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## DEVELOPMENT OF A HYBRID SCOOPTRAM



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## HYBRID SCOOPTRAM

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4. Benefits
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## HYBRID SCOOPTRAM OBJECTIVES

- ↯ To offer production equipment requiring limited underground mining ventilation for narrow-vein deposits
- ↯ To be proactive with respect to legislation related to emissions of combustible particles
- ↯ To promote and maintain mechanization of narrow-vein mining

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## ENCOUNTERED PROBLEMS IN NARROW-VEIN DEPOSITS

- ↯ Ventilation of distant stopes
- ↯ Stricter standards for emissions of respirable combustible dust particles
- ↯ Reduction of scooptram flexibility related to electric cables
  - ↯ Limited mechanical availability due to frequent electric cable damages (cable reel system)

*These aspects adversely affect the introduction of scooptrams and mechanization of narrow-vein deposits*

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## APPROACH

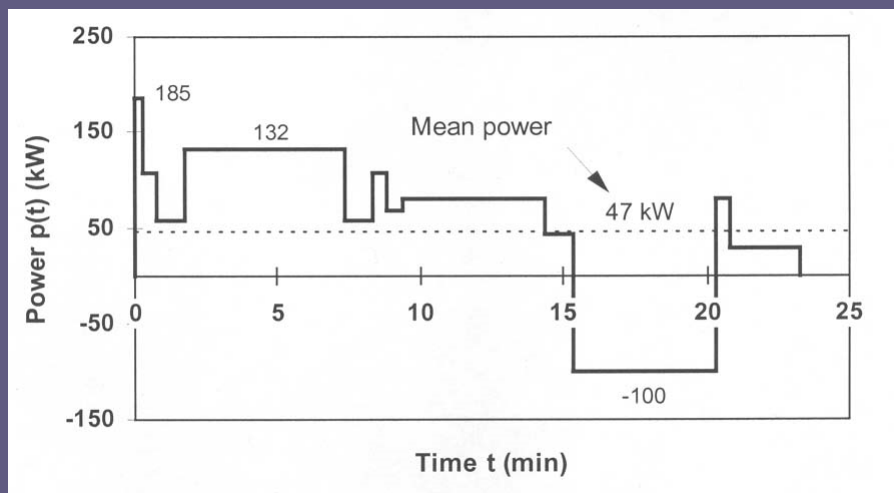
- ↖ Offer to the industry an intermediate solution between zero emission and diesel engine vehicles
- ↖ Replacement of diesel engine by an electrical motor connected to a battery stack
- ↖ Utilization of a small diesel engine running at a steady RPM connected to a diesel auxiliary power unit
- ↖ Motor utilization at its optimum range of efficiency

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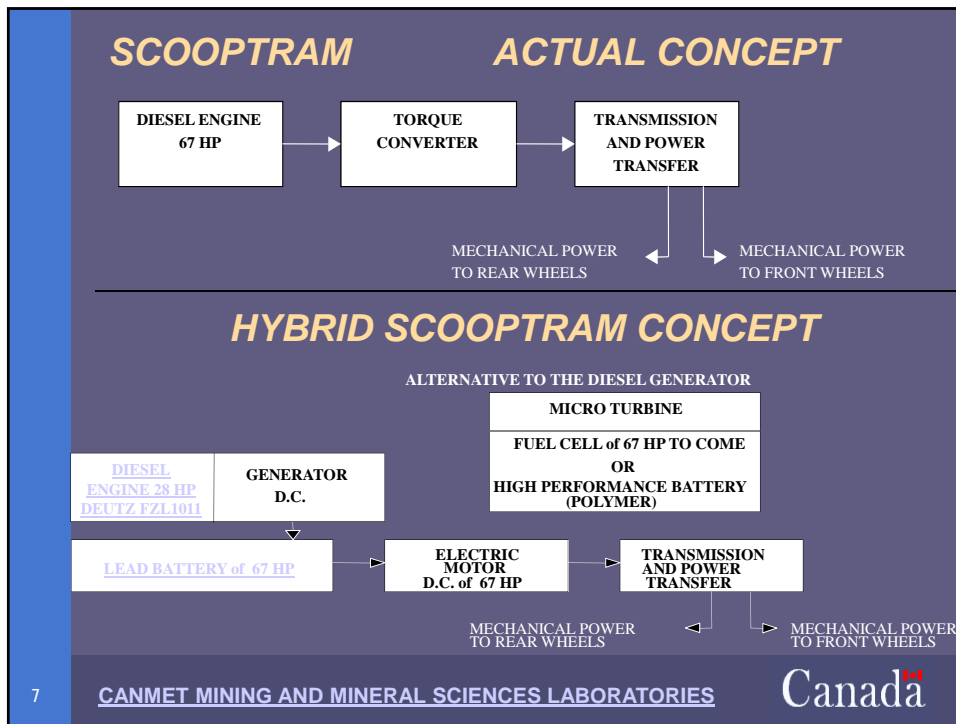
The power of an engine is calibrated to react to a maximum effort in a portion of the cycle



