Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

TECHNICAL SUPPORT DOCUMENT

CHOOSING THE HEATING FUEL

OCTOBER 1984

Canada

TSD-5I-26

Technical Services and Contracts | **Services techniques et marchés**

CHOOSING THE HEATING FUEL

OCTOBER 1984

Disponible en français

CHOOSING THE HEATING FUEL

Table of Contents

CHOOSING THE HEATING FUEL

1.0 INTRODUCTION

1.1 General Remarks

This is a technical support document to DRM 10-7/51, Building Design, and is intended primarily as a guideline for the following users:

a. building services design engineers and technologists,

b. building planners and architects,

c. field engineering staff, and

d. engineering consultants.

1.2 Purpose

The purpose of this publication is to establish a standard evaluation procedure for selecting the most suitable fuels for use in Departmental buildings.

1.3 Scope

The publication sets out each step in the procedure for obtaining and evaluating all the relevant technical and non-technical information required in order that the design specialist may select the most suitable fuel(s)--based on established technical parameters and sound judgement--for the energy requirements of a building.

Note: Here the term "energy" includes all energy requirements for space conditioning and process and special energy loads, such as domestic hot water heating, process steam for the building and electrical energy but excludes requirements for lighting.

2.0 FUEL UTILIZATION ASSESSMENT

2.1 Gathering Data

The first step in assessing the needs of a particular building is to contact all fuel dealers and supply sources in the area to obtain pertinent data:

a. description of all fuels available in the area, whether in general use or not, including the average commercial calorific rating per delivery unit (Appendix A gives some examples with equivalent quantities);

b. description and average commercial calorific rating per delivery unit for other fuels which could be supplied or delivered to the site, but which are not in use in the area;

c. source of supply and long-term availability;

d. cost per delivery unit for each fuel load delivered to the building, where normal delivery situations prevail;

e. where the supplier's price does not include delivery charges, because of unusual site or delivery conditions, e.g. isolated areas, separate explanation of these situations and extra charges;

f. when long term site storage of fuel is required due to delivery procedures, climatic restrictions etc., details and estimated duration of this storage period; and

g. where site labour-intensive fuels such as coal, wood, peat, waste material, biomass, etc. are under consideration, provide this additional information:

   (1) availability of labour force and its reliability for uninterrupted fuel supply,

   (2) local wage rates for the labour classifications required and the number of employees anticipated in each group,

   (3) present asset value of and operating costs for existing local systems, and equipment used for fuel harvesting, processing, delivery, storage and use, and

(4) comments on the social and economic effect that the use or non-use of these fuels might have on the life of the community.

2.2 Comparing Heating Value

One must next establish the net calorific heating value by comparing the average commercial heating value per unit of fuel (see a. and b. above) with the official values listed in Appendix B for each type, class and grade of fuel being surveyed. In each case, the lower value shall be used in calculating fuel consumption.

3.0 BUILDING ENERGY REQUIREMENTS

3.1 Heating, Cooling and Ventilating Loads

Annual energy requirements for heating, cooling and ventilating are to be established in kilowatts by engineering calculations, using technically accepted methods and procedures such as those recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) in their current handbooks.

Refer to TSD 51-25 Space Conditioning Systems for Buildings for recommended procedures for establishing the building's energy requirements and the type of heating/cooling/ventilating systems to be installed.

3.2 Process and Special Energy Application Loads

Similarly, calculate annual energy requirements for process and special energy application loads where applicable. When the building under consideration requires fuel for domestic water heating, laundry or process drying equipment, process steam generation, etc., consideration should be given to using the same type of fuel which will ultimately be selected for space heating. This would have the following advantages:

a. reduced unit fuel costs due to larger volume consumption (where such reductions are available); and

b. use of common storage, delivery, and handling facilities, thus reducing initial capital and ongoing service costs.

4.0 FUEL COMPARISON/COSTING PROCEDURE

4.1 Annual Fuel Consumption

Take the energy demands calculated in sub-sections 3.1 and 3.2 and the heating values of fuels previously established in sub-section 2.2, and calculate the annual consumption for each type of fuel under consideration. This calculation must be done for both building space conditioning and process and special loads.

