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Intelligent transportation systems — Energy-based green ITS services for smart city mobility applications via nomadic and mobile devices —

Part 1: General information and use case definitions

Systèmes de transport intelligents - Services STI écologiques basés sur l'énergie pour les applications de mobilité des villes intelligentes via des dispositifs nomades et mobiles —

Partie 1: Informations générales et définitions des cas d'utilisation

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Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

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Introduction

Environmentally friendly and energy-efficient mobility services have been deployed around the world to address rising urban energy problems caused by population growth, rapid climate change and increased energy use. While attempts are being made to combine technical solutions for transportation and energy use for improved energy efficiency, there are no traffic-energy-related guidelines that meet the various needs of diverse stakeholders in the transportation industry.

A smart city uses foundation technologies to manage energy efficiency. A smart city does this by measuring, metering and forecasting demand for energy, and by providing data platforms on the transport sector. These can be presented as management technology for solving urban problems.

An energy-based green intelligent transport systems (G-ITS) service provides users with customized services to meet their energy needs. The service does this by keeping users informed about their energy use and integrating management using nomadic devices to maximize energy efficiency.

This document considers the conversion of the existing efficiency and safety-oriented transportation system into a more energy-efficient system through the distribution of urban energy, allowing for improved management and energy consumption measurements.

Specifically, this document:

— identifies the general information of the applicable framework for energy-based green intelligent transport systems(G-ITS) services;

— identifies the method to describe the general information for all subjects related to energy-based G-ITS services interfaced with smart city cloud and charging infrastructure, with vehicle stations based on nomadic devices;

— specifies the general use cases for inclusion in energy-based G-ITS as services.

Intelligent transportation systems — Energy-based green ITS services for smart city mobility applications via nomadic and mobile devices —

Part 1: General information and use case definitions

1 Scope

This document provides a framework and information on the total amount of energy appropriate for the deployment of smart city mobility and energy efficiency technologies. These technologies can increase operational energy efficiency and unlock enhanced transportation waste-free energy applications, as well as measuring energy consumption.

The standard framework for energy-based green intelligent transport systems (G-ITS) builds on the best practices for energy efficient transport and management systems, as well as applications of intelligent transport systems (ITS), and aims to accommodate the specific needs of energy-based green ITS in smart cities.

G-ITS use data platforms to measure energy for transport and to forecast demand. A smart city provides G-ITS services to improve energy efficiency by using nomadic devices and by monitoring energy supply and demand.

This document describes the change in the traffic paradigm from the perspective of energy efficiency. It outlines:

— general information for energy-based G-ITS as a service using nomadic and mobile devices;

— use cases for energy-based G-ITS services using nomadic and mobile devices;

— use cases for energy-based mobility services, for example electric vehicles (EV), transportation infrastructure and other mobility services using nomadic devices.

2 Normative references

There are no normative references in this document.

3 Terms and definitions and abbreviated terms

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

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

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

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

3.1
nomadic device
ND
device that provides communications connectivity via equipment such as cellular telephones, mobile wireless broadband (e.g. WIMAX, HC-SDMA), WiFi, etc.

3.2
mobile charging truck
mobile energy storage truck that can go anywhere and provide power, including charging electric vehicles

3.3
smart city
advanced city using advanced information and communication technology to intelligently network key functions of the city

3.4
eco-mobility
eco-friendly transport systems and services based on eco-friendly vehicles and their related facilities

3.5
e-hub
energy-hub
storage for electrical energy, including renewable energy, which can be used when charging an electric vehicle

3.6
demand-responsive charging
DRC
technology that induces changes in electricity consumption patterns according to electricity supply and demand conditions, such as peak periods, through incentive benefits for demand management in a charging zone

3.7
discharging
reversing the remaining amount of mobility energy to the power system

4 General information on energy-based green intelligent transport systems

4.1 Overview of energy-based G-ITS

4.1.1 The background and challenges of energy-based G-ITS

The increase in urbanization due to population growth, energy depletion, rising carbon emission and traffic congestion contributes to climate change and affects cities and local communities. Cities are addressing these issues by adopting environmentally friendly and energy-efficient ITS services.

