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Smart community infrastructures — Smart transportation for energy saving operation by slowly driving intentionally

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Foreword

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This document was prepared by Technical Committee ISO/TC 268, Sustainable cities and communities, Subcommittee SC 1, Smart community infrastructures

In the development of this document, ISO Guide 82 has been taken into account in addressing sustainability issues.

Introduction

Energy saving is one of top prioritized issues to be solved in every city in the world. This is already pointed out by ISO 37154: 2017[1] and ISO 37161: 2020.[2] Particularly in ISO 37161, how, where and in what situations energy consumed in transportation services can be saved are mentioned.

Rail services are common but indispensable transportation means to convey people, delivery items and freight within cities, between cities and in a large city zone. Rail services consist of a lot of service and technical aspects and functions supporting the transportation performance. Thus, to save energy in rail services, there are many options applicable thereto. Energy saving by modifying speed profiles of running trains or trying to run slowly as far as service schedules permit is a typical way that has been practically used and is even now being improved in train operation, since all trains are operated by scheduling. Energy saving by this method is focused on rail services. The theory is, however, still applicable to other transportation services or modes that are operated based on scheduling. Therefore, energy saving by modifying speed profiles can be widely applied to other transportation services adopted in cities and offers great scale saving of energy consumed in transportation services.

The principle to save energy by modifying speed profiles is very simple. All trains, buses/trucks and ferries are able to run on a service line or sailing route at a maximum speed technically allowed. By reducing the running speed, energy consumption can be depressed. Commonly, trains, buses/trucks and ferries are scheduled by including standing-by time to provide passengers and freight senders/recipients with convenient service schedules, for example, to offer good connections and to avoid odd time for shipping/picking-up. Besides such service reasons, technical situations will force trains, buses/trucks and ferries not to run at a maximum speed. A typical case will be that they have to pass another service at a station with more tracks/lanes on a single track line/traffic road or at a wider point on a narrow sailing route. They should come to the station/point not absolutely at but by the time designated. This operation brings leeway or buffer time to be used on the way to the place. To kill the time until arriving thereat at the designated time, they can run slowly. This leads to the reduction in the amount of energy to be consumed when running at a maximum speed.

Slow running avoids high acceleration/deceleration, compared to when running at a higher speed. Passenger-friendly driving will additionally be realized when arranging energy saving operation in transportation services. From environmental viewpoints, such slow running would contribute to reduction in emission from vehicles, which are carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides, lead and aromatic compounds and so on.

This document describes how to save energy in scheduled transportation services by modifying speed profiles.

Smart community infrastructures — Smart transportation for energy saving operation by slowly driving intentionally

1 Scope

This document describes to organize smart transportation to save energy consumed in operation, by modifying speed profiles of trains, buses/trucks and ferries, which is also able to offer passenger-friendly driving of transportation vehicles.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
transportation dispatch
services operated by using vehicles along with service schedules

Note 1 to entry: The vehicles used are normally trains, buses, trucks, ferries and others as listed in ISO 37154, 2.5.4.

3.2
service schedule
timetable to be followed when driving for transportation dispatch

3.3
section
tracks, lanes or sailing routes active for operation of transportation dispatch between stations, stops or terminals

3.4
line
sections combined

3.5
route
lines or part thereof that are combined for through transportation services between lines

3.6
division
specific parts created and identified on a line or route by dividing a section thereon to gradually change running speed in a section

3.7
buffer time
leeway time given to transportation dispatch, with which energy saving can be achieved

3.8
speed profile
figures illustrating speed changes of transportation dispatch in divisions

Note 1 to entry: In smart transportation for energy saving operation, speed profiles are useful to find the most effective driving way by identifying divisions where to slowly run as far as service schedules permit. A typical speed profile is illustrated in Annex A for reference.