4.2 Costing Procedure

The following steps are recommended for arriving at fuel costs:

a. Calculating Current Cost of Fuels

Take the unit cost for each fuel (see d., sub- section 2.1) and add to these costs all supplementary charges calculated on a per unit basis given in points e. and g.

For projects annually consuming 50 000 kW of energy or less, no further costing is required, and the most economical fuel can be established at this stage.

Note: For projects of this size, the economics of the fuel selection should be considered with the non-economic considerations outlined in section 5.0 before selecting the fuel. For projects with higher energy consumption, proceed to step b.

b. Owning and Operating Cost

For projects with an annual energy consumption in excess of 50 000 kW, add the following costs for each fuel to the annnal fuel costs obtained in step a.:

(1) Annual Fixed Owning Costs

(a) Estimate the total cost of construction of the energy production system, e.g. boiler or furnace, boiler room equipment, chimney, fuel burning, and handling and storage facilities.

(b) Apply the appropriate capital recovery factor (CFR) (See Appendix 3) required to amortize this cost over the selected system life expectancy to obtain the required annual fixed owning cost. Use the same amortizing period for each system and current bank interest rates.

(2) Annual Operating and Maintenance Allowances

Estimate the annual cost of:

(a) operational labour charges,

(b) contracted maintenance service, and

(c) replacement, servicing, and lubrication of parts.

4.3 Economic Fuel Usage Evaluation

The estimated annual cost of choosing a particular fuel over others considered for a project establishes relationships among these fuels which are unique to the project. The relationships permit the designers to quickly evaluate the economic merits of each fuel system and select the one with the greatest economic advantage.

Note: The fuel and service costs used in the calculations may change considerably during the effective life of the system. However, these costs should rise proportionally to one another, and the relationship between the costs of fuels and services should remain relatively constant. Exceptional situations created by unpredictable economic, political or social implications have not been considered.

5.0 NON-ECONOMIC CONSIDERATIONS

On some projects, local, social or regional factors may become a significant or over-riding influence in the final choice of the heating fuel(s). Very often these factors cannot be compared or assessed on a strictly economic basis as can the costs of different fuels.

These factors or considerations are usually associated with the application of labour-intensive fuels such as wood, biomass, and coal, where local labour is needed on a continuing basis and its use

or non-use has a high impact on the social and perhaps economic well-being of the community. The factors listed in point g. of sub-section 2.1 should now be evaluated to ensure that the effect on the community is considered.

STEPS FOR THE SELECTION OF HEATING FUEL

PROCEDURE FOR CHOOSING HEATING FUEL

1. List fuels available and their commercial cal. value. (Refer to subsections 2.1a, 2.1b, 2.2).

2. Establish cost of fuel per unit delivered. (Ref. to sub-sections 2.1d, 2.1e, 2.1g).

3. Calculate annual energy demands for bldg. (Ref. to subsections 3.1; 3.2.)

4. Calculate annual fuel consumption for each fuel from heating values Box 1 and energy demands Box 3. (Ref. to subsection 4.1)

5. Calculate annual cost of each fuel from cost per unit delivered Box 2 and annual fuel consumption Box 4. (Refer to sub-section 4.2a).

6. For projects with fuel consumption of 50 000 kW or less make economic and non-economic evaluation at this stage to select fuel. (Ref. to sub-section 4.2, Step b; 5.0)

PROCEDURE FOR PROJECTS WITH ENERGY DEMANDS EXCEEDING 50 000 kW

7. Estimate total cost of construction of the energy production system and apply the capital recovery factor. (Ref. to sub-section 4.2b(1).

