PEAT FUEL TYPES FOR SUPPLY LOGISTICS

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Abstract

The rapidly growing biofuel industry poses considerable challenges to its supply chain network design and operations. Along with coal, natural gas and nuclear power, one of the most important sources of energy is peat. This paper presents the key characteristics of the peat fuel for supply chain that comprises of feedstock production and logistics.

Local peat fuels play an important role in the decentralized and diversified energy system. Fuel peat is a local, indigenous, solid fuel that is use as milled peat or sod peat, or as peat briquettes, pellets and granules.

The main advantages of energy density peat fuel: low cost on unit of heating capacity; close arrangement of the mining enterprises (about 100 km); the possibility of sharp increase in consumption of fuel in peak loads, i.e. is not present need of accumulation and according to derivation of current assets on fuel purchase.

The logistic scheme of energy dense peat fuel production consists of three levels. The first level is peat field. Here the peat raw materials are mining, exposing to roughing-out and collecting in points of storage of raw materials. The main production operations connected with production of energy dense peat fuel are carried out at the second level - points of fuel production on which initially processed peat raw materials are separated, crushed, pressed, passes heat treatment and is packed. Further ready fuel is delivering to region heat sources - the third level of logistic system.

Keywords: Peat fuel, feedstock supply, logistics

1. INTRODUCTION

Peat product intended for energy production. Fuel peat is a local, indigenous, solid fuel which is used as milled peat or sod peat, or as peat briquettes, pellets and granules.

Peat is harvested as an important source of fuel in certain parts of the world. By volume, there are about 4 trillion m³ of peat in the world covering a total of around 3% of global land area (about 4 million km²), containing about 8 billion Terajoules of energy (around 500 billion tons of carbon). 85% of the global peatland area is in only four countries, Russia, Canada, USA and Indonesia. Peat is commonly used in Belarus, Estonia, Finland, Ireland, Latvia, Lithuania, Russia, Ukraine and Sweden for energy production [1, 2]. In Finland and in Ireland about 5-7% of primary energy consumption relies on peat. In Estonia and Sweden this share is 1.9% and 0.7% respectively. In Latvia and Lithuania peat makes a smaller contribution to primary energy consumption.

Peat is mostly used for combined heat and power (CHP) production, resulting in a high total efficiency of the fuel used. The flue gas emissions can be effectively reduced to meet the requirements the EU has set for combustion plants. The co-firing of peat with biomass fuels is an important issue at local, regional and national levels for reasons related to accessibility, technical availability and pricing.

Due to technical reasons, biomass-fired boilers often need peat as a support fuel. Peat is an important domestic fuel for the Nordic and Baltic countries for security of supply and employment reasons. The use of domestic energy sources as heating materials increases in world every year. The reasons for this are simple; e.g., peat fuel is renewable, environmentally friendly, domestic and economical energy source, which decrease the amount of Sulphur and greenhouse gas emissions into the atmosphere. Peat fuel correspond to the demands of sustainable development set for heating energy sources of today [3].

Peat is combusted in the same way as biomass and coal. Local peat fuels play an important role in the decentralized and diversified energy system. They provide employment and welfare, and they secure the supply of energy.

2. CURRENT PEAT FUEL TYPES

Peat is a decomposed material, which has accumulated in waterlogged conditions. A substantial proportion consists of dead organic, plant-based matter. It is a slowly renewable natural resource for which there are many uses, particularly in energy and horticulture. The carbon content and calorific value, particularly those of highly decomposed peat, make peat suitable for use in energy. Generally, raw peat is high in moisture, low in bulk density, low in energy density.

There are some main forms in which peat is used as a fuel:

- **Milled peat (Fig.1, a)** - granulated peat, produced on a large scale by special machines; used either as a power station fuel or as raw material for briquettes;
- **Sod peat (fig.1, b)** - slabs of peat, cut by hand or by machine, and dried in the air; mostly used as a household fuel;
- **Peat granules (fig.1, c)** - fuel in the form of short cylindrical units, extruded peat, and dried in the drier; mostly used as a household fuel;
- **Peat briquettes (fig.1, d)** - small blocks or cylinders of dried, highly compressed peat; used mainly as a household fuel;
- **Peat pellets (fig.1, e)** - fuel in the form of short cylindrical units. highly compressed peat; used mainly as a household fuel.

