

# 16

## **CONCEPT OF A DECISION SUPPORT SYSTEM TO SELECT THE OPTIMAL CCT SOLUTION FOR A CHOSEN LOCATION IN SILESIA REGION**

### **16.1 INTRODUCTION**

The implementation process of Clean Coal Technology (CCT) belongs to complex investment projects. Implementation of innovative technologies in response to the stringent requirements of energy and climate policies should be done in accordance with the principles of sustainable development. This is also as a result of the project scale and the conduction of the investment process. Selection and evaluation of technologies and also the implementation of the project leads to the point of making the right decision.

Human factor plays the main role during the process of decision-making, because of the decision responsibility. In classical terms, the decision process is based on expert opinion and analysis carried out in the form of compiled documentation, containing a number of technical and economic – financial assumptions. On those bases the decision-maker makes a choice between rejecting or accepting the project for implementation or among several presented variants selects the most efficient one, having the best chances to succeed, or taking under consideration other criteria set up by them. The main drawback of this ongoing process is time-consuming and the impact of "human factor" on decision's objectivity. Reviews and ratings of experts are formulated on the basis of their knowledge and experience, are often dependent on decision-makers point of view, guided by the appropriate investment of financial resources at their disposal. This narrows down the field of criteria and freedom of choice [1].

Due to the nature of CCT implementation process, the investment risk is borne not only by the potential investor but also by the local community. It is also an important issue for officials fully responsible for the agreement process and partially for decision-making. A large number of data to be analyzed prior to the investment process makes it difficult to take the right decision without adequate support of computer-based systems. The role of computer support systems were found to be significant in making strategic decisions, the implementation of which involves a long time span and the result is dependent on external factors.

The authors believe that it is necessary to develop a system supporting decision-making in the context of the selection of the most optimal technology of clean coal technologies for a specified and considered location in Silesia region. The expected effects of the decision support system development for the implementation of the CCT will be:

- General availability to data on CCT
- Dissemination of information on CCT,
- Access to data related to geological characteristics of the Upper Silesian Coal Basin (USCB).

**16.2 DECISION SUPPORT SYSTEM – GENERAL INFORMATION**

The research literature has shown that so far there has not been developed a system of implementation of clean coal technologies, which can strongly improve the time-consuming process of implementing innovative technologies, taking into account the location choice and community dialogue as the determinants of the investment process. The use of this tool during the decision-making process allows the sustainable development of USCB by using the available resource base.

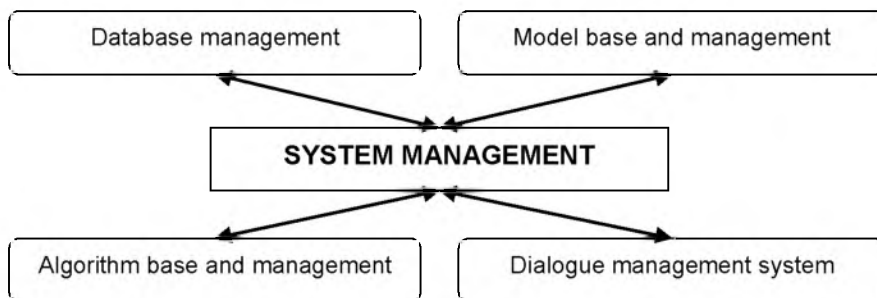
The Decision Support System (DSS) it will be an interactive computer system aimed to aid decision makers use data and models to solve unstructured problems. In other words, helps the user in the organization and management of rational decision-making process and contains a representation of knowledge about the decision by means of the analytical model.

DSS has: precision in recreating a wider perception of the world, where solutions suggested by the system may be used without any modification; immunity, although the values used as parameters are only an estimate of the truth; modifiability, allowing you to change the parameters of the models, resulting experience gained during the operation of the system and through the use of communicative support, tailored to different users. The term "user" refers to all users of the system, i.e. decision-maker, expert, system analyst or a group with a common objective [2].

The basic components of the scheme are:

- user interface, i.e. menu with the language allowing to give commands to the system;
- the system knowledge base, i.e. database, spreadsheets, models, graphics;
- processing system of the problem, i.e. inference, database management and analysis of the results.