For example, mobility ecosystems have been created where various mobility services can be accessed through mobile apps or web interfaces, providing energy-efficient routes and optimizing travel routes while allowing users to pay for the most suitable mobility services in terms of time and cost.

Additionally, efforts to reduce carbon emissions have been made, including a shift from fossil fuel energy sources to electricity. Various electric mobility services are emerging, contributing to the overall energy management of cities.

It is expected that numerous convergent services will emerge for decarbonization in transportation and energy. However, there is currently a lack of guidance to meet the diverse demands of these services. It is necessary to develop several leading service models for traffic energy management, including mobile charging vehicles, charging with renewable energy, and total energy consumption control in the public transportation sector.

4.1.2 The energy-based G-ITS concept

4.1.2.1 General

Some conceptual aspects of energy-based G-ITS services are illustrated in Figure 1.

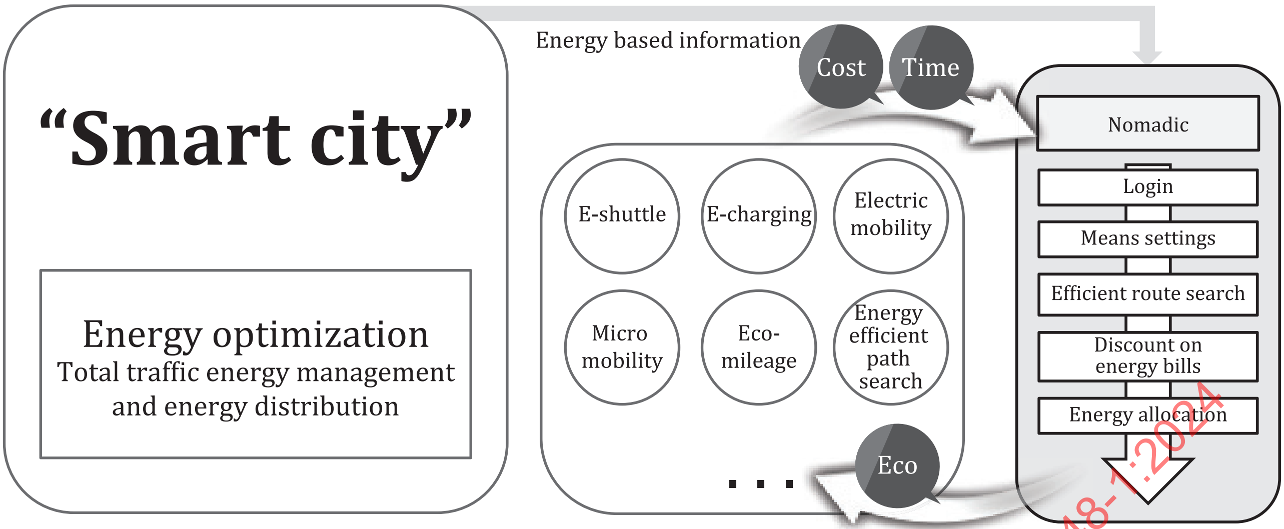

Figure 1 — Conceptual aspects of energy-based G-ITS

An energy-based G-ITS service consists of a data platform for smart cities that balances energy supply and demand using new information and communication (ICT)-based technologies such as smartphones, integrated data platforms and connected vehicles. To transform the existing paradigm of traffic efficiency and safety into an energy efficient system, an energy-based G-ITS service aims to allocate and distribute urban energy to manage the energy use of individuals. An energy-based G-ITS also supports the real-time operation management of complex transportation through connection with information systems such as generator information, system price information, and charging infrastructure.

The stakeholders for the proposition of energy-based G-ITS are described in the following subclauses.

4.1.2.2 Smart city cloud

A smart city collects data from various domains, such as administration, crime prevention, transportation, energy, climate, and welfare. A smart city provides each domain with real-time and static information by collecting data from intelligent urban infrastructure and network systems that are not accessible to the private sector.

