

Waste management 4.0 provides the rational use of natural and technical resources, maximized energy saving efficiency, secondary processing of all wastes, and the production of new products, raw materials, or energy from them. Waste management 4.0 is an integral part of the smart city development concept.

WASTE MANAGEMENT INFORMATION SYSTEMS (WMIS)

- According to the Russian and foreign experience, the efficient organization of the waste management system in a current smart city starts from the development of an waste management information system (WMIS).
- The problem of the waste registration automation can be solved by developing WMIS as a complex of information flows, economic-mathematical models, technical, program, and other technological means, and specialists operating it.
- The WMIS development is performed with consideration of economic, environmental, and social factors that affect the waste management efficiency



FUNCTIONAL AND PRACTICAL SIGNIFICANCE OF WASTES AIPS

The unified automated information processing system for registration of solid municipal waste generated in the city of Irkutsk (hereinafter referred to as WASTES AIPS) is a complex of means of communication, software, information resources (integrated databases), and qualified staff. The system is aimed at automating the processes of waste collection, production registration, accumulation, utilization, transportation, and disposal.

WASTES AIPS regards the Irkutsk city as a complex of basic systems:

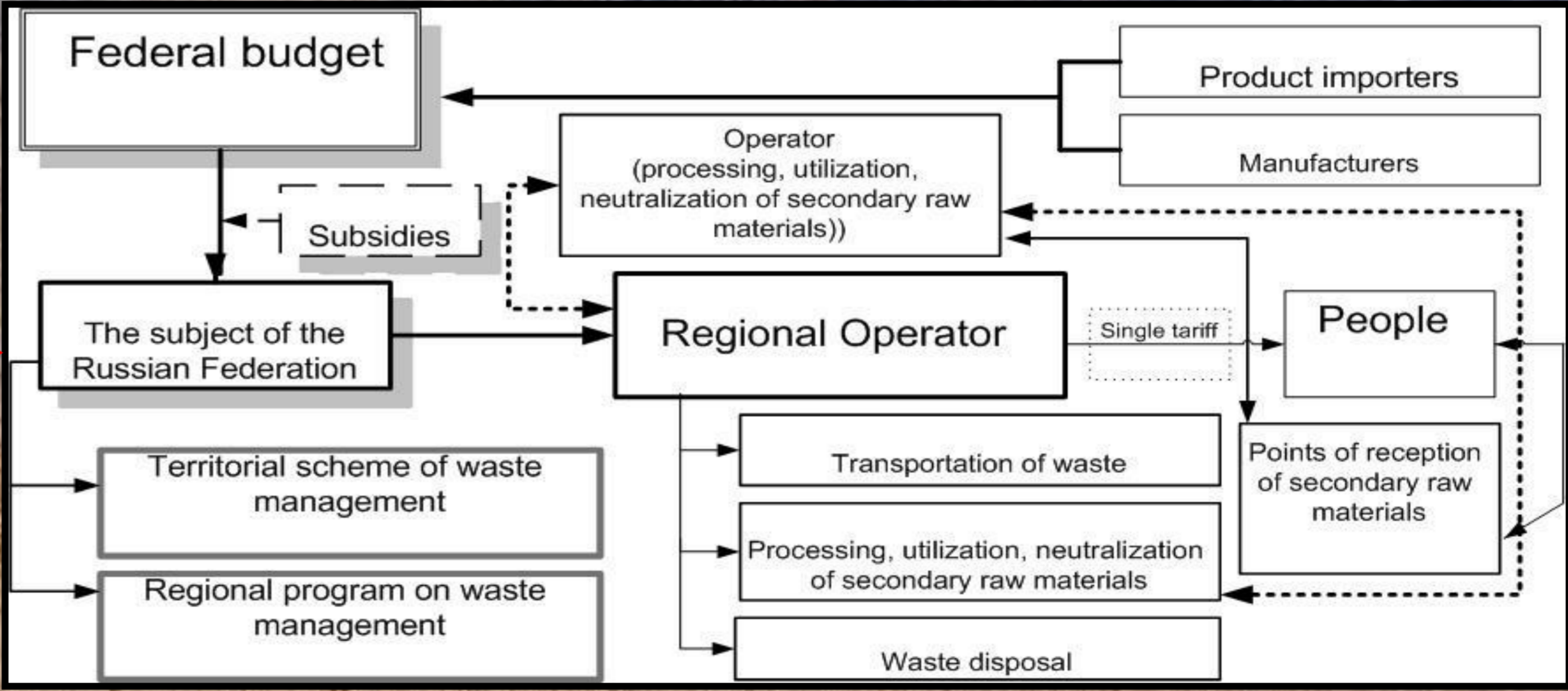
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| <ul style="list-style-type: none"><li>• territory (electronic city map showing the locations of collection sites);</li></ul>                                       | <ul style="list-style-type: none"><li>• city population (objects of multifamily housing stock are attributed to collection sites depending on availability, managing organizations specified);</li></ul> |
| <ul style="list-style-type: none"><li>• individuals and legal entities (enterprises, institutions, and organizations performing activities in the city);</li></ul> | <ul style="list-style-type: none"><li>• specialized organizations providing waste management services (collection, transportation, processing, utilization, disposal/burial).</li></ul>                  |

