Project Environmental Review (PER) Application for a S.82 *Impact Assessment Act* Permit
Vancouver Fraser Port Authority PER No. 22-017

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APPENDIX G: Project Energy Study

SACRÉ DAVEY

Project Energy Study

DP World Fraser Surrey

Canola Oil Export Facility

SDE #: 7819-EN-RPT-001
Revision A
June 30, 2022

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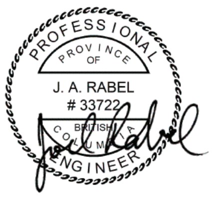

2022-07-01

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Revision History

Revision	Date	Revised by	Change Log	Approval
A	June 30, 2022	Joel Rabel Richard Mortimer	Issued for Permit	

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Glossary

The following abbreviations, acronyms and consecrated terms are used in this document:

ITEM	MEANING
BATNEC	Best Available Technology Not Entailing Excessive Cost
COHSR	Canada Occupational Health and Safety Regulations
DPW	DP World
ECM	Energy Conservation Measure
EMIS	Energy Management Information System
EIA	Environmental Impact Analysis
IESNA	Illuminating Engineering Society of North America
MT	Metric tonne (1 000 kg)
NBCC	National Building Code of Canada
PER	Project Environmental Review
SDE	Sacre-Davey Engineering
VFD	Variable Frequency Drive
VFPA	Vancouver Fraser Port Authority

1 Executive Summary

DP World Canada Inc. (DP World) is proposing to develop a canola oil transload facility (the Project) at DP World's Fraser Surrey Terminals located at 11060 Elevator Road, Surrey, British Columbia (BC) (the site). The Project includes development of new marine infrastructure to support vessel mooring and loading at the existing Berth 10, and the development of canola storage facilities and supporting transfer infrastructure on a parcel of land within the leased DP World Fraser Surrey terminal area. The Project site is fully located on federal lands and waters managed by the Vancouver Fraser Port Authority (VFPA).

The PER checklist provided by VFPA called for the preparation of a Project Energy Study. A review of the associated study guidelines revealed that it was geared towards existing facilities embarking upon capital projects involving (directly, or indirectly) energy conservation measures (ECM). This project is green-field in the sense that it is adding completely new facilities to an existing site and current "state of the art" technology and operational philosophies have already been included in the preliminary design process.

This report has been prepared with the belief that the intent of the study could be met by comparing the current forecasted energy usage calculations with a forecasted "non-optimised" design; with the difference being analogous to the potential savings that would normally be identified in a retrofit scenario.

The analysis took into account the following parameters:

- Energy loads in the plant: Motor loads, and lighting
- ECMs inherent in the current design:
  - Type of equipment (variable frequency drives versus normal fixed speed drives for the rail offloading and marine loading pumps).
  - Operational methodology (the control system design will use the variable frequency drives to operate the rail offloading pumps and the marine loading pumps only at the speed at which they are required to run, and not at full speed as would be the case for fixed speed drives).

Table 1: Net ECM Savings vs Discounted Design

#	ECM	Demand (kW)	Power Consumption (kWh/yr)
1	Pump VFDs - Railcar Unloading	29	81,688
2	Pump VFDs - Marine Loading	421	484,019
3	Lighting	14	91,551
	Total ECM Savings	464	657,258

2 Introduction

2.1 Project Overview

The Project includes the development of a canola storage facility, rail receiving, and marine loading infrastructure on Schedule A and B federal lands and waters lots within the VFPA leased DP World's Fraser Surrey Terminals.

A full description of the proposed plant is presented in the lead document of the PER application, and the reader is encouraged to refer to this document and its associated appendices for further details.

This particular document is one of the referenced appendices and is meant to be part of this application, as opposed to being a stand-alone study.

2.2 Existing Guidelines

VFPA's "Guidelines — Project Energy Study" were reviewed and in SDE's opinion, these were difficult to apply to the letter on the DPW project. The difficulty stemmed from the assumptions used, and requirements identified, in the guidelines which include:

- The assumption that the project under consideration involved the upgrade, in one form or another, of an existing facility.
- The study requirements for:
  - The cataloguing of existing energy consumption.
  - The identification of potential Energy Conservation Measures (ECM).
  - The analysis of the theoretical effect of the ECMs.

In contrast, the DPW project:

- Is not an upgrade but an entirely new development with totally new facilities, thus there are no preceding facilities to refer to for comparison purposes.
- There is no existing power consumption level to measure or categorize.
- The facility's design characteristics have already been established:
  - General arrangement.
  - Mechanical equipment quantities and characteristics.
  - Major structural elements.
  - Electrical power distribution.
  - Control system strategy.
  - Lighting.