The general structure of the decision support system is shown in figure 16.1



**Fig. 16.1 Main structure of the decision support system**

Source: [3]

The issue of implementation of the CCT in the USCB offers a wide range of criteria that have to be examined in order to accurately and reliably predict the technology which is to be implemented. To this purpose serves the designed system, its task will be the juxtaposition of

the information resulting from the EU and national legal requirements, the characteristics of the region and the resource base, technical parameters of coal technologies and components of sustainable development, i.e. the potential environmental risks, optimization of economic investment and community dialogue.

### 16.3 FUNDAMENTAL COMPONENTS OF DSS CONSTRUCTION

#### 16.3.1 Knowledge base

The knowledge base on which is embedded the real information system will enable the processing of the information collected in the parameterized analytical models. In the first building phase of the targeted solution the authors predict the creation of a database that will provide a base of knowledge about the technology, construction of geological - mining of USCB and aspects of sustainable development. This will enable collecting and organizing data in a logical way for data collection system which has been elaborated by the authors of the information system support concept and decision-makers associated with the selection of technological solution for the location.

The base for each construction investment is the location factor, so the authors recognize the location as a criterion for successful implementation process of clean coal technologies in Silesia region. Implementation of the investment process of CCT in Silesia region and the knowledge base of the proposed system is shown in figure 16.2.

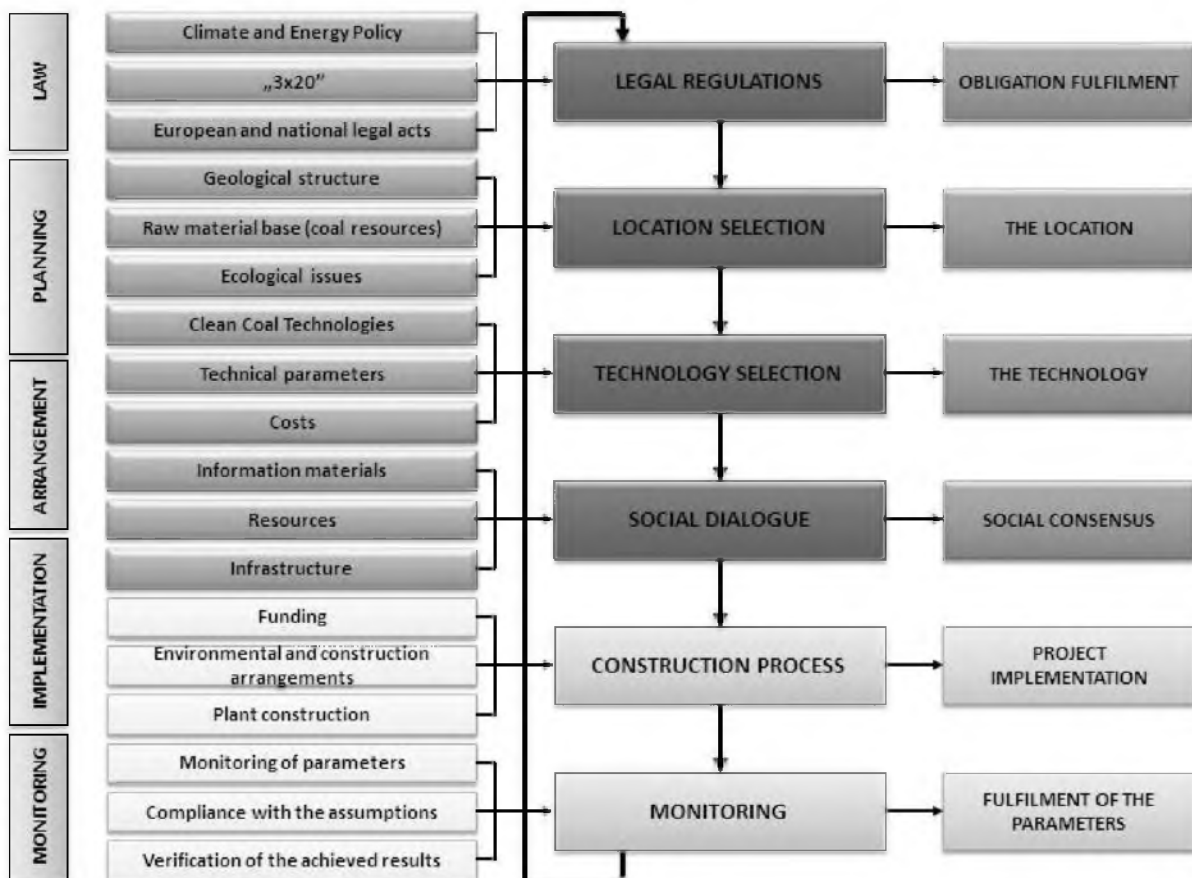


Fig. 16.2 Implementation process of CCT in the area of USCB

Source: [4]

### 16.3.2 Database

The database module is an essential part of the decision support system. It allows to collect data that will form the basis of analyzes carried out within the system. The structure of the proposed system will include database related to the location, technology and sustainability aspects.

