervals to

- realise that they have to use the energy resources with caution in the interest of the LVB and society;
- realise that they themselves can take on responsibility for the energy resources and be good examples through their own daily actions;
- inspire and convince third parties.

Communication

*Determination of the communication means and the interactive modes
Employee suggestion system*

(Preparation and gradual realisation of a communication concept as one of the most important tasks is to provide information, understanding, conviction and cooperation among the employees)

The management is responsible for making all relevant parties acquainted with the energy policy, the energy goals and the energetic performance. All interested parties and circles of relevance to energy management are to be informed accordingly. Suggestions for improvement and improvement measures are registered in accordance with the rules for the internal employee suggestion system and realised, if possible. To facilitate the energy team's communication with the employees, it can be helpful to set up a special e-mail account.

Internal communication

Internal communication is ensured at various levels. The main elements of internal communication about energy management are:

- the annual management review;
- the annual report on sustainability;
- the quarterly report;
- management meetings;
- the energy team's meetings;
- the intranet;



- LVB's internal newspaper (at irregular intervals);
- notices on notice boards;
- campaigns (at irregular intervals).

External communication

The LVB informs about its energy-related performance in an annual report on sustainability.

Documentation

Structured and controlled documentation of the process and the data

The LVB has prepared a manual on energy management and updates it at regular intervals. The EMR is responsible for the preparation and publication of this manual, which defines basic behaviour.

The energy data and the energy measures are supervised and examined within the scope of the certification. Therefore, they are to be reproducible and have to be stored.

It is recommended to use electronic media, especially the internal data server system and the corporate intranet, for documentation. The requirements for data security always have to be fulfilled. Moreover, it has to be ensured that only authorised persons have access to the data.

5.13. Operation

5.13.1. Planning and control of the operation

Control of the order of events of relevance to the use of energy

Scheduled preventive maintenance

The orders of events and processes in a public transport company of relevance to the determined use of energy are to be registered, analysed and described. This applies particularly to the following:

Operation of the vehicles

The operation of the vehicles is determined by fixed lines, timetables and operation of the vehicles in accordance with the requirements. Not only the technical equipment of the infrastructure and the vehicles but also the way in which the vehicles are operated influence the energy consumption significantly. All drivers are to be purposively trained in energy-efficient driving at regular intervals. All technical modifications are to adequately consider technical environmental, safety, energy-relevant, cost-oriented, resource-oriented and deadline-oriented points of view.

Maintenance

The public transport company performs the maintenance, which is to ensure the safety and the defined performance of the vehicles and the technical installations. Preventive maintenance ensures that the vehicles and the technical installations are always available



for the intended purpose. The energy consumption shall always be considered by the repair as well as by preventive and corrective maintenance. Deadline and maintenance schedules shall always be observed for all electrical consumers.

Energy consumption

The energy consumption is monitored by way of specified EnPIs, which are collected and analysed by the energy team. The energy is checked by evaluating the consumption bills, recording energy data and analysing any differentiation between the main consumers. Possibilities of saving energy are derived from the data analysis and specified in action plans. In the case of energy-intensive consumers, specific measures are made for the analysis of consumption.

Design

Purposive influence on new or modified systems, technical installations, equipment or processes for improvement of the energy efficiency

When new vehicles and technical installations or equipment are to be procured, they shall be analysed and assessed to find out whether their energy consumption can be reduced. The energetic efficiency of these vehicles, technical installations or equipment should be examined already at the planning stage to ensure that they correspond to the state of the art. If possible, the suppliers should be involved in the planning process. Particularly if technical installations or vehicles with a considerable energy demand or many technical installations or vehicles are to be procured, potentials for improving their energy-related performance should be determined and realised, if at all possible. The results of this analysis are to be recorded and considered by the planning of the project in question.

Procurement

Provision of a procurement algorithm with criteria for energy-related equipment and devices as well as determination of the energy sources

The realisation of purchase rules, consideration of the EnMS by calls for tenders for vehicles to ensure fulfilment of the strict requirements for energy efficiency

Assessment of the performance

Energy is mainly procured with a view to economic efficiency and reliable supply and in observance of the requirements and goals for the protection of the environment. A reliable, economic and low-emission supply of energy has top priority.