4 Principle of energy saving in transportation operation by modifying speed profiles of running vehicles and applicable city issues

4.1 General

The principle of energy saving in transportation operation by smart transportation designated in this document is simple, which is performed by modifying speed profiles of running vehicles, that is to say, with efforts to slowly run intentionally as far as service schedules permit. Basically, all vehicles including trains, buses/trucks and ferries running by following service schedules have leeway or buffer time for good transportation services for customers or due to transportation operational reasons. This means that they have to take longer time while going from a starting place to a final destination of the service, even if they can reach earlier by running at a maximum speed. Having to stand by somewhere on the way are commonly to meet other trains, buses/trucks or ferries at a station, stop, terminal or point for passengers' change, to pass another train, bus/truck or ferry at an interchange station/stop on a single track-line/lane-road or a wider point on a narrow sailing route, to provide arrival time at a destination convenient for customers. Anyhow, dispatch has buffer time to be used on the way. There are two options to kill the time. One is to stand by at a station after coming thereto by running at a maximum speed and the other to run slowly to use the time on the way until arriving at a station. In the latter case, the train, bus/truck or ferry runs at a speed lower than that in normal operation. Thus, the energy consumed is lower. This gap in energy consumption by running at a maximum and a lower speed gives a large amount of energy in total in a city, because so many trains, buses/trucks and ferries are dispatched every day.

Smart transportation for energy saving operation by modifying speed profiles of running vehicles is based on how leeway or buffer time can be reasonably used to bring out energy saving by allocating buffer time in a section where the time is created on the way of dispatch on a service line.

4.2 Applicable city issues and United Nations SDGs

The criteria for smart transportation are appropriate for addressing the city issue of large consumption of energy in transportation services, which are also pointed out by or related to United Nations Sustainable Development Goals, especially goal 7 "Ensure access to affordable, reliable, sustainable and modern energy for all," goal 8 "Promote inclusive and sustainable economic growth, employment and decent work for all," goal 9 "Build resilient infrastructure, promote sustainable industrialization and foster innovation," goal 11 "Make cities inclusive, safe, resilient and sustainable," goal 12 "Ensure sustainable consumption and production patterns," goal 13 "Take urgent action to combat climate change and its impacts" and goal 15 "Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss."

5 Adoption and implementation of smart transportation for energy saving operation

5.1 Objectives

As mentioned in 4.1, smart transportation for energy saving operation by modifying speed profiles can save energy consumed in scheduled transportation services. Smart transportation should be adopted and implemented by following 5.3.

5.2 Target transportation services

All transportation dispatch that is organized and operated by following service schedules arranged in advance.

5.3 Procedure to adopt smart transportation

Smart transportation can be adopted into transportation services currently organized or newly started in a city, between cities and in a large city zone by following the procedure designated in this subclause. The procedure consists of three steps. Find buffer time that can be created by scheduling transportation dispatch, allocate the buffer time to individual divisions in a target section, line or route and operate transportation dispatch by following speed profiles where the buffer time is allocated.

5.3.1 Selection of transportation services where smart transportation is applied

Select transportation services where smart transportation is applied, which are in a mode of:

— rail, including services by BRT (Bus rapid transit);

— bus (e.g. local bus, highway bus);

— truck;

— ferry.

5.3.2 Scheduling of transportation dispatch

Schedule each transportation dispatch in regular ways that have been applied in a target section, line or route as usual. When introducing smart transportation into newly started service sections, lines or routes, follow the scheduling manners that have been applied on other existing service lines.

In rail services, to schedule transportation dispatch aiming also at providing good ride comfort for customers by performing passenger-friendly driving, confirm the parameters listed below on traffic conditions in a target section, line or route when scheduling:

— minimum time to minimize changes in acceleration/deceleration;

— constant speed running;

— control of jerks at powering/braking (e.g. stepwise changes in acceleration/deceleration);

— restriction of making a brake when stopping at a station, stop or terminal;

— speed-suppressing running.

For rail services, the specific parameter below should be confirmed as well:

— taking coasting time when switching from powering to braking operation and vis versa.

5.3.3 Preparation of primary speed profiles of transportation dispatch

Draw a primary speed profile of each transportation dispatch in each section to make the running time each section minimum.

NOTE ISO 24675[5] mentions speed profiles in rail operation.

5.3.4 Identification of buffer time between stations/stops/terminals

Identify buffer time between stations, stops or terminals by scheduling transportation dispatch based on 5.3.2.