8. Estimate annual operating and maintenance costs. Ref. sub-section 4.2b(2).

9. Add the costs for each fuel obtained in Boxes 7 & 8 to annual cost of each fuel from Box 5.

10. Evaluate the fuel system from the economic and non-economic point of view.

SELECT HEATING FUEL

Appendix A

EQUIVALENT QUANTITIES OF ALTERNATIVE FUELS

One Tonne of Coal (As received) containing Kilojoules per Tonne	Domestic Fuel Oil No. 2 38,990 Kilojoules per Litre	Industrial Fuel Oils Nos. 5 and 6 41,770 Kilojoules per Litre	Natural Gas 37,260 Kilojoules per m^3	Propane 25,530 Kilojoules per Litre
Kilojoules	Litre	Litre	m^3	Litre
16,280,000	418	390	437	638
18,610,000	477	445	499	729
20,930,000	537	501	562	820
23,260,000	597	557	624	911
25,580,000	656	612	687	1002
27,910,000	716	668	749	1093
30,240,000	776	724	812	1184
32,560,000	835	780	874	1275

Appendix B

FUEL TYPES AND HEATING VALUES

FUEL TYPE	HEATING VALUE PER UNIT
Electricity	1 kWH = 3 600 KJ
Natural Gas	37.26 KJ/L
Propane Gas	25 530 KJ/L
Fuel Oil #2	38 990 KJ/L
Fuel Oil #1 (Arctic)	37 830 KJ/L
Fuel Oil 5B (Bunker)	42 700 KJ/L
Coal (Lignite)	16 280 - (17 440) 18 610 KJ/Kg
Coal (Hi-Grade Bituminous)	30 240 - (32 560) 34 890 KJ/Kg
Wood (well-seasoned, airdried) 15-25% moisture	14 890 KJ/Kg
Wood (Kiln dried) 8% moisture	19 770 KJ/Kg

Heating Value of Selected Woods

Species	Gross Heating Value per Air-Dry[1] CORD Kilojoule
Maple, Sugar	30,595,000
Ash, Green	26,375,000
Birch	25,320,000
Cottonwood, Poplar	16,880,000
Fir, Douglas	21,100,000
Hemlock, Western	21,100,000
Larch, Western	23,210,000
Pine, Ponderosa	18,990,000
Pine, Western	17,935,000
Cedar, Red	15,825,000
Spruce	15,825,000
Elm	24,265,000
Aspen	17,935,000

[1] A standard cord is the equivalent of a pile of 1.219 m logs stacked 1.219 m high and 2.438 m length, occupying a space of 3.62 m^3.

Appendix C

CAPITAL RECOVERY FACTORS

Rate of Return or Interest Rate, (%)

Years	3.5	4.5	6	8	10	12	15	20	25	30
2	0.52640	0.53400	0.54544	0.56077	0.57619	0.59170	0.61512	0.65455	0.69444	0.73478
4	.27225	.27874	.28859	.30192	.31547	.32923	.35027	.38629	.42344	.46163
6	.18767	.19388	.20336	.21632	.22961	.24323	.26424	.30071	.33882	.37839
8	.14548	.15161	.16104	.17401	.18744	.20130	.22285	.26061	.30040	.34192
10	.12024	.12638	.13587	.14903	.16275	.17698	.19925	.23852	.28007	.32346
12	0.10348	0.10967	0.11928	0.13270	0.14676	0.16144	0.18448	0.22526	0.26845	0.31345
14	.09157	.09782	.10758	.12130	.13575	.15087	.17469	.21689	.26150	.30782
16	.08268	.08902	.09895	.11298	.12782	.14339	.16795	.21144	.25724	.30458
18	.07582	.08224	.09236	.10670	.12183	.13794	.16319	.20781	.25458	.30269
20	.07036	.07688	.08718	.10185	.11746	.13388	.15976	.20536	.25292	.30159
25	0.06067	0.06744	0.07823	0.09368	0.11017	0.12750	0.15470	0.20212	0.25095	0.30043
30	.05437	.06139	.07265	.08883	.10608	.12414	.15230	.20085	.20531	.30011
35	.05000	.05727	.06897	.08580	.10369	.12232	.15113	.20034	.25010	.30003
40	.04683	.05434	.06646	.08386	.10226	.12130	.15056	.20014	.25006	.30001