When the LVB intends to procure new vehicles, technical installations or equipment that influence the energy-related performance significantly, the company informs the suppliers that the energy-related performance will be considered by the assessment of the offer and kindly requests them to actively contribute to improving the energy efficiency.

Supervision, measurement, analysis

Collection and evaluation of data, derivation of control requirements

Examination of the efficiency of the EnMS



A central task of the various departments is to ensure that the technical installations, the vehicles and the equipment etc. remain available. Consequently, they always monitor them closely and record their state of operation. Informative EnPIs are provided for vehicles, technical installations and equipment with SEUs by measuring their consumption, providing reference variables and including them in the relevant BBSC. To examine the EnPIs, the consumption data are compared with results from models based on statistical analyses. If the energy consumption differs much from the expected energy consumption, corrective measures are specified and documented.

Action plans are prepared on the basis of the energetic assessment and the given goals. The single measures are assessed before and after their realisation and assessed in respect of the intended and achieved energy savings.

Observation of legal requirements (binding commitments)

Examination of conformity with law and contracts

It is recommended to set up a register with all laws, acts, regulations, rules etc. that are relevant to energy aspects. The documents in this register are to be updated at regular intervals. Moreover, their conformity should be assessed at regular intervals.

5.14. Internal audit

Formal procedure for internal examination of the EnMS

Trained internal auditors perform the internal audits, which are to be performed at regular intervals (at least once a year). All normative specifications are to be examined at least once during a certification cycle (three years).

5.15. Management review

An instrument for information, assessment and derivation of corrections for the top management in consideration of all requirements given in standards and for ensuring the certification

By means of the aggregated results, the management examines whether the requirements put to the EnMS in the form of the energy policy are actually observed. If necessary, appropriate corrective measures are initiated and documented. The continual improvement process, also concerning the EnMS, is important in this respect. Moreover, it is important that the appropriate means and the qualified staff are determined and provided. The assessment and the reports on the corrective measures are filed by the EMR.

Input parameters for the management review

At least once a year the management examines whether the energy policy requirements for the EnMS have been met. This examination includes the following:

- evaluation of the earlier management assessments;
- modification of external and internal subjects and the EnMS-related chances emerging;
- audit results;
- review of the energy policy;
- review of the energy-related performance and the related indicators;



- assessment concerning harmonisation with valid legal provisions, inclusive of consideration of amended legal provisions;
- extent of achievement of the operative and strategic energy goals;
- evaluation of preventive and corrective measures;
- prospects of the energy-related performance;
- recommendations for improvements.

These data are used to document the result of the assessment and to derive further results and decisions.

The management review is used to check energy management in the sense of continual improvement processes in accordance with the PDCA cycle.

Results of the management reviews

The results of the management review are documented and stored in the EMR. The following is considered for the results:

- modification of the energy-related performance;
- modification of the energy policy;
- modification of the EnPIs;
- modification of needed and available resources;
- modification of the strategic and operative energy goals;
- possible improvement of the integration into business processes;
- modification of competence, awareness or communication;
- other EnMS elements that contribute to continually improving the process.

5.16. Improvements

Non-conformities and corrective measures

Reaction on determining deviations from the normative requirements or the energy-related performance

If it is detected that there are non-conformities in the EnMS, they are remedied by way of suitable corrective and preventive measures. In the event of an emergency or a malfunction quick handling of this situation, protection of life and health of persons and avoidance of environmental damage is more important than the energy management goals.

Non-conformities as well as preventive and corrective measures are observed by the management team.

Corrective measures

The EnMS is continually monitored in internal audits. Moreover, its suitability and efficiency are assessed by the management at least once a year in the form of a management assessment. For this purpose, data are consequently collected and evaluated. Suggestions and measures for improvement are registered in accordance with the rules for the employee suggestion system and realised, if possible. These data are inputs for the management's assessment of the EnMS.



Preventive measurements

Striving for continual improvement of all processes and performances is an integral part of a functioning EnMS. The employees are requested to document energy-relevant deviations and make suggestions for improvement accessible to the energy team, who examines them and integrates them into the EnMS in case of a positive assessment.