The conducted survey shows that the eligibility criteria concerning the location such as: ownership structure, type of the premises possession and land legal status clearly determine the qualification of the location for further consideration. Spatial factors such as density or spatial arrangement of buildings play an important role in decision-making, therefore should be assessed as well.

In addition to the formal criteria of the location, the database will contain information about the occurrence of various factors that may influence the selection process technology in place. Please note that USCB is a densely built-up area with developed industrial and communication infrastructure, which may limit the coal exploitation. Regional specification of USCB and existing coal exploitation has led to considerable environmental degradation. Currently, due to the surface and underground mining operations, the threat in the form of a mass movement still remains high. Hence accurate identification, development and inclusion in decision support system of reliable characteristics of land is needed to reduce the occurrence of mining damage like land collapsing and other forms of ground deformation.

Regardless of the database related to the location there is a database of available technologies on the world market such as: mechanical processing of CCT, carbon technologies, ground and underground coal gasification, co-firing of coal and biomass technologies, ground and underground coal liquefaction technologies for the capture and sequestration of CO<sup>2</sup>. Database is the result of earlier technology analysis designed to meet the CCT determinants of the possibility for their implementation in Silesia region. As in the case of location, the technology database will contain information about clearly categorizing them negatively or positively for implementation. These factors are: efficiency, performance, failure and information which may in varying degrees affect the decision making, such as coal cleaning before the process, saving expenditures in production, saving raw materials or the remainder [3].

CCT is a response to strict requirements of the European Union's climate policy in the context of reducing carbon dioxide emissions into the atmosphere, widely regarded as the cause of global warming. The requirements of the climate - energy, package "3x20" and the relevant provisions of EU and national legislation will be reflected in the proposed system.

Previously was mentioned that the implementation of innovative technologies, which is also the subject of strategic importance for the regional and national development must comply with the sustainable development principles, therefore the implementation and decision making process should include components like ecology, economics and ethics, i.e. social factor.

The decision support system, taking into account the environmental aspect will include the assessment of environmental risks resulting from hazards that may be caused by analyzed technologies. Air pollution, soil, surface water and groundwater contamination also the threat of sludge floods, noise, vibration, and waste generation will be evaluated and included in the

proposed system.

Accurate estimation of the risks associated with the implementation of the technology within the USCB area is necessary to maintain public acceptance of the proposed activity. This is due to both the principles of sustainable development and the process of legal regulations for the investment. Lack of social acceptance for large or innovative projects, such as the implementation of clean coal technologies, may be dictated by the fear of potential threats. It may even prevent their further development in the country. The proposed system takes into account a number of factors related to the expectations and concerns of the local community in relation to a potential investment in their place of residence.

The system also includes the last components of sustainable development - the economic aspect of the investment process. The implementation of clean technologies is a process requiring high costs, which are financed by a number of different financial sources. The proposed system will allow the user to make a preliminary feasibility analysis from the financial side.

#### 16.3.4 Model base

The purpose of the model base in the proposed system will allow the user to use the developed models without having to create them. Model base will work with databases, allowing for multiple use of the information in a variety of configurations, which once entered into the system is stored in the database. Knowledge base, in turn, will advise what models can be used, or what data are needed.

The control module is responsible for the co-operation of database with the model and knowledge base.

