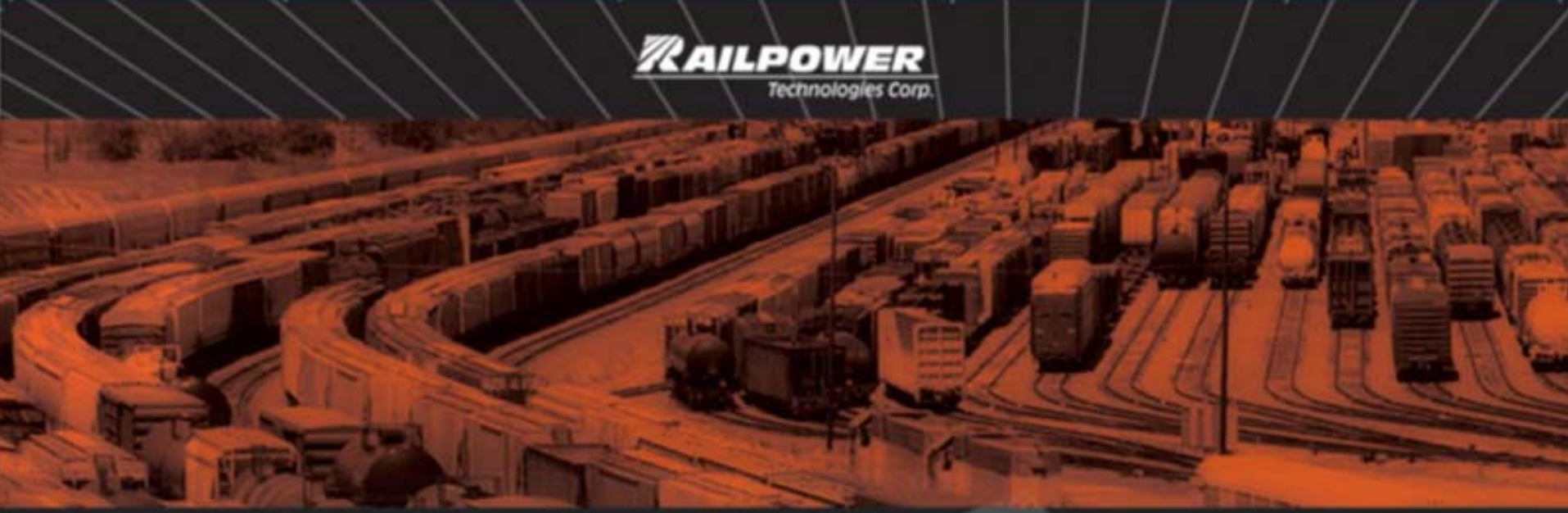


Idling Reduction Conference

Albany, N.Y.
May 17-19 2004

Ray Cousineau
Frank Donnelly

Duty Cycles* used by Different Authorities (% of time)

Throttle Notch	EPA Freight	EPA Switch	AAR Freight	AAR Switch	ISO (Europe)	RAC Freight	RAC Switch	GE Freight	EMD Freight
8	16.2	0.8	28	0	25	12	5	14	17
7	3	0.2	3	0	0	4	2	3	4
6	3.9	1.5	3	1	0	4	2	3	4
5	3.8	3.6	3	1	0	4	2	4	4
4	4.4	3.6	3	2	15	4	2	4	4
3	5.2	5.8	3	4	0	4	2	3	4
2	6.5	12.3	3	5	0	4	2	5	4
1	6.5	12.4	3	10	0	4	2	5	5
Dyn.Brk	12.5	0	8	0	0	0	0	4	9
Idle	0	0	0	0	0	60	81	50	46
Low Idle	38.00%	59.8	43	77	60	0	0	0	0