Fuel peat produced by milling peat from the surface of the peatland and by drying it. Drying is normally done at the peat site by solar energy. Milled fuel peat is nonhomogeneous in particle size and contains mainly pulverous peat as well as peat particles of various sizes.

Fuel peat produced by extracting peat from the peatland by processing it mechanically into sods (e.g. cylindrical, wave-like). The sods are dried out by solar energy, mainly at the peat site. Peat sods are homogeneous in diameter or shape, while the length of the sods may vary.

Generally, milled fuel peat is high in moisture, low in bulk density, and low in energy density. This causes high transport and handling costs [4].

Ample research is ongoing to address these challenges, including developing more efficient equipment for drying, comminution, and densification. Depending on the point at which these operations take place, they could have a significant impact on the supply chain. Downstream transportation costs could be reduced by drying the peat and increasing the dry matter bulk density. It is more economical to burn the drier fuel with more heating value.

The granulation of peat [5] is use for:

- increases of specific calorific ability of fuel;
- increases in overall performance and possibility of full automation of heat power installations with power from 10-40 kW to 10-20 MW with real efficiency of 80-85%;
- increases of physical and bulk density of fuel;
- simplifications of the equipment for fuel storage, including technological, interoperation transport;
- essential decrease in costs of transportation and storage of fuel;
- possibilities of long fuel storage without deterioration in its characteristics, its negative influence on environment, health of service personnel and fire and explosion safety;

- improvements of service personnel working conditions.

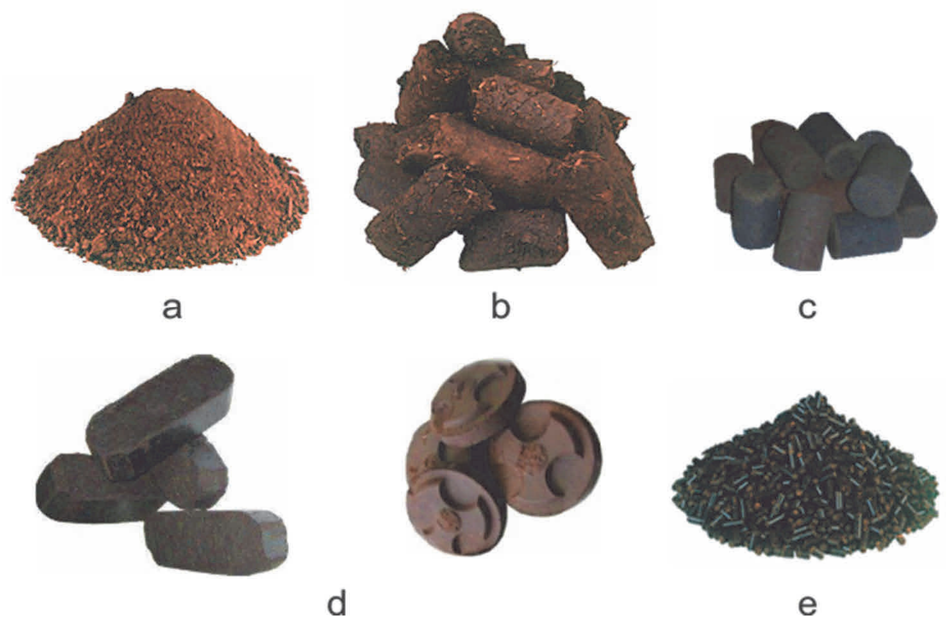

Fig. 1 Types of Peat Fuel. Source: [2, 6, 10].

Table 1 below shows approximate figures for how much energy is contained in different fuels per unit weight, or the "energy density" of fuel. Bulk density is important property for transportation, conveyors and for fuel feeding. The guidelines on classification, handling, storage and testing of fuel peat were produced in 2005 as a Nordtest method NT ENVIR 009 [6]. On **Fig. 2** was shown the space requirement for fuel consumption of 10 MWh.

