



Fisheries and Oceans
Canada

Pêches et Océans
Canada

Canadian
Coast Guard

Garde côtière
canadienne

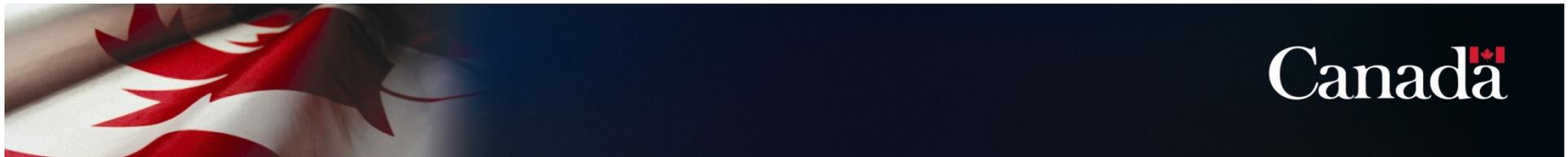


COMPARISON STUDY OF ELECTRIC, ELECTRO-HYDRAULIC, AND HYDRAULIC DRIVE SCIENCE WINCHES

Presented by: Vince De Angelis

Canadian Coast Guard, Major Crown Projects Directorate

ERVO Meeting, May 2009



Introduction

- CCG Major Crown Projects Directorate (MCPD) created in June 2006.
- Manage acquisition of new vessels under 25 year Fleet Renewal Plan.
- CCG fleet comprises 114 vessels and 22 helicopters.
- 38 vessels greater than 25 years old and 34 between 15 and 24 years old.
- Replacement vessels currently identified:
 - 12 Mid-Shore Patrol Vessels (MSPV);
 - 3 Offshore Fisheries Science Vessels (OFSV);
 - 1 Offshore Oceanographic Science Vessel (OOSV); and
 - 1 Polar Class Icebreaker.
- Project Support group provides technical support to MCPD.



Current CCG Fleet

Vessel Class	Number
Heavy Icebreakers	2
Medium Icebreakers	4
High Endurance Multi-Tasked Vessels	7
Medium Endurance Multi-Tasked Vessels	5
Offshore Patrol Vessels	4
Mid-Shore Patrol Vessels	7
Offshore Oceanographic Science Vessels	2
Offshore Fisheries Science Vessels	4
Air Cushion Vehicle	4
Special Nav aids Vessels	3
SAR Lifeboats	39
Hydrographic Survey Vessels	5
Channel Survey and Sounding Vessels	2
Mid-Shore Fishery Research	6
Specialty Vessels	20



Winch Drive Study

- Winch drive study conducted during winter of 2009.
- Compared AC electric drive, electro-hydraulic, and hydraulic drive science winches.
- CCG science winches traditionally powered by electro-hydraulic and hydraulic drive systems.
- Preferred by CCG Fleet due to:
 - cost;
 - maintainability;
 - performance; and
 - reliability.
- Negative experiences with DC electric drive winches due to:
 - inefficiency; and
 - maintainability.



Winches Evaluated

Winch Drive Study

Winch	Quantity	Bare Drum Pull (kg)	Bare Drum Speed (m/s)	Wire Length (m)	Wire Diameter (mm)
Sweepine	4	10,000	1.0	1,000	19.0
Trawl Sonar	1	6,000	2.0	3,000	11.0
Outhaul	1	6,000	1.0	850	16.0
Gilson	2	15,000	0.8	400	23.0
Codend	1	10,000	0.6	400	23.0
Trawling	2	60,000	1.0	4,100	32.0
Net Drum	1	20,000	0.5	10 m ³ Storage Capacity	
CTD	1	7,000	2.0	4,000	8.2
Plankton	1	3,000	3.0	4,200	10.0
Scientific A	1	7,500	0.8	3,000	8.2
Scientific B	1	7,500	0.8	3,000	12.0
Scientific C	1	3,000	3.0	2,500	10.0
Towfish	1	8,000	0.8	1,500	20.7
Oceanographic	1	18,000	1.2	5,000	25.4



- The following criteria were used to assess the advantages and disadvantages of the drive systems:
 - Size and mass;
 - Energy consumption;
 - Reliability;
 - Maintainability;
 - Cost;
 - Tension, speed and payout control;
 - Heating and cooling issues; and
 - Environmental impacts.