**Based on throttle settings*

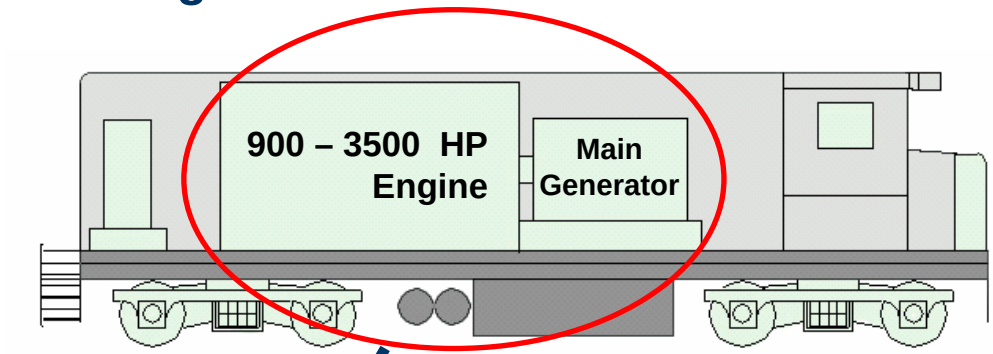
(Review of Memorandum of Understanding Between Environment Canada and The Railway Association of Canada Regarding Railway Locomotive Emissions)

Hybrid Locomotives

- Hybrids do not idle at any time
- Hybrids are more efficient at low power
- Yard switcher service is best optimised by a *Battery Dominant* Hybrid