Ultimately, by transmitting data to the data platform, a smart city aims to provide information on the supply and demand of energy usage in the transportation sector, such as energy reduction directions by smart cities.

4.1.2.3 Data platform

A data platform collects information on all transportation means so that users have access to related energy-based G-ITS services. The platform collects and analyses the usage history of these services to provide targets for energy reduction, charging and discharging, and integrated reservation and payment services.

4.1.2.4 Service provider (vehicles)

A vehicle service provider manages information about different modes of transport such as car sharing, personal mobility, demand responsive transport, etc. It also manages information on operations, location, charging and reservation fees. In the case of electric mobility, a service provider is a means of charging and discharging. The generated service provider information can be re-collected by smart city cloud subject to agreement from users.

4.1.2.5 Service provider (infrastructure operators)

Infrastructure operators manage transport energy infrastructure and relevant information services. The infrastructure includes charging facilities, renewable energy facilities, mobile charging trucks and parking lots.

4.1.2.6 Users (nomadic and mobile)

Users can use energy-based G-ITS services through nomadic and mobile devices with energy-optimized information. Users can also pay with green mileage points on their mobile phones.

The flow of data related to energy-based G-ITS services is illustrated in Figure 2.

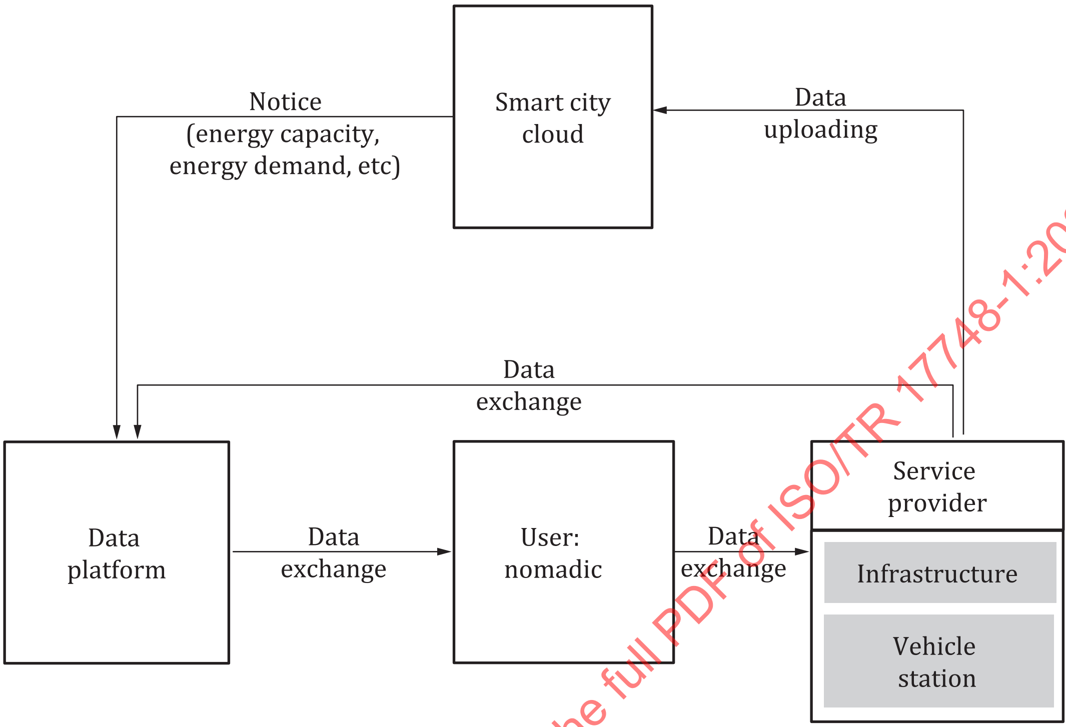

Figure 2 — Energy-based G-ITS data flow

5 Use cases overview and definitions

5.1 Use cases overview

5.1.1 Basic principles for use cases

Subclause 5.1 provides general information on use cases.