- The system work algorithm is as follows: on a daily basis, the WASTES AIPS specialists receive nature users (organizations) performing activities in the Irkutsk city (about 4,500 nature users are received yearly, all tenants and departments located in the Irkutsk city displayed).
- In online mode, the methodical calculation of the generated amount of waste is performed (with consideration of the accumulation limits), the information is input in the database, where the amounts of waste generated by enterprises, organizations, and their tenants and departments are attributed to waste accumulation facilities (container sites).
- Based on the provided data, a contract is concluded with the operator that maintains a specific container site.

This system makes it possible to fully control the waste management process in the Irkutsk city from waste accumulation facilities to the final waste disposal at the city landfill for SMW (solid municipal waste) with consideration of SMR (secondary material resources, or secondary raw materials) to be utilized. The database has been successfully implemented since 2000 and is improved yearly in accordance with the tendencies and changes in the current legislation. As of October 10, 2018, the database contains the data on 36,903 organizations (enterprises); 5,478 waste accumulation facilities; and 747 waste operator vehicles. The uniqueness of WASTES AIPS also consists in the fact that it is connected in real-time mode to the only solid municipal waste landfill in the Irkutsk city.

IMPLEMENTATION OF THE REGIONAL SOLID MUNICIPAL WASTE MANAGEMENT OPERATOR INSTITUTION

- The implementation of the new waste management system in Russia directly managed by the regional operators is focused on ordering the waste management activities, from the collection and the SMW generation data registration to the use of new environmentally oriented systems providing the integrated waste management service.
- The main documents regulating the regional operator activities are the territorial waste management scheme and the regional program in the sphere of waste management. The scheme of interaction of the regional operator with nature users (legal entities and individual entrepreneurs) and individuals on waste and SMR management.
- According to the approved territorial waste management scheme covering solid municipal waste for the Irkutsk region (2016), the Irkutsk region is divided into two zones: South and North. The territory of the Irkutsk city is referred to the South zone.



PRINCIPLES OF EFFICIENT MANAGEMENT. POTENTIAL OF INTERACTION OF THE MUNICIPALITY (IRKUTSK CITY) AND THE REGIONAL OPERATOR

For the development of the efficient environmental and economic scenarios in SMW flow management, the regional waste management operator should develop a functional model for the integrated waste management system, which should be organized as follows:

- 1) inventory
- 2) strategic
- 3) economic

CONCLUSION

In view of the basic principles of digitalization, the WASTES AIPS state-of-the-art and development approaches, and the development of the legislative initiatives toward the waste utilization, the regional waste management operator chosen for the zone that includes the Irkutsk city should transform the database into a system product integrated for the operation of the whole South zone of the Irkutsk region with the development of the unified information system for waste registration, the use of products and electronic services for supporting the extended responsibility of producers and importers, geosocial services on separate waste collection, etc.