Hybridized Locomotive

Conventional Switching Locomotive



Patented RailPower Hybrid Locomotive

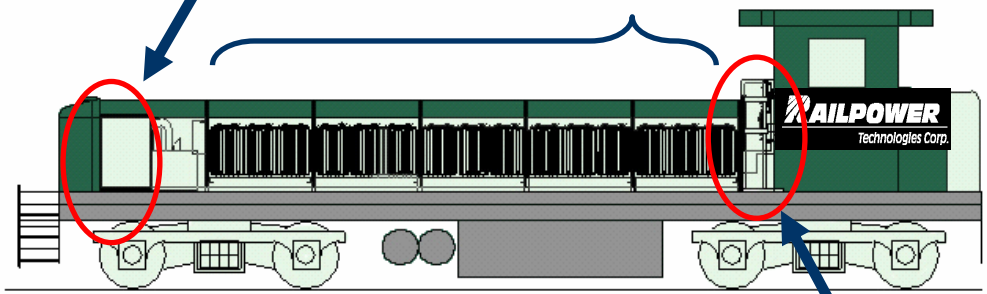
VRLA Battery

Sealed, Low Maintenance

Charging System

125-250 HP

Certifed Tier 2 Engine



Power Conversion & Energy Management

Green Goat

- High Visibility

- Operates virtually as any other GP-XX
- Fully MU-able

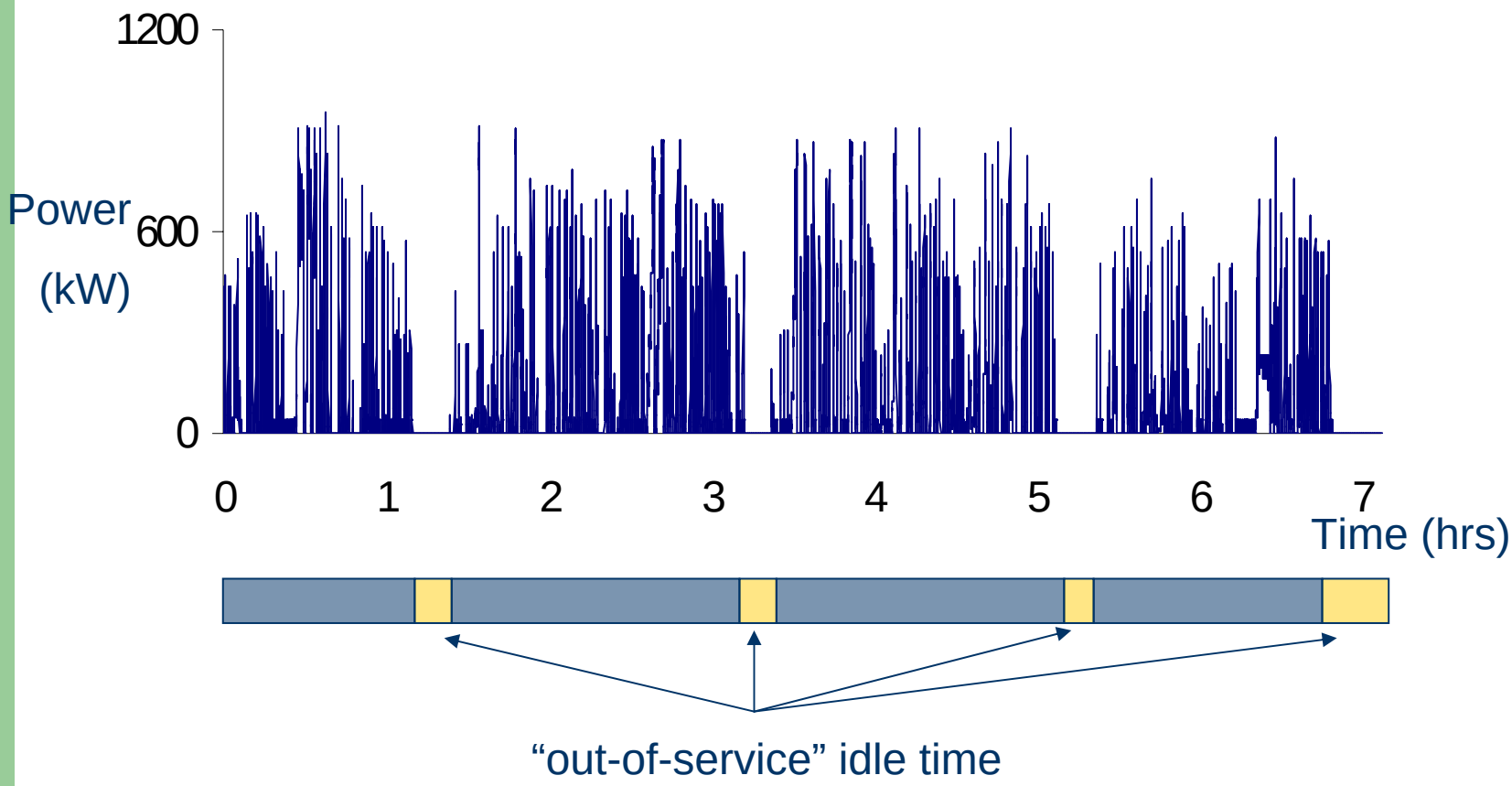
Engine Compartment

- Accessible
- Field Serviceable
- Low maintenance
- Quiet

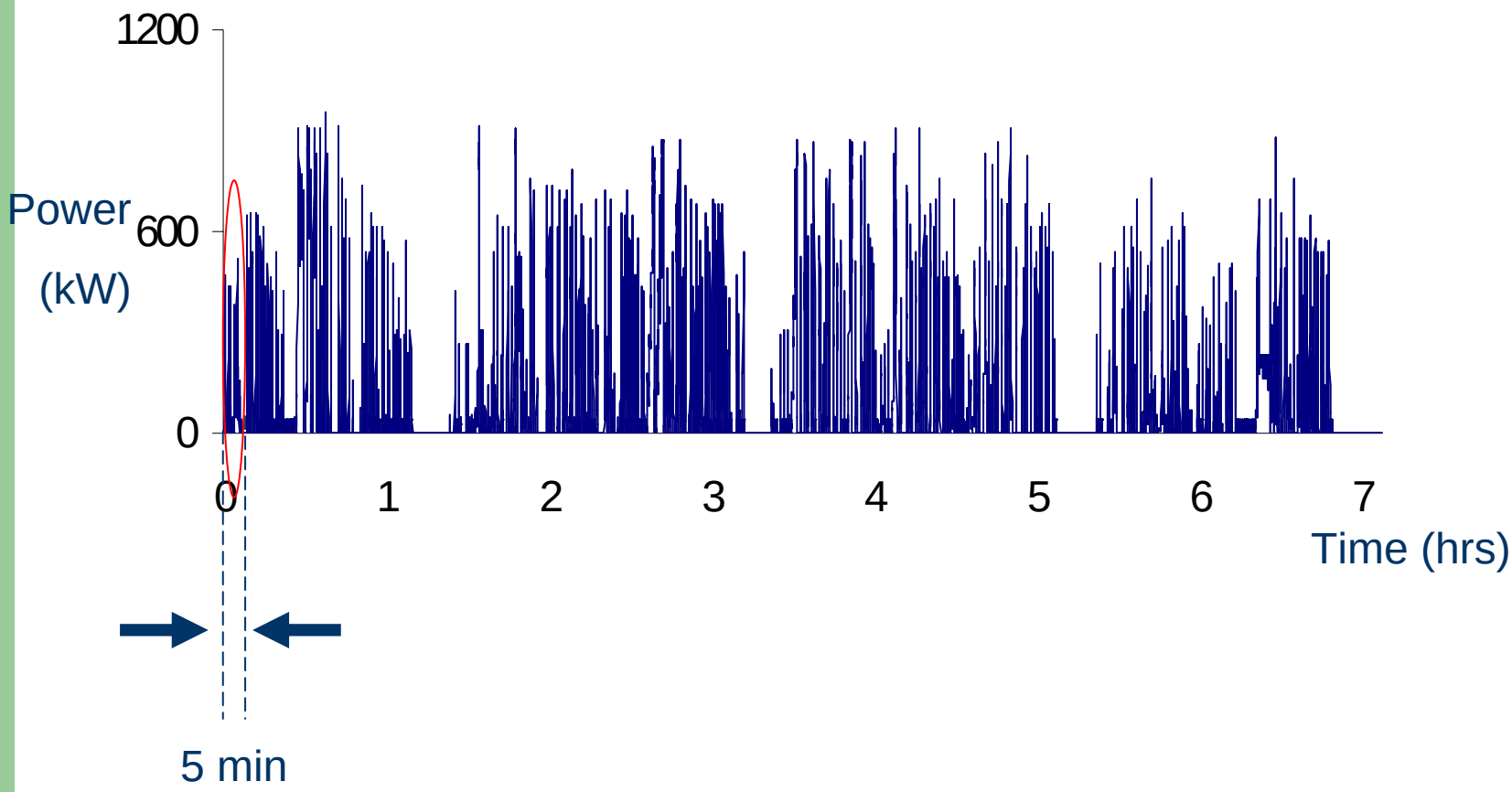
Main Battery Pack

- Accessible
- Low maintenance
