Chapter 2
Conceptual Approach

As discussed above, waste management is a complicated issue with a lot of options. We have mentioned different concepts, such as (i) landfilling with negative impact on GHG and potential deterioration of water sources and soil, (ii) prevention resulting in lower amounts of waste to be treated, (iii) separation of different fractions as a condition for subsequent material recovery, (iv) waste incineration as a process preferred for residual waste and (v) mechanical–biological treatment which separates the waste into several streams that are processed within this complex processing chain (see Fig. 2.1).

Different methods of MSW treatment are interconnected to each other. For example, calorific fraction from MBT enters WtE (incinerator), solid residues from WtE are disposed at landfills, etc. (see arrows in Fig. 2.1), and all the ways of treatment are also affected by legislation limitations and incentives imposed by policy-makers. In general, a strong political determination to change legislation related to waste management and to implement key economic instruments is missing in many countries. These changes could discourage cheap landfilling and encourage more sustainable forms of waste treatment (see dashed arrows in Fig. 2.1).

A shift towards more efficient utilization requires intelligent regional strategies and investors' willingness to build and operate new plants at the same time.

Particular projects have to be implemented and their operations must be successful to turn the given strategy into practice. The following conditions should be met from the investor's point of view:

- An acceptable risk of the project, waste availability at gate-fees providing satisfactory project economy and return on investments.
- Support from stakeholders.

P. Stehlik, *Up-to-Date Waste-to-Energy Approach*,
SpringerBriefs in Applied Sciences and Technology,
DOI 10.1007/978-3-319-15467-1_2

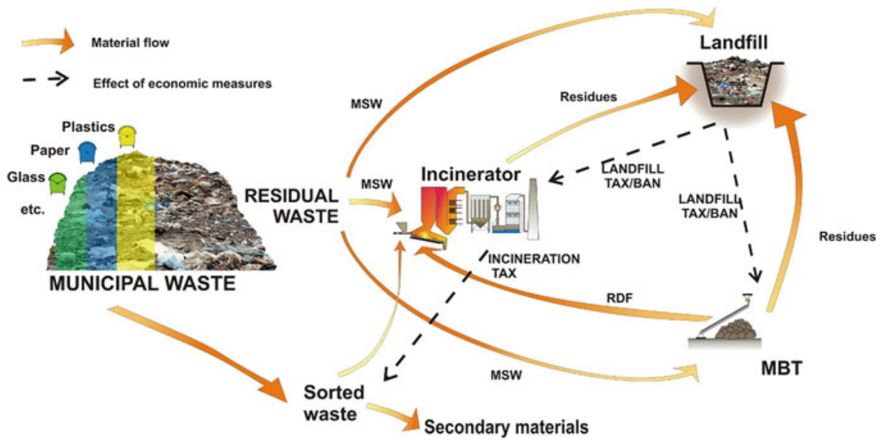

Fig. 2.1 Key components of waste management systems and effect of incentives on waste flow redirection

Present unstable conditions reported worldwide do not contribute to any of the above-mentioned points. Particularly, unpredictable energy prices stimulate project risks. In short, this is a dynamic world and an unforeseeable future outlook together with a combination of large infrastructure project planning taking several years, which makes the decision process even more complicated. Sometimes, compelling arguments for new WtE projects are missing.

Particular tasks to be solved within this project phase are as follows:

- Identification of a site for competitive technology including optimization of collection area with necessary infrastructure (i.e. considering transfer stations for long-distance hauling).
- Evaluation of costs of transport, emission production (caused by transport).

Detailed development of the overall concept includes:

- Optimization of capacity for individual projects and evaluation of waste availability (competition, collecting area, costs of transport).
- Heat utilization and integration within existing combined heat and power systems.
- Sustainability evaluation (risk) of individual projects.
- Requirements of plausible projects (for example waste disposal fees).

The first two points above, as they are of paramount importance for plant sustainability, will be discussed in more detail below.

2.1 Waste Availability

The basic condition in relation to a new WtE project development is a reliable supply of suitable waste during the whole plant lifetime (Themelis et al. 2012). The waste produced by many subjects including municipalities, industry and service sector, is first collected and then shipped to the plant. The geographical area, from which the waste ends in a particular plant, is called the collection area. The ideal situation and the wish of plant operators is to have a stable supply of waste guaranteed in long-term contracts with producers. On the other hand, producers are always looking for the cheapest option. The potential competitors differ according to the general state of waste management and these may be landfilling sites (in countries with less developed waste management), other WtE plants, MBT plants or recovery units. With increased processing capacities established in the area, the waste market is created. The balance between supply and demand is often disturbed and the collection area is subject to modification on a long-term basis. With increased plant capacity the collection area becomes larger, and the plant competes with more and more facilities (see Fig. 2.2).