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- ### BENEFITS FOR THE WORKING ENVIRONMENT
- ↯ More efficient catalytic system for constant high temperature of exhaust gases
  - ↯ Elimination of transient mode
  - ↯ Maximum elimination of polluting emission rate during intensive work
  - ↯ Reduction of released heat (40%-50%)
    - ↯ Diesel engine at optimal operating point
    - ↯ Elimination of torque converter
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## BENEFITS FOR THE INDUSTRY

- ↖ Reduce or maintain the ventilation flow in order to respect the new upcoming legislation
- ↖ Effect on capital cost (ventilation raise, surface ventilation)
- ↖ Savings on operation cost
  - ↖ Heating
  - ↖ Electricity - main ventilation
  - ↖ Electricity - auxiliary ventilation
  - ↖ Climatization (if required)

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## BENEFITS FOR THE INDUSTRY

### DOWNSIDE

- ↖ Initial cost of hybrid scooptram will be at least 25% higher
- ↖ Higher operation costs
  - ↙ Battery replacement
- ↖ Reliability to be proven
  - ↙ Electric components
    - Traction motor reliability
    - Battery cycle life
- ↖ High voltage hazards (300 volts DC)

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## HYBRID SCOOPTRAM PROJECT DEFINED MARKET

- ↖ LHD technology is already strongly established in mines
- ↖ Regulations dealing with diesel emissions will be tightened in the coming years (zero emission)
- ↖ Potential of this approach validated during data collection in Canada, the United States and Australia
- ↖ Same conclusions reached by the manufacturer with its own market survey (MTI)

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## HYBRID SCOOPTRAM - BUDGET ESTIMATED COST OF THE PROJECT

↖ Validation with bench testing	\$ 44 000
↖ Material, including new scooptram	\$ 350 000
↖ Scooptram modifications	\$ 75 000
↖ Testing and optimization	\$ 70 000
↖ Comparative study with conventional scooptram	\$ 60 000
↖ Three-month underground testing	\$ 110 000
↖ Reporting and documentation	\$ 35 000
↖ Contingencies (20%)	\$ <u>149 000</u>
↖ TOTAL	\$ 893 000

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## **HYBRID SCOOPTRAM - BUDGET PARTNERS AND POTENTIAL FINANCING**

- ↖ **IRSST - Occupational Health and Safety Research Institute (Quebec)**
- ↖ **MTI - Mining Technologies International Inc.**
- ↖ **CED - Canada Economic Development and FEDNOR - Federal Economic Development Initiative for Northern Ontario**
- ↖ **NRCan - Climate change**
- ↖ **Agence de l'efficacité énergétique (Québec)**

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## **HYBRID SCOOPTRAM NEXT STEPS**