#### 16.3.5 Recommendation reports

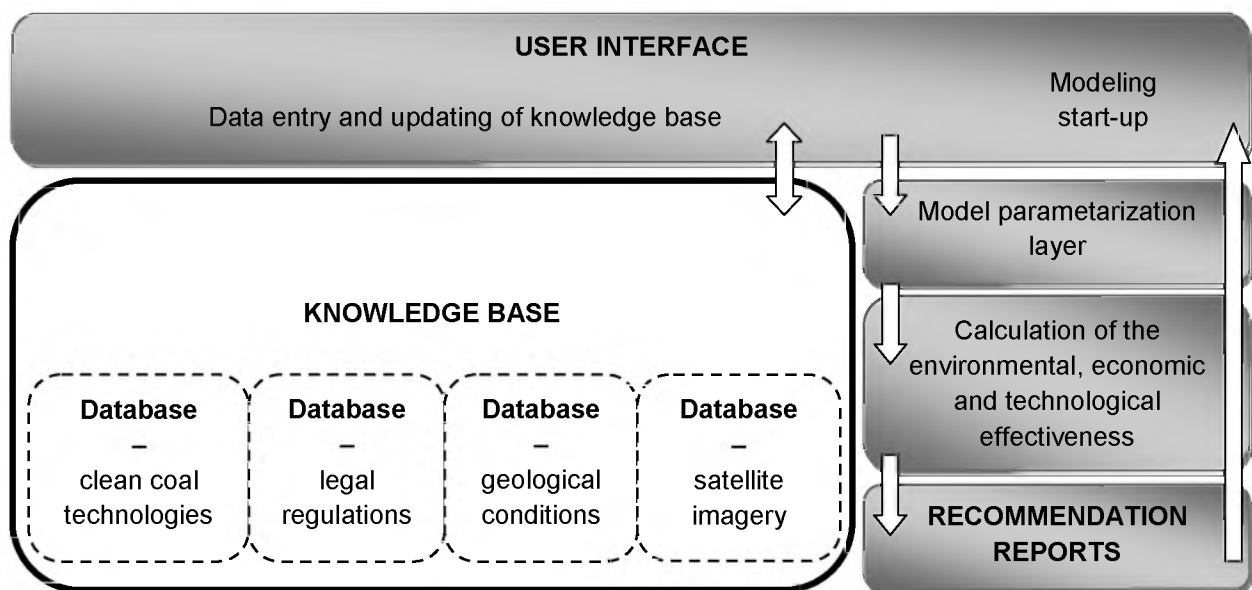


Fig. 16.3 Design concept of DSS

Source: own source

The analytical models used in the computer system will allow for the development and

generation of recommendation reports. Possessing the recommendation report the user is capable of making a decision in a conscious way to use or not to use CCT technology selected for analysis.

The concept of the proposed decision support system in the context of the cost-optimal choice, environmentally and socially clean coal technology in the Upper Silesian Coal Basin is shown in figure 16.3.

**16.4 IDENTIFIED NEEDS OF DSS USERS**

The purpose of the system is to assist in decision-making, not substitute the user therefore it is also an important factor in the interaction of the system with the user.

Users of DSS are divided in five groups which have a direct impact on the implementation process of the CCT in the Upper Silesian Coal Basin. These include local governments, investors, academics, representatives of NGOs and the local community [4]. For each of these groups, the designed system will carry out a different function and provide different information. The needs of the system users are summarized in table 16.1.

**Table 16.1 Identified needs of DSS users**

User of DSS	Identified needs
<b>Local authorities</b>	<ul style="list-style-type: none"> <li>- tool to improve the process of issuing administrative decisions and permits,</li> <li>- database about the state of the environment,</li> <li>- tool for providing information on environmental impact assessment</li> </ul>
<b>Investors</b>	<ul style="list-style-type: none"> <li>- tool for pre-investment feasibility studies,</li> <li>- tool for the presumptive identification of investment risk factors</li> </ul>
<b>Representatives of the scientific community</b>	<ul style="list-style-type: none"> <li>- tool to identify areas for detailed research,</li> <li>- information base related to CCT</li> <li>- basis for the improvement of DSS or the creation of new decision support tools</li> </ul>
<b>NGO's</b>	<ul style="list-style-type: none"> <li>- tool for verification of the decisions issued by the administrative bodies</li> <li>- tool to support the conduction of public consultation process</li> </ul>
<b>Local communities</b>	<ul style="list-style-type: none"> <li>- tool for effectively carrying out public consultation process</li> <li>- information and education platform for the CCT and the impact on the environment</li> </ul>

Source: own source

Additional aspects, convincing for the implementation of a decision support system in order to implement the CCT in Silesia are [5]:

- short-time processing of large amounts of data,
- possibility of carrying out the rapid analyses,
- possibility to combine different techniques of data processing,
- possibility to use intuitive elements,
- access to the information stored in the database,
- possibility to verify the designed system,
- easy to use,
- guarantee of precise and accurate result,
- fast response to the problem posed,
- compatibility with personal computers,
- low equipment requirements.