Certain basic principles have been established as a framework to define the use cases.

— The use cases of energy-based G-ITS services describe the interaction between conventional ITS services and mobility for eco transport systems and services based on various vehicles and their related facilities.

— The use cases outlined in this document define a sample case for energy-based G-ITS services for transport users, including general drivers, freight drivers and pedestrians. These use cases are applicable for any personal ITS station.

5.1.2 Use case clusters

Table 1 provides an overview of the use case clusters.

Table 1 — Use case clusters and overview

Title	Brief description
1) Energy saving MaaS	This cluster specifies energy-based G-ITS services focused on mobility sharing to reduce energy waste. This includes energy use management and residual energy support. For example, a user selects a route and charge energy according to the expected energy use. The remaining energy can then be discharged to a rental place or e-hub, thus facilitating energy-efficient transfers. — UC 5.2.1.1 – Shared mobility driving (see Table 2) — UC 5.2.1.2 – Multimodal shared mobility driving (see Table 3) — UC 5.2.1.3 – Park and ride driving (see Table 4)
2) Traffic energy management	This cluster specifies energy-based G-ITS services focused on the capacity to manage transport energy. It includes real-time transportation energy usage and an optimized charging service. For example, when the demand for traffic energy is high, charging time is dispersed through a charging reduction instruction. Conversely, when the supply of energy is high, users are encouraged to charge their devices, resulting in the supply of energy meeting demand. — UC 5.2.2.1 – Demand responsive charging (see Table 5) — UC 5.2.2.2 – Demand responsive discharging (see Table 6) — UC 5.2.2.3 – Temporary provision of electricity for disaster situations (see Table 7) — UC 5.2.2.4 – Peak charging demand management (see Table 8) — UC 5.2.2.5 – Public transit bus energy management (see Table 9) — UC 5.2.2.6 – Carbon emission credits trading on floating vehicle emission data (see Table 10)
3) Energy based information and navigation	This cluster describes the provision of information to users. — UC 5.2.3.1 – Charging/discharging reservation (see Table 11) — UC 5.2.3.2 – Charging/discharging status information (see Table 12) — UC 5.2.3.3 – Providing estimates for the energy consumption of a route (see Table 13) — UC 5.2.3.4 – Energy efficient travel route (see Table 14) — UC 5.2.3.5 – Optimal charging station in the travel route (see Table 15) — UC 5.2.3.6 – Green mileage points and CO_2 certificate (see Table 16) — UC 5.2.3.7 – Optimal changing transport modes (see Table 17) — UC 5.2.3.8. – Charging station charge statistics (see Table 18)
4) Mobile charging service	This cluster is a mobile charging service that provides an example of energy exchange among vehicles and infrastructures, etc. — UC 5.2.4.1 – Insufficient charging stations (see Table 19) — UC 5.2.4.2 – Renewable energy sales (see Table 20) — UC 5.2.4.3 – Portable energy storage (see Table 21)

5.2 Use case definition

5.2.1 Use case cluster 1: Energy saving MaaS

5.2.1.1 Shared mobility driving

Table 2 — UC 5.2.1.1 – Shared mobility driving

Actor	Passenger, nomadic device, data platform, smart city cloud server.
Goal	To improve the consistent energy supply and demand for transport through electric mobility.
Use case input	Eco-driving request by the nomadic device.
Use case output	Notification of energy efficient path and charging location.
Brief description	The user is provided with a route after inputting a destination. The user then charges the amount of energy needed for the route, and when the user returns, the remaining energy in a charging area is discharged. This information can include: — EV charging station information requests; — information of the closest charging station; — real-time electricity prices.

5.2.1.2 Multimodal shared mobility driving

Table 3 — UC 5.2.1.2 – Multimodal shared mobility driving

Actor	Passenger, nomadic device, data platform, smart city cloud server.
Goal	To improve eco-driving identification and notification through multimodal electric mobility.
Use case input	Eco-driving request through the nomadic device.
Use case output	Notification of energy efficient path and charging station.
Brief description	The user requests a destination route. When moving in multiple modes of transport, the energy of the previous mode of transport is returned to a charging station. This information can include: — EV charging station information requests; — real-time electricity prices; — information on the closest charging station; — status of transfer mobility.