- ↖ **Concept validation with bench tests at CANMET, Ottawa**
- ↖ **Negotiations of a commercialization agreement with a manufacturer**
- ↖ **Construction of prototype**
- ↖ **Prototype testing at CANMET Experimental Mine (Val-d'Or, Québec)**
- ↖ **Publication of results**
- ↖ **Tests in an industrial environment**

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## HYBRID SCOOPTRAM ECONOMIC MODEL-AGNICO-EAGLE MINE

YEAR	0	1	2	3	4	5
VENTILATION SAVING (cfm)	6000	6000	6000	6000	6000	6000
VENTILATION CAPITALIZATION						
Main (\$/cfm)	25.00					
Auxiliary (\$/cfm)	0.98					
Climatization (\$/cfm)	7.50					
OPERATION COSTS						
Heating		0.73	0.73	0.73	0.73	0.73
Electricity - main ventilation		0.29	0.29	0.29	0.29	0.29
Electricity - auxiliary ventilation		0.87	0.87	0.87	0.87	0.87
Climatization		0.20	0.20	0.20	0.20	0.20
<b>TOTAL SAVING (\$/cfm)</b>	<b>33.48</b>	<b>2.09</b>	<b>2.09</b>	<b>2.09</b>	<b>2.09</b>	<b>2.09</b>
<b>TOTAL SAVING (\$)</b>	<b>200,880.00</b>	<b>12,540.00</b>	<b>12,540.00</b>	<b>12,540.00</b>	<b>12,540.00</b>	<b>12,540.00</b>
FUEL SAVING (\$)	0.00	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00
STANDARD SCOOPTRAM 250 000\$						
HYBRID SCOOPTRAM 312 500\$						
ADDITIONAL COSTS	(62,500.00)					
<b>CASH FLOW</b>	<b>138,380.00</b>	<b>13,740.00</b>	<b>13,740.00</b>	<b>13,740.00</b>	<b>13,740.00</b>	<b>13,740.00</b>
<b>YEAR-TO-DATE CASH FLOW</b>	<b>138,380.00</b>	<b>152,120.00</b>	<b>165,860.00</b>	<b>179,600.00</b>	<b>193,340.00</b>	<b>207,080.00</b>

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## HYBRID SCOOPTRAM ECONOMIC MODEL - DOYON MINE

YEAR	0	1	2	3	4	5
VENTILATION SAVING (cfm)	6000	6000	6000	6000	6000	6000
VENTILATION CAPITALIZATION						
Main (\$/cfm)	10.00					
Auxiliary (\$/cfm)	0.98					
OPERATION COSTS						
Heating		0.73	0.73	0.73	0.73	0.73
Electricity - main ventilation		0.29	0.29	0.29	0.29	0.29
Electricity - auxiliary ventilation		0.87	0.87	0.87	0.87	0.87
<b>TOTAL SAVING (\$/cfm)</b>	<b>10.98</b>	<b>1.89</b>	<b>1.89</b>	<b>1.89</b>	<b>1.89</b>	<b>1.89</b>
<b>TOTAL ECONOMY (\$)</b>	<b>65,880.00</b>	<b>11,340.00</b>	<b>11,340.00</b>	<b>11,340.00</b>	<b>11,340.00</b>	<b>11,340.00</b>
FUEL SAVING (\$)	0.00	1,200.00	1,200.00	1,200.00	1,200.00	1,200.00
STANDARD SCOOPTRAM 250 000\$						
HYBRID SCOOPTRAM 312 500\$						
ADDITIONAL COSTS	(62,500.00)					
<b>CASH FLOW</b>	<b>3,380.00</b>	<b>12,540.00</b>	<b>12,540.00</b>	<b>12,540.00</b>	<b>12,540.00</b>	<b>12,540.00</b>
<b>YEAR-TO-DATE CASH FLOW</b>	<b>3,380.00</b>	<b>15,920.00</b>	<b>28,460.00</b>	<b>41,000.00</b>	<b>53,540.00</b>	<b>66,080.00</b>

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