Experience from many countries with economic instruments as well as current gate-fees at landfills were analysed in a report by Arena (2012) which highlights the correlation between a decrease in landfilling and landfill tax (European Commission DG Env 2012). Another positive effect of reported incentives is significantly decreased generation of residual waste at least to half its original amount a decade ago.

In other words, waste travels between producers and processors. Therefore, logistic and associated transportation cost is another important aspect of WtE. Uncertain future changes in the population, waste production in households and the share and exploitation of marketable forms of recyclables have a direct influence on waste availability and waste transport in the region.

All the above indicated aspects related to future waste availability should be tackled even in the conceptual development phase of a new WtE plant. The future collection area should be proposed and tested for its stability. An example of such an investigation is depicted in Fig. 2.3. Many scenarios are included. The collection area is calculated for each scenario. Since the collection area may differ for each of the scenarios, particular producers are evaluated in terms of their stability to deliver waste to the plant (the higher the probability, the more stable contract between the operator and producer can be expected). The impact of decreased production of waste per capita is tested as well. For the same WtE throughput, the collection area in case of a reduced residual waste production by 20 % (Fig. 2.3 right) is significantly extended by newly involved producers. The results are obtained by a complex simulation in NERUDA tool. The tool is described in detail in Sect. 3.1.

Since risk related to the insufficient supply of waste in the future is one of the major hazards, it is included in a complex methodology towards investment risk quantification in a project development phase as introduced by Ferdan et al. (2015). The new term *waste availability factor* is defined. In short, it is a ratio of the amount

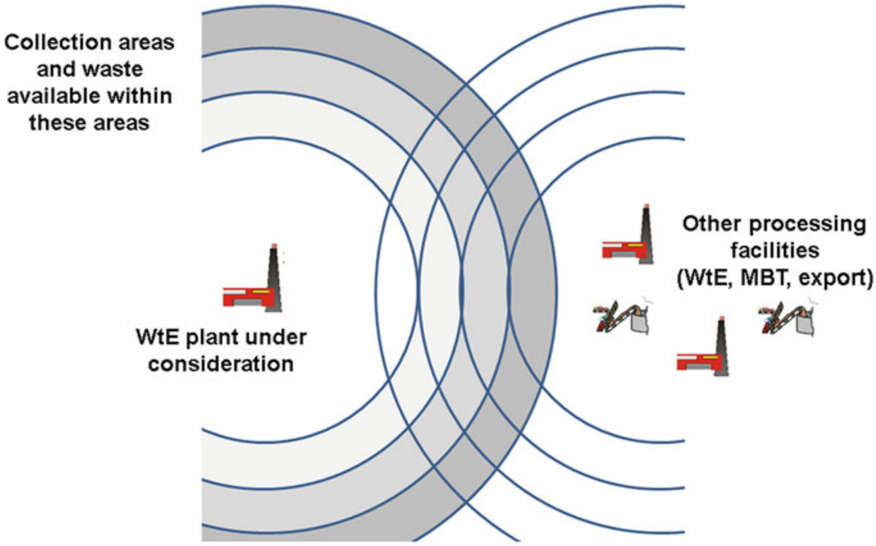

Fig. 2.2 Interference of collection areas resulting in limited waste availability

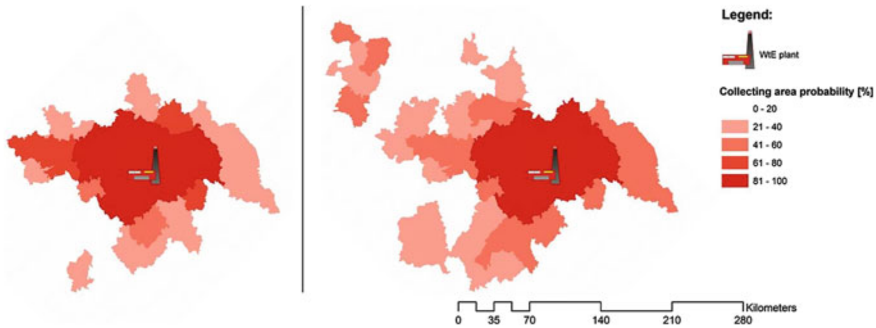

Fig. 2.3 Comparison of collection areas for one WtE plant in case of decreased waste production —results of simulation in NERUDA tool