AC Electric Drive Winches

Winch Drive Study

- Viable alternative to electro-hydraulic and hydraulic drive winches.
- Preferred for new science and commercial fishing vessels due to:
 - reduced energy consumption;
 - reduced maintenance;
 - less noise;
 - precision control; and
 - no hydraulic oil required.
- AC electric drive winches comprise of:
 - a variable frequency drive;
 - an AC induction motor;
 - a reduction gearbox;
 - a sensor feedback and control system;
 - a cooling system; and
 - a braking system.



<http://www.vacon.com>



Electro-Hydraulic Drive Winches

Winch Drive Study

- Used in marine environment for decades.
- Preferred due to:
 - reliability;
 - adaptable to various operating conditions;
 - relatively simple to operate and maintain;
 - precision control.
- Electro-hydraulic drive winches comprise of:
 - a hydraulic power unit (HPU);
 - a hydraulic motor;
 - a sensor feedback and control system;
 - a cooling system; and
 - a braking system.



Hydraulic Drive Winches

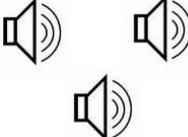
Winch Drive Study

- Similar to electro-hydraulic drive systems except one HPU is used to power various hydraulic motors.
- Use a header and branch configuration (i.e., hydraulic ring-main).



Size and Mass

Winch Drive Study

	Winch Footprint & Volume	Winch Mass	Total System Volume	Total System Mass
Electric Drive				
Electro-Hydraulic Drive				
Hydraulic Drive				



<http://www.hzpt.com>



www.offshore-technology.com

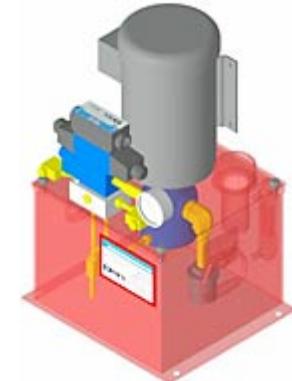
Total system volume and total system mass includes piping, fittings, hydraulic power units, electrical cabling, conduits, and control cabinets. The results are dependant on the number of winches fitted.



Energy Consumption

- Electric drive winches gaining preference due to reduced energy consumption.
- Reduced energy consumption attributed to:
 - winch efficiency (input/output power).
 - power generated during regen. braking.
- Electric drive winch efficiency estimated to vary between 70% to 85%.
- Electro-hydraulic drive winch efficiency estimated to vary between 45% to 70%.
- Hydraulic drive winch efficiency estimated to vary between 35% to 60%.