- Field serviceable
- No-spill

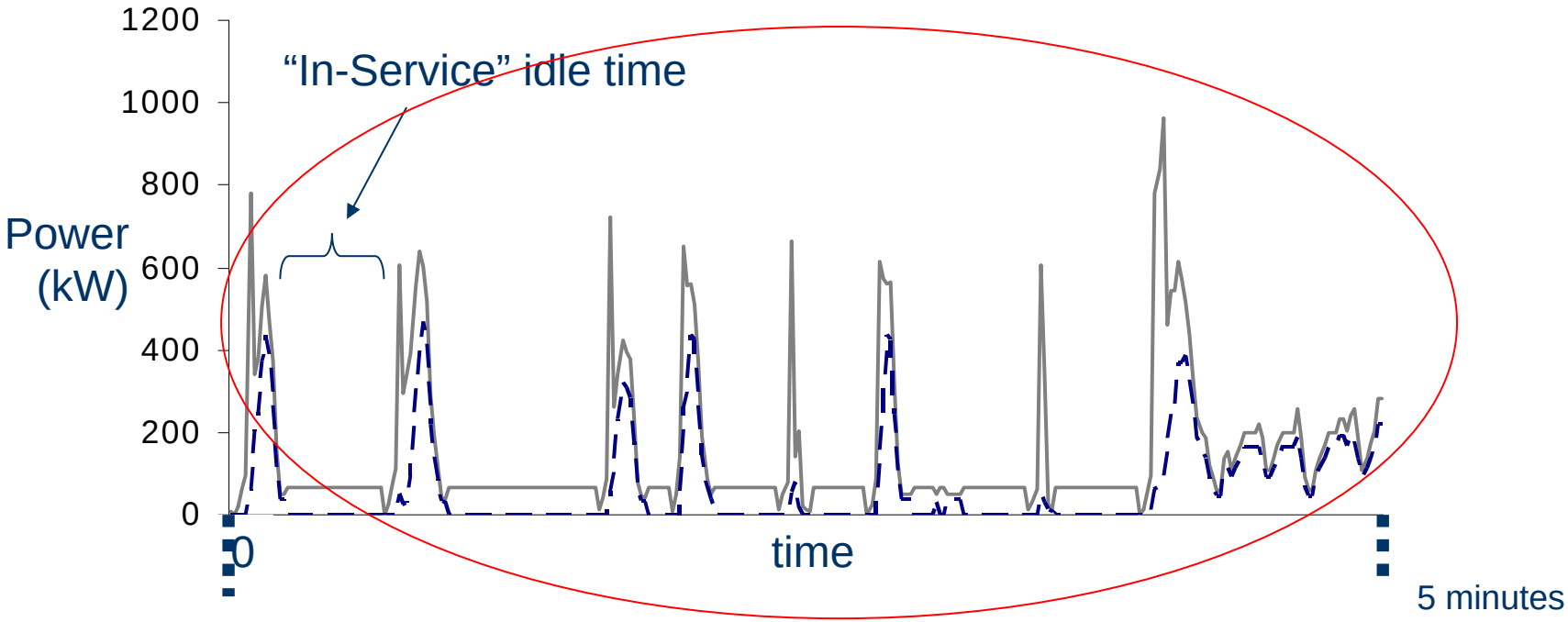
Switcher Operation



Conventional Switcher Operation



Conventional Switcher Operation

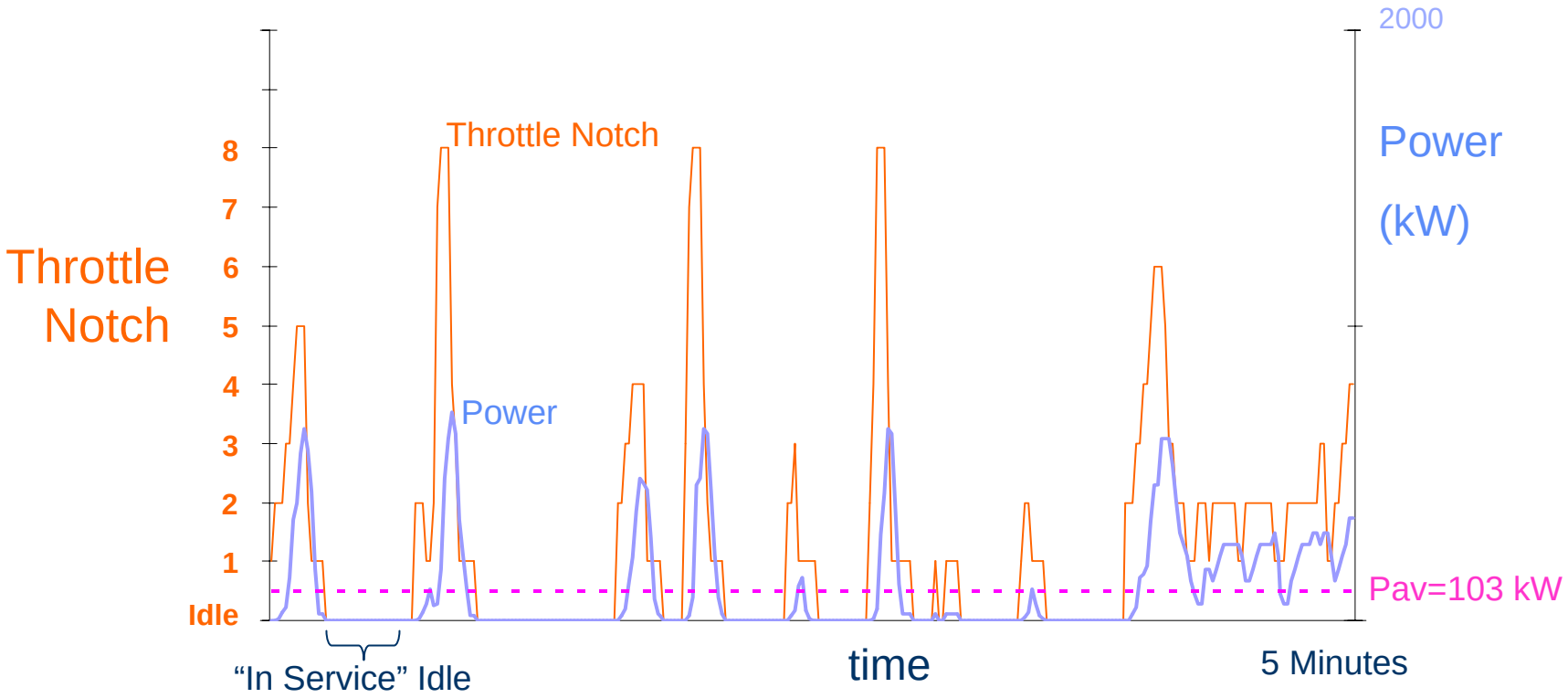


Average Power for useful work = 64.57 kW

Average Power delivered from Generator = 151.19 kW

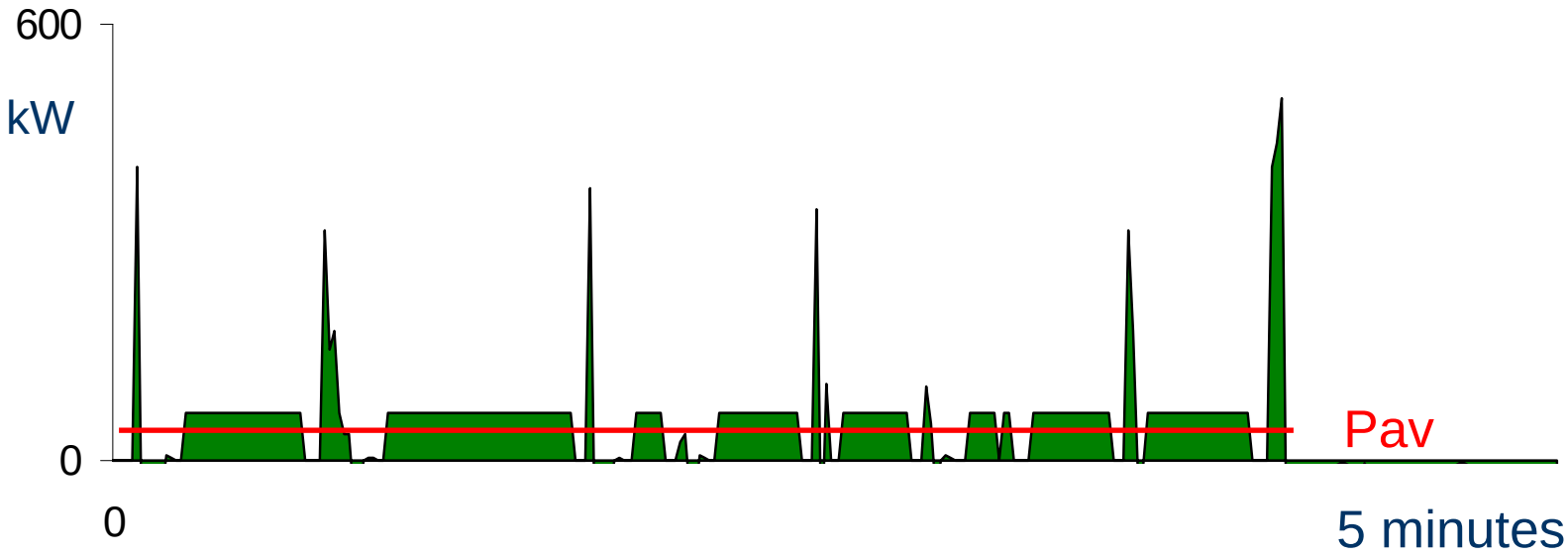
Average power used in Idle = 33.16 kW

Switcher Operation



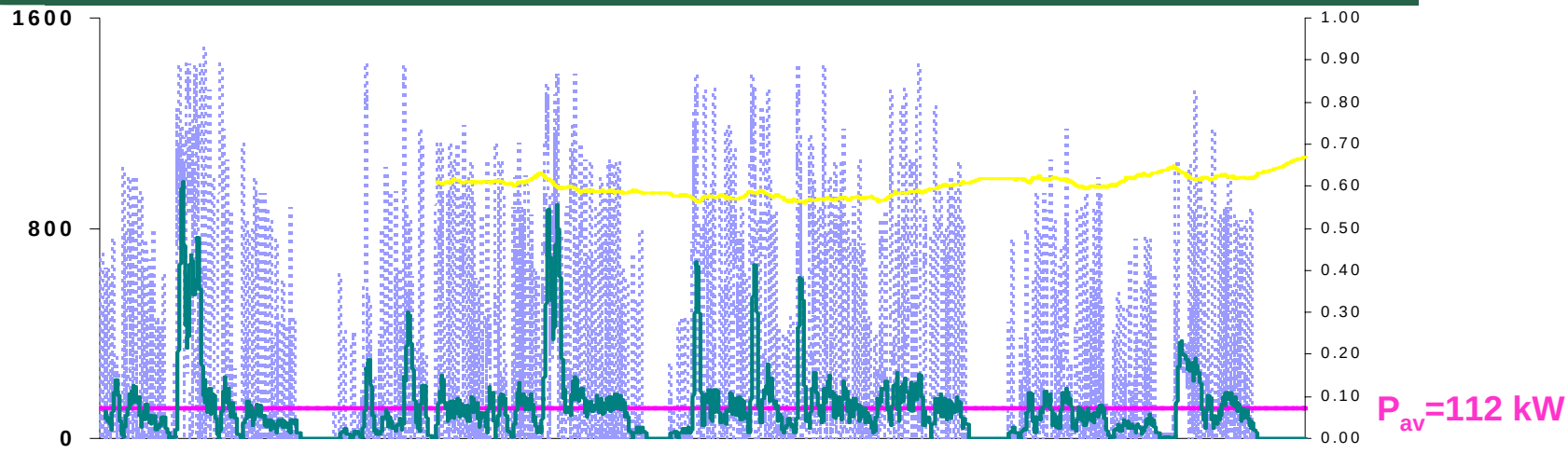
Hybrid Locomotive

Reduction in Power



Average Total Reduction in Power supplied to traction motors = 46.8 kW