- DPW have requested that the plant's design incorporate current best technologies, an approach which included ECMs to reduce power consumption (and thus cost of operation). As such, there are no major new ECMs to consider and evaluate.

In order to meet the intents of the Project Energy Study Guideline Studies, the following have been included in this study:

- Identify the ECMs that have been applied to the plant design.
- Compare the current forecast energy utilization calculations with a modified forecast for facilities not including the ECM (see further explanation in Section 3), the difference would be analogous to the potential savings normally identified in the retrofit scenario.

3 Study Methodology

The ECMs identified for analysis are the following:

Table 2: ECMs Identified for Analysis

#	ECM	Equipment Details
1	Pump VFDs - Railcar Unloading	
	Baseline (Downgrade)	Std. motor driven pump - 100% Load, No Profiles
	ECM 1A	VFD w/ Flow Profile
	ECM 1B	VFD w/ Lower Viscosity Profile
	ECM 1C	VFD w/ Tank Operating Profile
2	Pump VFDs - Marine Loading	
	Baseline (Downgrade)	Std. motor driven pump - 100% Load, No Profiles
	ECM 2A	VFD w/ Flow Profile
	ECM 2B	VFD w/ Lower Viscosity Profile
	ECM 2C	VFD w/ Tank Operating Profile
	ECM 2D	VFD w/ Head & Flow Rate Profile
3	Lighting	
	Baseline (Downgrade)	HID/Fluorescent Equivalent - No Controls
	ECM 3A	LED Lighting - No Controls
	ECM 3B	LED Lighting w/ Controls

4 ECM #1 - Railcar Unloading

4.1 Equipment Overview and Selection Criteria

4.1.1 Pump Sizing – Design Requirements

The pumps were sized in order to be able to complete an unloading cycle for 32 railcars within a single eight-hour shift under the worst conditions, which are:

- When the ambient temperature is at the site minimum of -13°C as this is when the canola oil viscosity is highest, thus requiring more pump discharge head and power.
- When the storage tank level is at it's maximum level beyond which the pumps would be tripped to prevent overfilling of the tank.

Note: The difference in size between the railcar unloading pumps and the marine loading pumps is so large that it was not even considered to be a feasible solution of providing one combined set of pumps for both duties, this will therefore not be evaluated further in this study.

4.1.2 Line Sizing

Pump discharge liquid lines have been sized conservatively with line velocities in the region of 3 m/s rather than 5 to 6 m/s, this results in a higher capital cost but reduces pump required discharge head and required power significantly. SDE would not recommend sizing lines for higher velocities and this will therefore not be evaluated further in this study, although it is a substantial power saving that is incorporated in the current design.

4.1.3 Operation – As Required

In any scenario the control system planned for DPW will operate only the equipment that is required for any particular operation for the duration that is required for that activity. In no scenario (As Selected or Baseline) are pumps assumed to run when not required to. For example, when unloading railcars the railcar unloading pumps will only be running at the frequency required to unload the number of railcars being drained and the marine loading pumps would not even be running unless marine loading was also occurring simultaneously.

4.1.4 Operation – VFD Demand

The Selected Equipment of VFDs and the Operational Methodology are inter-related, it would not be possible to employ the selected Operational Methodology without the VFDs as the Selected Equipment.

4.2 Railcar Unloading ECM – Baseline (Downgrade)

4.2.1 Methodology

Calculate annual power consumed for the railcar unloading pumps based on the required driver power at the design conditions for a fixed speed drive i.e. Direct on Line or Soft Starter (the design NOT selected). Fixed speed pumps would run at full speed and would need to be throttled via flow control valves.

4.3 Railcar Unloading VFD – As Selected

4.3.1 Methodology

Calculate annual power consumed for the railcar unloading pumps based on the required driver power at the actual conditions for variable frequency drives running at the actually required pump speed i.e. for the design selected. There are three contributing factors to the difference in power consumed for the VFDs versus fixed speed drivers (baseline) for the railcar unloading pumps. Pump power for the VFDs was therefore calculated taking each of these three benefits into account, as detailed below.

4.3.1.1 ECM 1A - Variable Flow Rates

Each unloading cycle includes two periods (connection and opening the railcars to commence unloading, and end of cycle when the railcars are emptied and are closed and disconnected) when full flow (VFD speed) is not required on the pumps. The VFDs are able to run only at the required speed whereas the fixed speed pumps would be throttled and hence have their normal power consumption under these conditions.

4.3.1.2 ECM 1B - Canola Viscosity (Variable Hydraulics)

The pumps and motors were sized based on worst case conditions outlined in section 4.1 above.