produced within a technically and economically feasible collection area over the intended plant capacity. Typically, the factor increases with lower gate-fee, since more producers even in remote locations become interested. The problem of long-distance transport may be neglected in case of small units which serve the needs of a region/micro-region. The number of producers bound by contracts is small as they often feel responsible. The plant owner and waste producer is commonly the same entity. An example of such a unit is given in REGION and EVELINE systems.

2.2 Energy Utilization

The main aim of WtE is waste processing with minimized impact on environment (environmental performance). There are other important aspects related to WtE operation defined under the so-called "3E business", that is, ***E***nvironmental, ***E***nergy and ***E***conomic issues. Energy can be produced and delivered to the consumers in the form of electricity, heat and/or cold. Energy production in an efficient cogeneration system has a positive effect on environment (conservation of fossil fuels and minimization of GHG), plant economy and its competitiveness in terms of securing enough waste for its operation. Integration of WtE into an existing CHP system represents another task related to the conceptual development (see Fig. 2.4).

Tous et al. (2011) focus on integrated operation of WtE plants with a concrete processing capacity into an existing heat supply network. In that case, the authors considered an integrated system comprising a combined heat and power plant and a new WtE plant. Operations of such an interconnected system must be efficient. The existing heating plant utilizes renewables: It co-fires coal and biomass and the plan is to extend the system with heat delivery from a WtE unit to decrease the dependence on fossil fuels and increase the share of renewable/alternative fuels. This is a typical objective of commercial applications. The future operational strategy is investigated.

The integration and conceptual development include very basic operation planning, for example heat and electricity production on a yearly or monthly basis during a plant's life span—long-term operation planning. Once the plant is put into operation, planning of short-term operations begins. This involves planning on an hourly or daily basis, and more detailed models are needed. The objective is to plan the operation to maximize the financial effect. There are various objectives and solution methods in short-term operation planning for cogeneration systems.

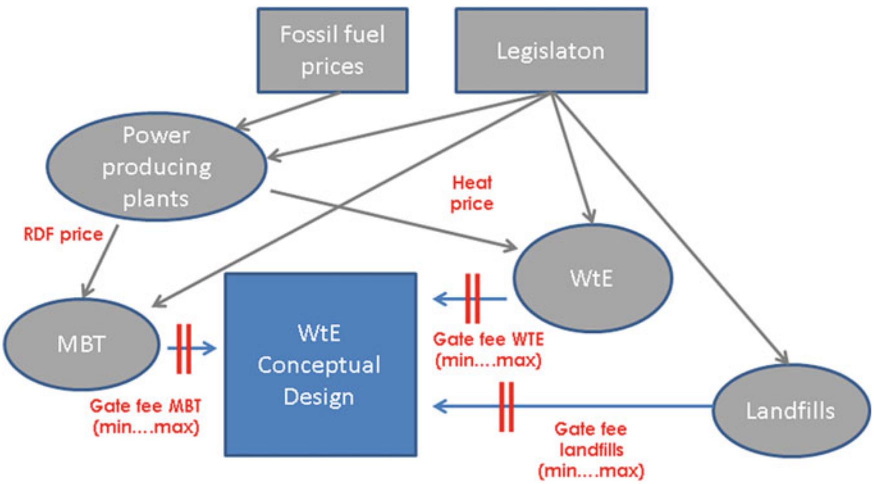

Fig. 2.4 Relations in a complex system where heat utilization contributes to WtE feasibility

Salgado and Pedrero (2008) present an extensive survey of researches in this area. According to this paper, the stochastic approach should be applied more. The stochastic approach has great application potential for WtE plants where lower heating value of waste is randomly fluctuating within the frame of short-term operation. Tous et al. (2015) present an application of a stochastic model for short-term combined heat and power production planning in the case of an existing WtE plant.

http://www.springer.com/978-3-319-15466-4

Up-to-Date Waste-to-Energy Approach
From Idea to Industrial Application
Stehlik, P.
2016, XIV, 101 p. 64 illus., 4 illus. in color., Softcover
ISBN: 978-3-319-15466-4