Continual improvements

Demonstration of the continual improvement of the energy-related performance and the EnMS

The LVB is obliged to continually improve the suitability, adequacy and efficiency of the EnMS. This obligation is proved by the continual improvement of energy-related performance on the basis of indicators and suitable methods for standardisation as well as consideration of decisive variables and statistical factors.

Checking possibilities of support and funding of improvement measures

Examination of published funding programmes for useful employment

Suitable funding programmes can be made use of in several ways depending on the use case and the company. It is recommended to check information portals and publications concerning public funding programmes at regular intervals and then to check whether an application for support might be promising for the company. It can sometimes be meaningful to directly ask the funding authority about the general conditions.

6. Experiences and main results

A summary of the practical success and challenges is offered below:

- Gradual improvement of the specific consumption data of tramcars

Thanks to the regular registration of the EnPIs it became possible to visualise the target values and the actual values to the persons responsible for making the tramcars ready for service and the persons responsible for the operation of the tramcars.

Modern tramcars were equipped with displays for the drivers to support economic driving.

- Gradual improvement of the specific consumption data of buses

The procurement of new diesel-powered buses with exhaust gas after-treatment in accordance with the Euro 6 standard has reduced the fuel consumption of the bus fleet significantly.

The transition to buses with electric drives has increased energy efficiency to an even higher degree. The LVB has decided to operate buses with batteries that can be charged both at the



terminals (opportunity charging) and in the depot. The energetic efficiency of these buses is about three times as high as that of buses with internal combustion engines.

The LVB now operates 21 standard buses (12 m long), and in the near future, the company will put 10 articulated buses (18 m long) into operation.

- Building a new workshop or reconstruction of an existing workshop

Energetic measures are planned and considered at an early planning stage. The requirements for air conditioning and ventilation, compressed air systems and lighting have top priority. The consequent use of presence-controlled lighting with LED technology increases the energy efficiency by up to 90 % in comparison to the lighting used so far.

The permanent attention to energetic subjects, e.g. via internal communication, and the constant presence of these subjects in everyday life has increased the employees' sensitivity to contributing to energy efficiency little by little, but not all of a sudden. The general discussion about our climate has also contributed to the employees' higher interest in energy-related matters.

7. Examples of using an EnMS

In the intensive discussions about the possibilities of using energy economically it has turned out that the energy law and the energy tax law often have to be considered by the technologies for internal generation of electrical energy and for storage of this energy and/or recuperated braking energy. Not all provisions are compatible with the energy strategy intentions of the company and there are many pitfalls for unintended infringements. Sometimes certain energy amounts that are exchanged within the networks cannot be determined or measured, and yet they have to be assessed in one way for energy business reasons and in another way for energy tax reasons.

8. Annexes

Terms and definitions used in this document:

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|-------------------------------------|---|
| Significant energy use (SEU) | Substantial energy consumed by systems, technical installations, equipment, devices or processes |
| Audit | Systematic, independent and documented process for the achievement of audit evidence and objective evaluation of audits to determine whether the audit criteria have been fulfilled |



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|---|---|
| Energetic starting basis | Quantitative reference point(s) as the basis for a comparison of the energy-related performance |
| Energetic assessment | Analysis of the energy efficiency, energy use and energy consumption on the basis of data and other information that are needed to identify SEUs and can be used to improve the energetic performance |
| Energy | Electricity, fuels, damp, heat, compressed air or comparable media |
| Energy-related performance | Measurable result(s) concerning energy efficiency, energy use and the energy consumption |
| Energy efficiency | Ratio or another quantitative relation between an achieved performance or proceeds of services, commodities, goods or energy or energy used |
| Energy use | Energy used for a performance |
| Energy performance indicator (EnPI) | Unit for the energy-related performance as determined by the company |
| Energy management representative (EMR) | Person who takes care of the energy management |
| Energy management system (EnMS) | Management system for determination of the energy policy, general goals, energy goals, action plans and processes for achievement of the general goals and energy goals |
| Energy management team (energy team) | Person(s) authorised to efficiently realise the EnMS and improve the energy-related performance |



| | |
|---------------------------|--|
| Energy policy | Statement of the company on intention(s), direction(s) and commitment(s) of overriding importance to the energy-related performance, which is provided by the top management |
| Energy consumption | Amount of energy used |
| Energy goal | Quantifiable goal for improving the energy-related performance |