Table 1 Comparison of the energy contents of different peat fuels

Fuel name	Typical shape and particle size	Moisture content, %	Bulk density, kg/m^3	Energy density, MWh/t
Milled fuel peat	Ø < 25 mm	40-50	200-350	2.7 - 2.9
Sod peat	Ø < 80 mm cylinder, cubic or wave like sod	33-40	280-550	3.2 - 3.4
Peat granules	Ø < 25 mm	30-40	400-500	3.4 - 4.0
Peat pellets	Ø < 25 mm	12	500-700	4.3 - 4.9
Peat briquettes	Diameter or the smallest dimension >25 mm	15-20	550-650	4.5 - 5.1

Pellet prices remain competitive compared with fossil fuels, which are more sensitive to market fluctuations. The startup of a pellet-fired plant is quick and easy, and the plant also reacts quickly to load changes. The high energy density of pellets enables simple fuel logistics, which minimizes the plant's environmental impacts. Pellet technology make possible to utilize renewable fuels in the form of wood pellets or briquettes.

Pellet boiler plant solutions ranging from 3 to 25 MWth/boiler support the production of renewable energy, providing improved cost-effectiveness for municipalities, industries and service providers.

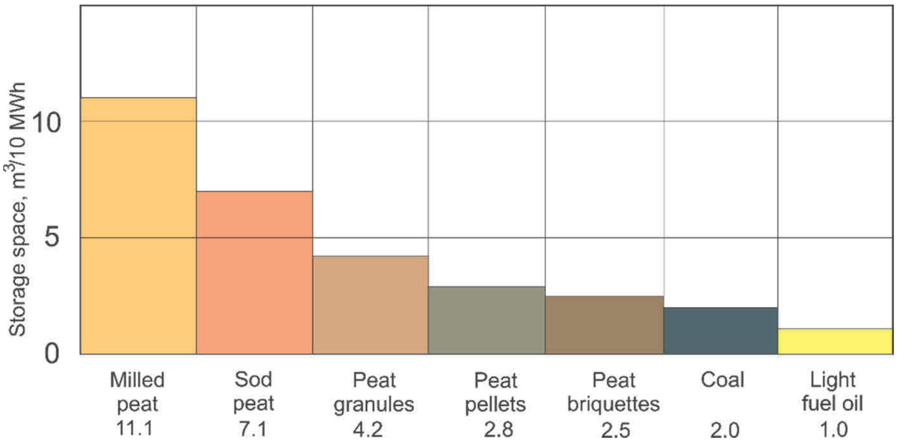

Fig. 2 Comparison of different peat fuel (fuel amount required for producing the same energy amount). Source: [10].

The pellet solution utilizes existing technologies to form a new combination of pulverized combustion technology and traditional water or steam boiler technologies.

Now the main advantages it is possible to call the following:

- low cost on unit of heating capacity;
- close arrangement of the mining enterprise (about 100 km);
- the possibility of sharp increase in consumption of fuel in peak loads, i.e. is not present need of accumulation and according to derivation of current assets on fuel purchase;
- small ash content; low sulfur content in fuel.

It is recommended to aim at fuel moisture that does not exceed 40% in bio systems with power less than 1000 kW. Peat fuel needs to be characterized by determining physical and chemical properties. Physical properties include mass and energy density, particle size and shape, but also mechanical properties such as flowability, storability and grindability. This shows that optimal excavation methods should be developed in combination with mechanical processing technologies that allow producing materials with properties that have been generated by optimization of the complete biofuel production chain [7].

3. CURRENT PEAT FUEL SUPPLY

Although there are some niche feedstocks that can be relatively easily harvested, transported, and used, peat has numerous inherent logistical challenges as a feedstock for fuels production [8].

A peat fuel supply chain encompasses all activities from feedstock production, peat logistics of storage and transportation, fuel production, and distribution to end consumers. **Fig. 3** depicts a schematic overview of a peat fuel supply chain network.

The logistic scheme of energy dense peat fuel production consists of three levels. The first level is peat field. Here the peat raw materials are formed, are exposed to roughing-out and collect in points of storage of raw materials. The main production operations connected with production of energy dense peat fuel are carried out at the third level - points of fuel production on which initially processed peat raw materials are separated, crushed, pressed, passes heat treatment and is packed. Further ready fuel is delivered to region heat sources - the third level of logistic system.

In general, peat energy supply chains can be divided into chains based on Peat field production, or Peat field production and Processing at the plant (**Fig. 3**).

