

# HOLISTIC APPROACH TO THE ELECTRIFICATION OF A 500HP RATED POWERTRAIN IN COMMUTER EXPRESS COACH

BUS & PARATRANSIT CONFERENCE

MAY 8 2017

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Chief Project Manager



# PREVOST IS PART OF THE VOLVO GROUP FAMILY



# OTHER FAMILAR IMAGES

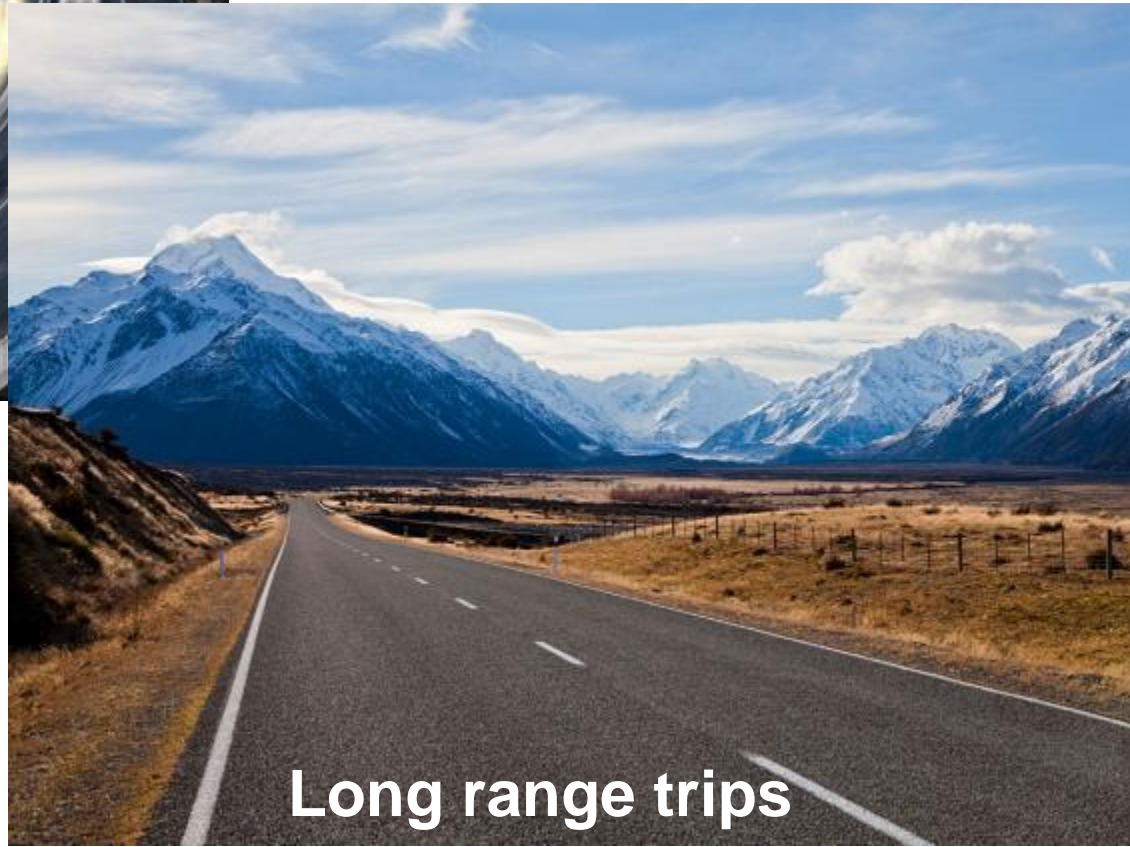