It is thus apparent that for ambient temperatures higher than – 13°C the required pump head and therefore required break horsepower power will be lower. The VFDs can reduce their output power by varying the pump speed to match the required system power.

4.3.1.3 ECM 1C - Storage Tank Level - Variable Hydraulics

The pumps and motors were sized based on worst case conditions outlined in section 4.1 above.

It is thus apparent that for tank levels lower than the maximum tank level, the required pump head and therefore required break horsepower power will be lower. The VFDs can reduce their output power by varying the pump speed to match the required system power.

5 ECM #2 – Marine Loading

5.1 Equipment Overview and Selection Criteria

5.1.1 Pump Sizing – Design Requirements

The pumps are required to be able to load a ship at a rate of 1,000 MT/h under the worst conditions, which are:

- When the ambient temperature is at the site minimum of -13 C as this is when the canola oil viscosity is highest, thus requiring more pump discharge head and power
- When the storage tank level is at it's minimum beyond which the pumps would be tripped to prevent cavitation of the pumps
- A further much larger factor is that the pumps have been sized in order for any single marine loading pump to be able to maintain a minimum loading rate of 700 MT/h as this is a contractual minimum average loading rate in the contract which DPW have with their client in order to minimize costs associated with the ship being loaded. This is a significant excess of capacity for normal conditions when two pumps are operational, but is required for any periods when only one pump may be operational in order to avoid financial penalties as per the contract.

5.2 Marine Loading Pump - ECM Baseline (Downgrade)

5.2.1 Methodology

Calculate annual power consumed for the Marine Loading pumps based on the required driver power at the design conditions for a fixed speed drive i.e. Direct on Line or Soft Starter (the design NOT selected). Fixed speed pumps would run at full speed and would need to be throttled via flow control valves.

5.3 Marine Loading Pump VFD – As Selected

5.3.1 Methodology

Calculate annual power consumed for the marine loading pumps based on the required driver power at the actual conditions for variable frequency drives running at the actually required pump speed i.e. for the design selected. There are four contributing factors to the difference in power consumed for the VFDs versus fixed speed drivers (baseline) for the marine loading pumps. Pump power for the VFDs was therefore calculated taking each of these four benefits into account, as detailed below.

5.3.1.1 ECM 2A - Variable Flow Rates

Each loading cycle includes two periods (connection and ramping up of flow to the ship when commencing with loading, and end of cycle when the loading rate is ramped down to avoid overfilling of the ship's cargo tanks as well as to prevent a hydraulic hammer of the marine loading line when loading is complete) when full speed is not required on the pumps, the VFDS are able to run only at the required speed whereas the fixed speed pumps would be throttled and hence have their normal power consumption under these conditions

5.3.1.2 ECM 2B - Canola Viscosity (Variable Hydraulics)

The pumps and motors were sized based on worst case conditions outlined in section 4.1 above.

It is thus apparent that for ambient temperatures higher than – 13°C, the required pump head and therefore required break horsepower power will be lower. The VFDs can reduce their output power by varying the pump speed to match the required system power.

5.3.1.3 ECM 2C - Storage Tank Level - Variable Hydraulics

The pumps and motors were sized based on worst case conditions outlined in section 4.1 above.

It is thus apparent that for tank levels higher than the minimum tank level, the required pump head and therefore required break horsepower power will be lower. The VFDs can reduce their output power by varying the pump speed to match the required system power.

5.3.1.4 ECM 2D – Required Pump Capacity

The pumps and motors were sized based on worst case conditions outlined in section 4.1 above.

It is thus apparent that when two pumps are operational, the required flow from each is reduced and the break horsepower will be significantly reduced. The VFDs can reduce their output power by varying the pump speed to match the required system power.

6 ECM #3 – Lighting

6.1 Equipment Overview and Selection Criteria

The proposed lighting system has several features to reduce energy consumption and light pollution.

6.1.1 Lighting Technology

All lights shall be modern LED technology and associated long lasting LED drivers. Lights shall be full cut-off or equivalent lensing.

6.1.2 Proposed Lighting Controls

Exterior area lighting will normally be maintained via photocells and dimmers (where suitable) at the lowest possible levels to meet emergency egress code requirements (COHSR, NBCC). Should access be required for nighttime work, lighting levels will be increased at the specific areas to the required WSB approved levels on an as needed basis by operations, using local and/or remote lighting controls. See below for DP World's lighting requirements:

DP World Lighting Requirements **Minimum Standards for Safety Environment / Operational Safety Standard – Pedestrian Safety (OS1)**	Min. Lighting Level
Sites shall provide a minimum of 10 Lux in all roadways and segregated pedestrian routes.	10 Lux
Sites shall provide a minimum of 50 Lux in areas where personnel and equipment work in close proximity.	50 Lux

Standard operating procedures (SOPs) and 24/7 security will ensure lighting is only used by authorized personnel as required.