Hybrid Switcher Operation



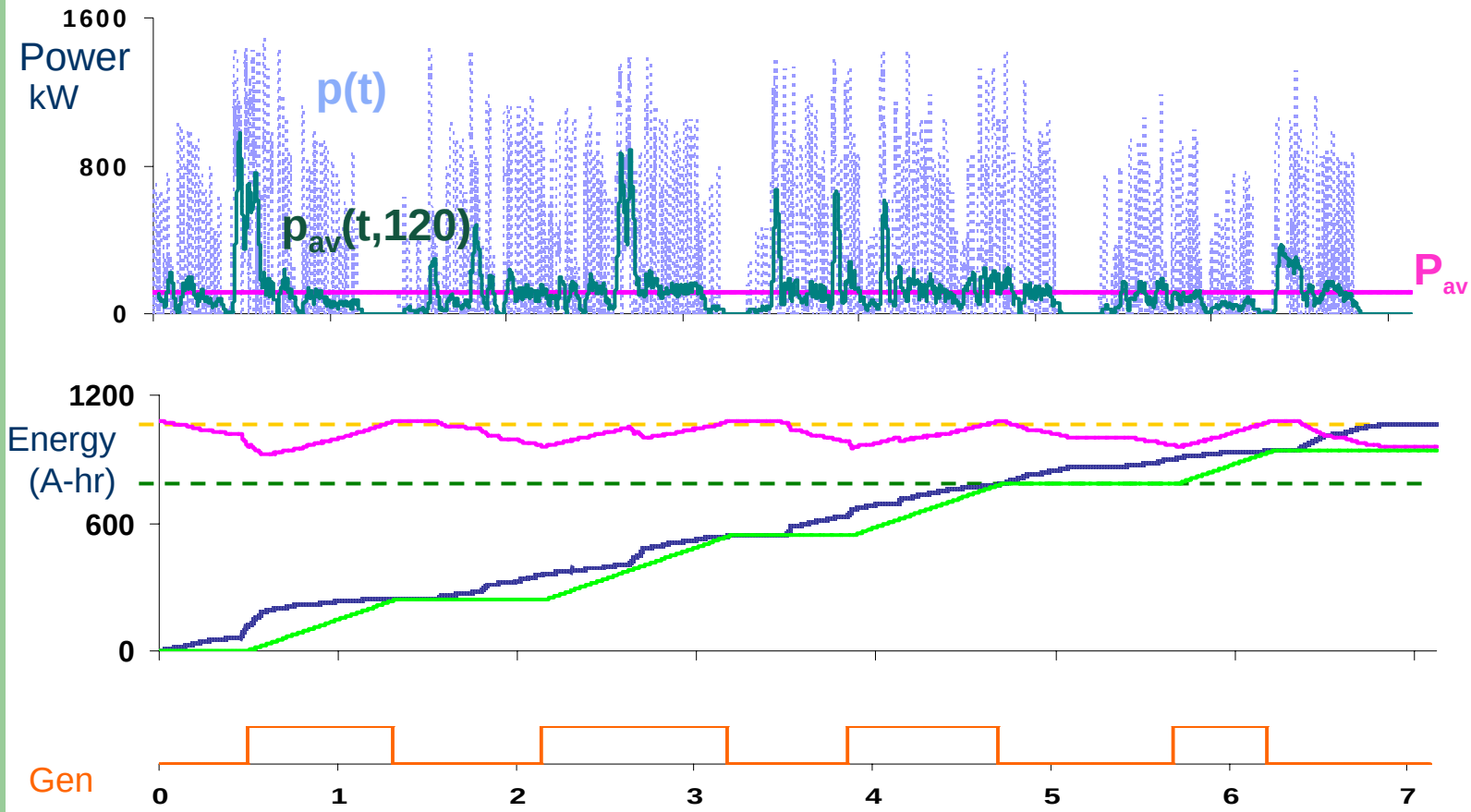
7.2 hours of operation

Idle	60.72%
1	15.01
2	7.19
3	4.14
4	2.42
5	1.25
6	2.89
7	1.41
8	4.96

Summary

- 26.28 miles
- 327 displacements, @ 424 ft. ea
- 688 kW-hrs=983 bHp/hrs energy usage
- Average Rail Power = 69.5 kW
- Average Power delivered by Hybrid= 112 kW
- Average Power (Conventional Loco)= 149.2 kW

Hybrid Battery/Engine Cycle



7.2 Hours of Operation

48 Gal Total Fuel Consumption for 6.7 gal/hr operation

Some Examples of Fuel Savings

	Typical	Heavy duty
• Idle	79.56 %	60.11 %