# ***THE OBJECTIVE OF ELECTRIFICATION***

**Maximum uptime**  
**Easy maintainability**  
**Efficiency**



# ***THE CONDITIONS***

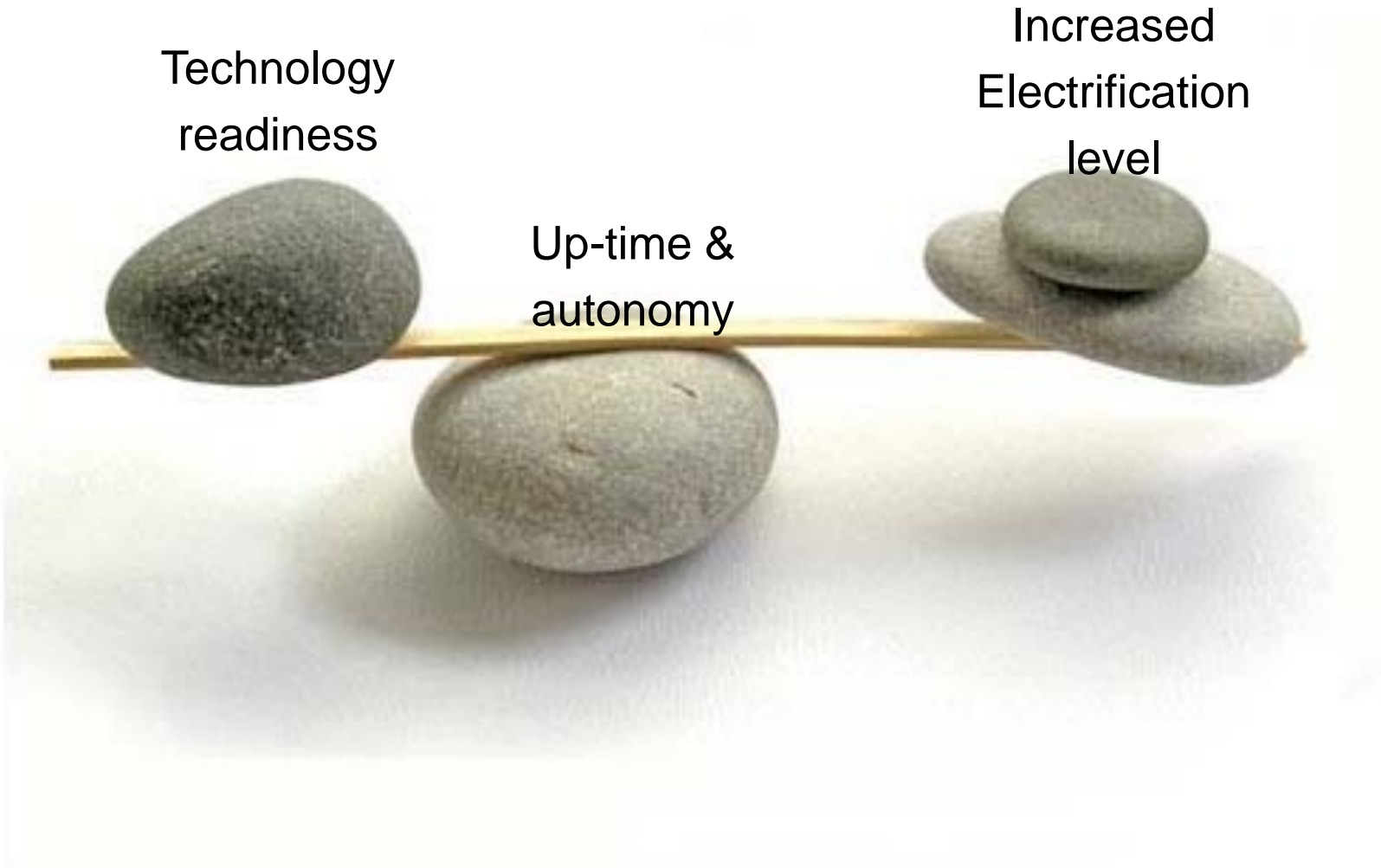


# A DELICATE BALANCE

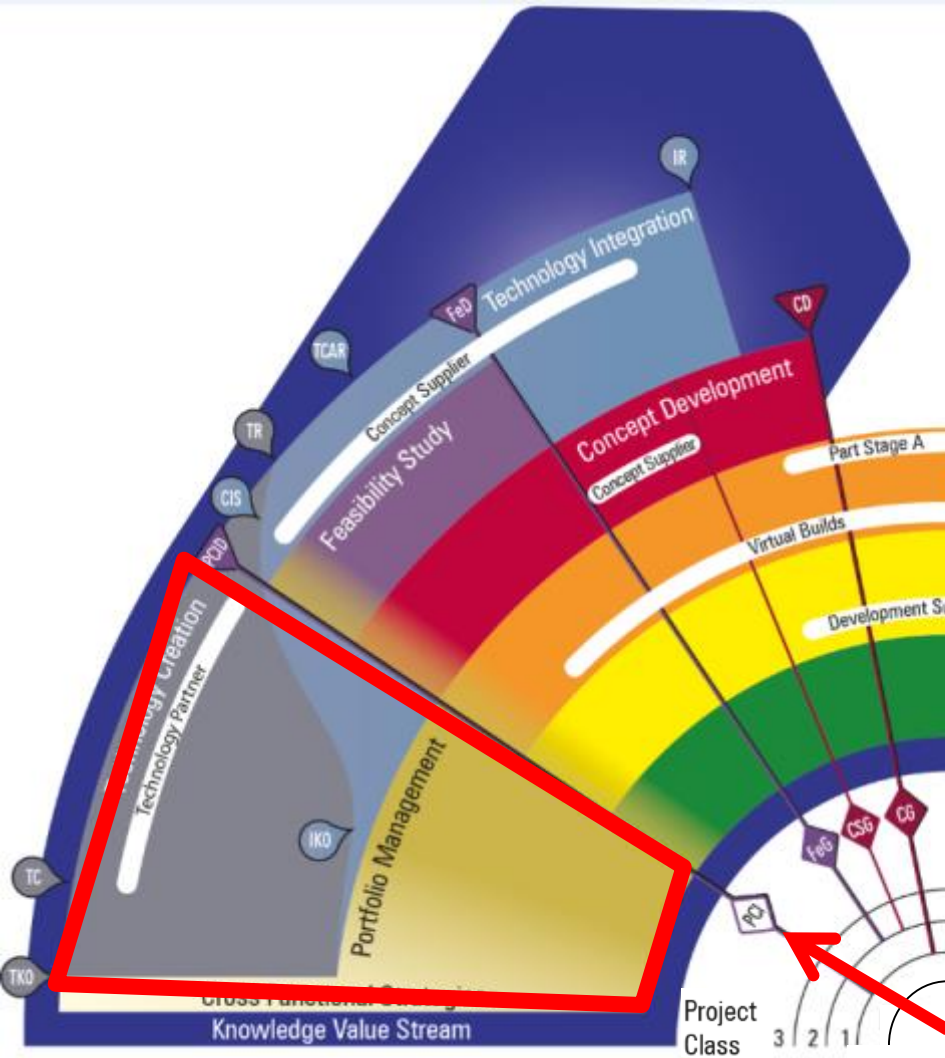
Technology  
readiness

Increased  