5.2.1.3 Park and ride driving

Table 4 — UC 5.2.1.3 – Park and ride driving

Actor	Personal mobility, nomadic device, data platform, smart city cloud server.
Goal	To improve efficient transfer management by the park and ride guidance.
Use case input	Parking and charging space detection and location.
Use case output	Parking and charging space notification.
Brief description	This use case provides users with a travel route that combines personal electrical mobility and shared mobility. According to the generated travel route, the user charges their EV at public transportation hubs, then completes the rest of a journey until arrival at the destination using public transportation. Public transportation hubs can include train stations and major subway transfer stations. This information can include: — parking and charging space detection and guidance; — status of transfer mobility.

5.2.2 Use case cluster 2: Traffic energy management

5.2.2.1 Demand responsive charging

Table 5 — UC 5.2.2.1 – Demand responsive charging

Actor	EV, nomadic device, data platform, smart city cloud server.
Goal	To charge electric mobility in areas where a surplus is generated.
Use case input	Surplus electric energy notification.
Use case output	Charging electric mobility at low prices (or free).
Brief description	The smart city informs the data platform about where surplus power is generated and makes reservations with users who wish to charge their vehicles. This information can include: — smart city requests; — surplus electrical energy from renewable resources; — the amount of energy available.

5.2.2.2 Demand responsive discharging

Table 6 — UC 5.2.2.2 – Demand responsive discharging

Actor	EV, nomadic device, data platform, smart city cloud server.
Goal	To discharge energy by electric mobility in areas where they are expected to run out of electricity.
Use case input	Peak load electric energy notification.
Use case output	The reverse energy transmission of electric mobility.
Brief description	Smart cities can inform areas where power shortages are expected through data platforms. Electric mobility with surplus power can provide power to these areas. This information can include: — smart city requests; — regional energy information; — real-time peak load information.

5.2.2.3 Temporary provision of electricity for disaster situations

Table 7 — UC 5.2.2.3 – Temporary provision of electricity for disaster situations

Actor	Passenger, nomadic device, data platform, smart city cloud server.
Goal	To supply electric mobility power during disaster situations.
Use case input	Notification of low power to infrastructures, such as traffic lights and streetlights.
Use case output	Electric mobility supplies temporary power.
Brief description	Electric mobility is dispatched to supply electricity to infrastructure, such as traffic lights and street lights, when supply is interrupted due to a disaster. This information can include: — smart city requests; — infrastructure location information such as traffic lights and street lights.

5.2.2.4 Peak charging demand management

Table 8 — UC 5.2.2.4 – Peak charging demand management

Actor	EV charging provider, nomadic device, data platform, smart city cloud server
Goal	To support EV charging guidance and access management
Use case input	EV charging station information
Use case output	Information on new charging areas with abundant energy supply
Brief description	A peak charging demand notification can guide mobility users to other charging areas according to energy demand (if an area is at peak energy or energy shortages are feared). When implementing the guidance, users can receive green mileage points, and smart cities can receive help to manage peak demand. This information can include: — EV charging information; — EV charging station location; — EV charging navigation and route guidance.

5.2.2.5 Public transit bus energy management

Table 9 — UC 5.2.2.5 – Public transit bus energy management

Actor	Energy charging provider, nomadic device, data platform, smart city cloud server.
Goal	To support charging guidance and driver behaviour management.
Use case input	Energy usage of public transit bus.
Use case output	Provide information on charging stations and driver behaviour.
Brief description	A smart city collects the information on public transit bus energy usage [compressed natural gas (CNG), EV, fossil fuel]. The energy usage of the public transit bus can be monitored and drivers can receive recommendations of appropriate charging stations via their mobile devices. This can also help to manage driver behaviour by providing information on energy usage behaviour and consumption. This information can include: — public transit bus energy (CNG, EV, fossil fuel) usage information; — charging station navigation and route guidance.