• Notch 1	4.40 %	14.36 %
• Notch 2	5.26 %	7.81 %
• Notch 3	6.09 %	6.75 %
• Notch 4	4.42 %	3.94 %
• Notch 5	1.08 %	2.39 %
• Notch 6	0.00 %	1.46 %
• Notch 7	0.00 %	0.50 %
• Notch 8	0.00 %	2.66 %
• Energy Usage	200 kW-h	780 kW-h
• Fuel Usage	22.4 US gal	61.5 US gal
• Charging Time	4.5 hrs	10.5 hrs
• (Equivalent) MP-15	60.8 US gal	95.9 US gal

Examples of Fuel Reduction

				Savings
• EPA GP38-2	14.8 Gal/hr	vs	10.7 Hybrid	(28%)
• AAR GP38-2	8.8 Gal/hr	vs	5.2 Hybrid	(41%)
• LAJ	8.5 Gal/hr	vs	4.9 Hybrid	(43%)

Additionnal Benefits

- Fuel savings
- Superior performance (fast response from batteries allows better traction control)
- Tier 2 engine reduces emissions >80%
- Low/easy maintenance
- Improved safety
  - Visibility
  - Less operator fatigue
- Quiet operation (neighborhoods)
- Ability to operate inside buildings (with engine off)
- Inherent redundancy (reliability)
  - Can operate on engine or battery alone
  - Can easily isolate individual battery cells and traction motors.

Summary

- Hybrid locomotives achieve fuel savings through elimination of both “short-term” and “long term” idling, as well as better overall efficiency
- Considerable Benefits of reduced idling in terms of Nox and PM10 reduction.
- Economics justifies wholesale replacement of switcher locomotives in many situations based entirely on fuel/maintenance savings and improved availability, especially if the unit is due for a major overhaul.
- Further incentives are/are becoming available for emissions redcutions in certain areas such as Carl Moyer in California and TERP (Texas Emissions Reduction Program)
- Hybrid locomotives offer many additionnal benefits for railroad switcher operation.