6.2 Lighting Baseline – Downgrade to HID, No Controls

6.2.1 Methodology

Based on the preliminary Lighting Plan's lighting schedule summary, replace the lights with the equivalent wattage "downgraded" HID or fluorescent luminary. Sum the total load based on quantities. The energy consumption is calculated by assuming the lights are on from dusk to dawn, only controlled by a photocell.

6.3 ECM 3A - Lighting – LED Lights, No Controls

6.3.1 Methodology

Based on the preliminary Lighting Plan's lighting schedule summary, sum the total load based on quantities. The energy consumption is calculated by assuming the lights are on from dusk to dawn, only controlled by a photocell.

6.4 ECM 3B - Lighting – LED Lights, With Controls

6.4.1 Methodology

Based on the preliminary Lighting Plan's lighting schedule summary, sum the total load based on quantities each area. Next assign the operating hours for each lighting zone. Factor any operating hours that are expected to be between dusk and dawn. Sum the total for this first part, then determine if each zone can be operated at a lower lighting level when the zone is not in use at night. For areas that can be reduce, apply the dimming factor (we assumed 33%), for the remainder of the annual dusk to dawn hours. Sum the total dimmed hours energy consumption (W x hrs), and add this to the Operating ours to get the total energy consumption.

It should be noted that these lighting control savings estimates are approximate, the actual savings will depend on application characteristics such as occupant behavior, building design, site orientation, availability of daylight, device settings and level of commissioning.

7 Summary of Results and Expected Savings

The summary of the study results are as follows:

Table 3: Summary of Energy Savings

#	ECM	Demand (kW)	Power Consumption (kWh/yr)
1	**Pump VFDs - Railcar Unloading**		
	Baseline (Downgrade)	158	285,261
	ECM 1A	158	248,689
	ECM 1B	155	243,215
	ECM 1C	130	203,574
	Savings	**29**	**81,688**
	% Reduction	**18%**	**29%**
2	**Pump VFDs - Marine Loading**		
	Baseline (Downgrade)	1,011	1,073,891
	ECM 2A	1,011	1,010,721
	ECM 2B	874	874,380
	ECM 2C	826	825,612
	ECM 2D	590	589,872
	Savings	**421**	**484,019**
	% Reduction	**42%**	**45%**
3	**Lighting**		
	Baseline (Downgrade)	30	145,550
	ECM 3A	16	78,367
	ECM 3B	16	54,000
	Savings	**14**	**91,551**
	% Reduction	**47%**	**63%**
	Combined Baseline (Downgrade)	**1,199**	**1,504,703**
	Combined ECMs	**735**	**657,258**
	TOTAL Savings	**464**	**847,445**
	TOTAL % Reduction	**39%**	**56%**

Notes:

1. "Baseline (Downgrade)" represents the scenario where both the equipment choices AND the operational methodology that are features of the current design HAVE NOT BEEN INCORPORATED in the design.
2. The figures above are theoretical and approximate. The actual energy usage will depend (among other factors) upon the specific equipment selected.

8 Implementation Strategy

8.1 Measurement

Modern VFDs have current and power measurement integral to their controls. These can and should be tied to the plant control system and data historian.

Similarly, power or current measurement can be added to lighting panels and feeder breakers to monitor system wide and subsystem power consumption. This is recommended as is will be a key part of the inputs to the energy management information system (EMIS).

8.2 Energy Management System

It is recommended that DPW implement an Energy Management System, which is typically comprised of an EMIS for gathering the energy consumption information, and corporate reporting system to assign responsibilities, allow for recommendations and suggestions, and track performance and other key metrics.

9 Conclusions

The use of VFD on the main motor loads ECM #1- Railcar Unloading pumps, and ECM #2 – Marine Loading pumps, provide significant demand and energy consumptions savings (29% and 45% for annual energy use reduction respectively). This is primarily since these pumps must be sized for the worst-case conditions, but normally operate at more favorable conditions. The use of VFDs allow the pumps to reduce the output power to match the demand as needed, while conventionally driven motors are limited to using less efficient throttling valves.

The use of LED lighting and lighting controls in ECM #3, vs a downgraded baseline of less efficient HID and fluorescent lighting also saves a significant percentage of annual energy consumption (56%), however it is a small contributor being only 10.8% of the proposed systems consumption.

All three ECMs are clearly worth including in the detailed design phase of this project.

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