Winch Drive Study



<http://www.dynexhydraulics.com/puspecs.htm>



http://www.nasa.gov/audience/forstudents/k-4/dictionary/Gauge_prt.htm

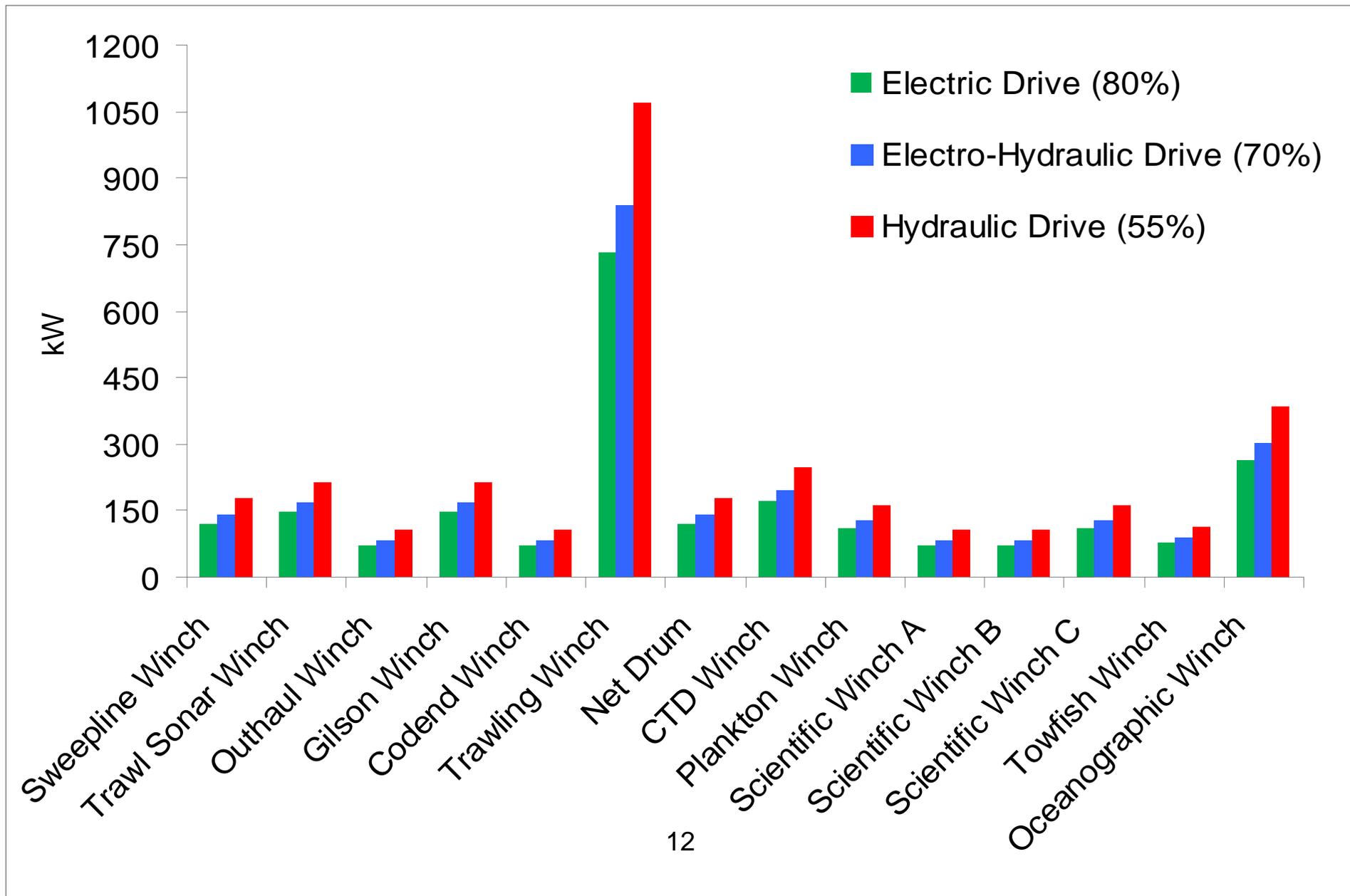


<http://www.eberhardbauer.com/agseriesen.htm>



Energy Consumption

Winch Drive Study



Energy Consumption

Winch Drive Study

- Atlantic Enterprise consumed approximately 70% less power during trawling than the Ocean Tiger.
- Atlantic enterprise generates approximately 200 kW of power during lowering of trawl net.
- Ocean Tiger consumes approximately 300 kW during lowering of trawl net.
- Estimate average of 400 kW of power per trawling winch per 24 hours generated during regenerative braking.



<http://www.cbc.ca/canada/north/story/2008/12/08/crash-update.html>



<http://www.ocean-prawns.com/tiger.html>



Electro-Hydraulic & Hydraulic Drive Winches:

- Successfully used on board CCG Ships for decades.
- Used on board research vessels and commercial fishing vessels due to reliability in extreme environments.



Electric Drive Winches:

- Increased use among new commercial fishing vessel and research vessels in Europe and the USA (5 -10 years).
- Fewer moving parts maintains reliability over time.
- Failures of electric drives, power supplies and controls have been reported.