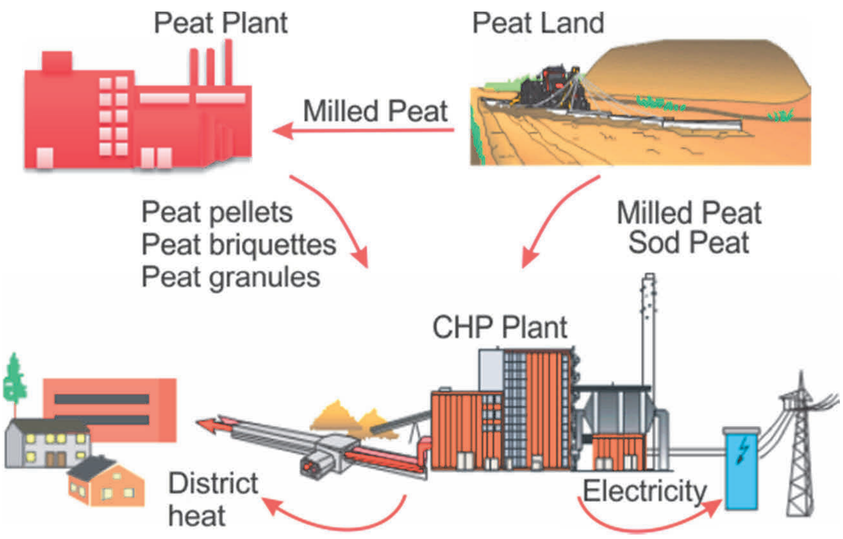

Fig. 3 Schematic description of peat fuel supply chain network. Source: [10].

Use of local types of fuel in Russia, including peat, gives the real chance of fuel costs reduction (Improving Logistics from 4000-5000 to 50-100 km).

Develop densification systems that do not impact convertibility and can be applied early in the supply chain to leverage reduced transportation cost, high- capacity transport, and handling infrastructure.

- bulk density can be increased by processing peat reducing particle size;
- peat pellets have a dry bulk density up to three to four times greater than that found in milled peat.

Storage systems are another component of logistics systems that offer an opportunity for supply chain integration.

Coordination between supply chains components could reduce the need for longer- term storage, such as by using "just-in-time" delivery. Alternatively, long-term storage capacity allows more flexibility in supply chain and provides a supply buffer.

Peat fuel supply chain network primarily focus on the supply side of uncertainties associated with seasonality of milled peat and sod peat production.

Today in regions (with peat fuel) of Russia, more than 14 thousand boiler rooms work at coals. The increase in prices for energy carriers with use of delivered non-renewable types of fuel (gas, coal, fuel oil) declines regions to use of local types of fuel.

At decision-making on power supply on the basis of increase in use of local fuel resources it is necessary to consider all aspects, including creation of additional workplaces (raw fuel base), growth of fossil fuel cost (non-renewable types of fuel), transport costs for fuel supply (delivered fuel), tax revenues in the consolidated budgets of regions.

Predesigns show that in 2015 the potential volume of replacement with peat fuel of non-renewable types of fuel on various regions can make about 3.6 million toe.

It can be as a result provided:

- release of 43 thousand railcars delivering fuel;
- economy of budgetary funds for fuel delivery of more than 49 million USD;
- increase up to 1,86 thousand workplaces in regions;
- receiving additional money in regional and local budgets for the sum more than 64 million USD.

To integrate the overall preparation (peat mining, harvest, storage, transport, and processing) of an advanced, uniform-format feedstock supply, we are pursuing development of a system that links regionally distributed peat fuel processing depots to a decentralized and diversified energy system [9].

4. CONCLUSION

Making use of local biofuels is an important means of reducing the dependency on imported fuels and creates employment opportunities for the local communities.

The availability, good quality, stable and predictable price of peat fuels are important factors to the users.

A peat fuel supply chain consists of various interdependent components from feedstock resources all the way to energy demand sites. This study focuses on the properties of peat fuel for evaluating the economic potential of feedstock supply interfaces and logistics.

Use of local renewable peat fuel resources in regions will allow providing growth of an internal national product, to cut down the budgetary expenses and, eventually, to increase power safety and non-volatility of regions, to optimum use the available fuel reserves in the country, to contain an increase in prices for energy carriers and thermal energy.

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