5.2.2.6 Carbon emission credits trading on floating vehicle emission data

Table 10 — UC 5.2.2.6 – Carbon emission credits trading on floating vehicle emission data

Actor	Taxi fleets, freight vehicles, nomadic device, data platform, smart city cloud server.
Goal	To transfer from carbon emission analysis to carbon emission credits.
Use case input	Request to purchase carbon emission credits.
Use case output	Transaction based on available carbon emissions information.
Brief description	High mileage fleet operators can flexibly purchase or sell carbon emission credits depending on the volume of their carbon emissions. To support trade in carbon emission credits, information on carbon emission consumed between movements can be measured in high mileage fleet operators, and a transaction volume can be determined through a data platform. High mileage fleet operators can flexibly manage carbon emissions and help maintain the total amount of carbon emissions in a smart city This information can include: — information on the volume of high mileage fleet operator's carbon emissions; — guidance on carbon emission credits; — match information for carbon emission credit buyers and sellers.

5.2.3 Use case cluster 3: Energy based information and navigation

5.2.3.1 Charging/discharging reservation

Table 11 — UC 5.2.3.1 – Charging/discharging reservation

Actor	EV, nomadic device, data platform, smart city cloud server.
Goal	To provide a schedule for charging and discharging electric vehicles.
Use case input	Estimated reservation time for charging or discharging.
Use case output	Match with a user charging station or discharging operator.
Brief description	This use case connects electric mobility users to charging or discharging services at the desired time. This information can include: — the available time for charging or discharging; — charging infrastructure location; — real-time charging price; — identification of matching users or charging infrastructures.

5.2.3.2 Charging/discharging status information

Table 12 — UC 5.2.3.2 – Charging/discharging status information

Actor	Nomadic device, data platform, smart city cloud server.
Goal	To provide a smart city with energy charging and discharging information in the transportation sector.
Use case input	Payment through the nomadic devices based on the charging or discharging amount.
Use case output	Provide smart cities with energy information.
Brief description	When a user pays for charging, the usage information is transmitted to the smart city. This information can be used to manage the total amount of energy in the smart city. This information can include: — requests to charge or discharge made via nomadic device; — the amount of energy in the user's vehicle.

5.2.3.3 Providing estimates for the energy consumption of a route

Table 13 — UC 5.2.3.3 – Providing estimates for the energy consumption of a route

Actor	Nomadic device, data platform, smart city cloud server.
Goal	To supply electric mobility power during disaster situations.
Use case input	Selection of transportation routes and means of transportation.
Use case output	Provide smart cities with estimated energy consumption information.
Brief description	To provide information on energy consumption for all routes. Energy consumption (e.g. electricity consumption, energy currency value conversion) is calculated based on the transport data, model year and conditions (e.g. slope) of the route. This information can include: — the specifications of mobility; — road environment information of the travel route.

5.2.3.4 Energy efficient travel route

Table 14 — UC 5.2.3.4 – Energy efficient travel route

Actor	Passenger, nomadic device, data platform, smart city cloud server.
Goal	To navigate paths with energy savings.
Use case input	Passenger destination and travel time.
Use case output	Provides energy-efficient routes, achieving goals such as reducing energy use and lowering energy costs.
Brief description	To increase efficiency in terms of energy operations, travel routes are created with options for saving energy. This information can include: — the specifications of mobility; — real-time charging price.

5.2.3.5 Optimal charging station in the travel route

Table 15 — UC 5.2.3.5 – Optimal charging station in the travel route

Actor	Passenger, nomadic device, data platform, smart city cloud server.
Goal	To guide a travel route including charging station location.
Use case input	Eco-driver's destination and travel time.
Use case output	Optimal charging station location and reservation.
Brief description	Information on charging station location to support travel route guides is provided. The user receives guidance on the reservation and the location of the charging station. This information can include: — charging station location; — charging information for different types of vehicles.