Vessels Fitted with AC Electric Drive Winches

Vessel	Flag State	Year Commissioned	Type of Vessel
Arctic Endurance	Canada	2000	Fishing Vessel
Atlantic Enterprise	Denmark	2002	Fishing Vessel
Brimnes	Iceland	2003	Fishing Vessel
Centurion del Atlantico	Argentina	1986	Fishing Vessel
Newfoundland Lynx	Canada	2004	Fishing Vessel
New Found Pioneer	Canada	1989 ¹	Fishing Vessel
RRS James Cook	UK	2006	Research Vessel
RV Arni Fridriksson	Iceland	2000	Research Vessel
RV G.O. Sars	Norway	2003	Research Vessel
RV Hugh R. Sharp	USA	2006	Research Vessel
RV Kilo Moana	USA	2003 ²	Research Vessel
RV Maria S. Merian	Germany	2006	Research Vessel

Notes: 1. New Found Pioneer winch motors and drives upgraded in 1994-1995.

2. AC electric drive winch to be installed in December 2009.

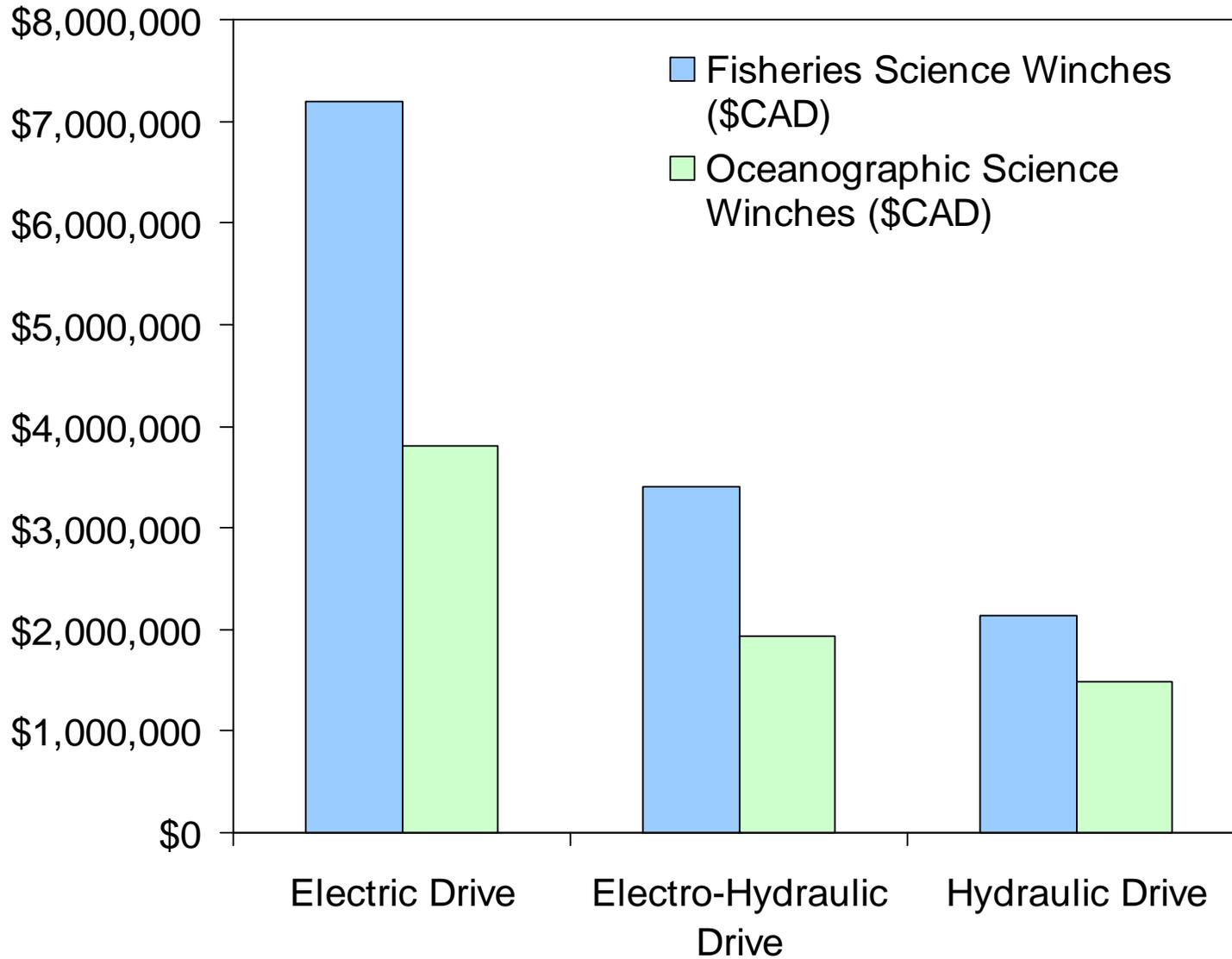


	Electric Drive	Electro-Hydraulic & Hydraulic Drive
Routine Maintenance	<ul style="list-style-type: none"> • minimal 	<ul style="list-style-type: none"> • significantly greater
Preventive Maintenance	<ul style="list-style-type: none"> • minimal 	<ul style="list-style-type: none"> • significantly greater
Troubleshooting & Repair	<ul style="list-style-type: none"> • time consuming to troubleshoot • specialized electrical training 	<ul style="list-style-type: none"> • easier to troubleshoot • familiarity with technology
Spare Parts	<ul style="list-style-type: none"> • less consumables • repair by replacement requires large quantity of spares • limited to specific suppliers 	<ul style="list-style-type: none"> • suppliers worldwide • parts can be manufactured or used from other systems on board (e.g., cranes)
FSR Support	<ul style="list-style-type: none"> • availability and cost an issue 	<ul style="list-style-type: none"> • available support within organization



Acquisition Cost

Winch Drive Study



Electric Drive:

Issues:

- AC motor & VFD failures due to:
 - lack of cooling;
 - moisture; and
 - contaminants.

Solutions:

- Water cooled motors & enclosures.

Advantages:

- Prevent overheating.