## SUMMARY

The decision making process is a complex procedure that includes rationality and intuition, requiring skillful articulation of tasks. The decision precedes information collection, data and preliminary project preparation. The process is an act unfolded in time. Decision support system aids at each these steps.

In case of strategic decision-making for the development of the country which is the selection and implementation of the technology from the CCT group, the decision is influenced by many entities which in their assessments must take into account the multifaceted issues. The problem becomes more complex when taking into the account the fact the local communities expect from decision authorities act based on rational evidence and scientific method but also on activities that are consistent with their expectations.

Through the use of multi-criteria methods, decision support systems, compiling quantitative and qualitative variables, aspects which on one hand seek to maximize the economic efficiency and on the other hand meet social expectations of citizens, allow decision-makers to deliberately and consciously to make a comprehensive analysis of the problem and make a decision from a variety of options, leading to an effective solution [6].

The designed decision support system for the selection of the optimal technology out of CCT group for the selected location is the basis for the creation of a computer application, a tool designed for participants involved in the implementation process of the technology in the Upper Silesian Coal Basin, including local government, investors and the local community as well as representatives of the scientific community and NGOs.

The application not only will help the decision-making process in the context of selecting the technology which will be implemented in the selected location. It will also help to organize the knowledge concerning the availability of clean coal technologies on the market, geological-mining regulations and resource base in Silesia region.

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## CONCEPT OF A DECISION SUPPORT SYSTEM TO SELECT THE OPTIMAL CCT SOLUTION FOR A CHOSEN LOCATION IN SILESIA REGION

**Abstract:** *Decision Support Systems (DSS) are computer-based tools which can assist managers of different disciplines, local governments, investors and other stakeholders to simulate, evaluate, and/or optimize management alternatives.*

*This study aims to elaborate and develop a concept design of a DSS and explore the possibilities which it offers in selecting the most optimal Clean Coal Technology for a given location in the Upper Silesian Coal Basin.*

*The implementation of CCT is a very complex process and is characterized by the interaction of many factors such as: economic, environmental, legal and social therefore, as a consequence the decision-making becomes intricate.*

*The study consisted and relied on the draw-up structure, the determination of fundamental components of the DSS and the generation of recommendation reports. Furthermore, the identification of the DSS user's needs was carried out along with the classification of the main groups of users, which have a direct impact on the implementation processes of the CCT in the Upper Silesian Coal Basin.*

**Key words:** *Decision Support Systems, Clean Coal Technologies, decision-making, technology implementation.*

## KONCEPCJA SYSTEMU WSPOMAGANIA DECYZJI WYBORU OPTYMALNEJ TECHNOLOGII CTW DLA WYBRANEJ LOKALIZACJI NA ŚLĄSKU

**Streszczenie:** *System wspomaganie decyzji (SWD) jest narzędziem komputerowym, który może pomóc menadżerom z różnych dyscyplin, przedstawicielom środowisk samorządowych i innym zainteresowanym stronom w przeprowadzeniu symulacji, ocenie i/lub optymalizacji procesu zarządzania.*

*Prowadzone badania mają na celu opracowanie i stworzenie projektu SWD, który okaże się pomocny w wyborze optymalnej technologii czystego węgla dla danej lokalizacji w Górnośląskim Zagłębiu Węglowym. Implementacja technologii CTW jest bardzo złożonym procesem i bazuje na interakcji czynników: ekonomicznych, środowiskowych, prawnych i społeczne w związku z tym, w wyniku czego podejmowanie decyzji w tym zakresie staje się skomplikowane.*

*W pracy opisano strukturę systemu, określono podstawowe elementy SWD i uwzględniono generowanie raportów rekomendacyjnych. Ponadto zidentyfikowano potencjalne grupy użytkowników SWD, mających bezpośredni wpływ na procesy implementacji WTC w Górnośląskim Zagłębiu Węglowym. Przeprowadzono również identyfikację potrzeb użytkowników systemu.*

**Słowa kluczowe:** *System wspomaganie decyzji, czyste technologie węglowe, podejmowanie decyzji, wdrażanie technologii*

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