- Eliminate moisture & contaminants issues.

Disadvantages:

- Increase the cost of the system.
- Require cooling water.

Electro-Hydraulic & Hydraulic Drive:

Issues:

- Poor hydraulic fluid performance due to hot & cold liquid temperatures.

Solutions:

- Immersion heaters & cooling systems.
- Relocated HPU within the vessel.

Advantages:

- Immersion heaters are less expensive.
- HPU is protected from the elements & less expensive to heat & cool.

Disadvantages:

- Increase piping required to deliver fluid to the winches.



Electric Drive:

Advantages:

- Quiet operation.
- Eliminate hydraulic fluid.

Disadvantages:

- Faulty electrical components must be disposed of through proper channels.

Electro-Hydraulic & Hydraulic Drive:

Advantages:

- HPU can be relocated within vessel to control noise.

Disadvantages:

- Airborne & structural noise – expensive noise reduction techniques.
- Dirty hydraulic fluid, hydraulic filters and cleaning rags must be disposed of through proper channels.
- Potential for hydraulic fluid spills and fires.



Summary

Winch Drive Study

Criteria	Electric Drive	Electro-Hydraulic Drive	Hydraulic Drive
Size & Weight	Good	Bad	Satisfactory
Energy Consumption	Very Good	Good	Bad
Reliability	Very Good	Very Good	Very Good
Maintainability	Satisfactory	Very Good	Very Good
Acquisition Cost	Bad	Good	Very Good
Installation Cost	Very Good	Very Good	Bad
Maintenance Cost	Good	Bad	Satisfactory
Tension, Speed & Payout Control	Very Good	Very Good	Satisfactory
Heating & Cooling	Good	Good	Very Good
Environmental Impacts	Very Good	Bad	Satisfactory



- Electric, electro-hydraulic, and hydraulic drive winches each possess advantages and disadvantages.
- Selection of winch drive should be based on the intended use and should be compared against weighted criteria.
- All three drive systems have been used successfully on board commercial fishing vessels and research vessels.
- Many newly constructed commercial fishing vessels and research vessels are installing electric drive winches.