Electrification  
level

Up-time &  
autonomy



# TECHNOLOGY AWARENESS



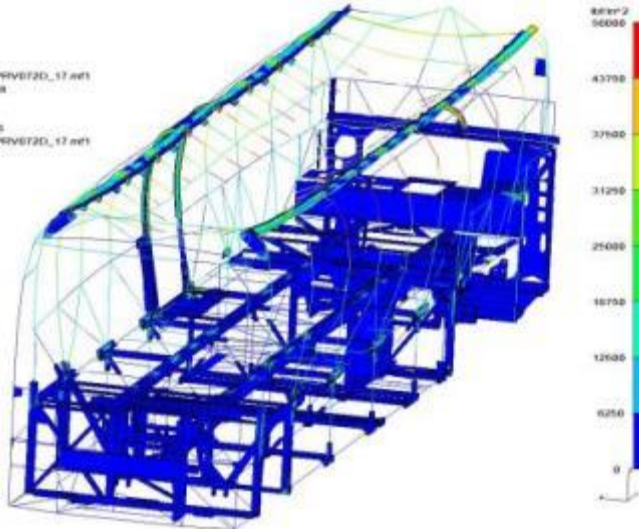
## Technology readiness level (TRL)

TRL 9	Has an identical unit of the technology been successfully launched/operated on the market in an identical configuration/environment?		Product Launched
TRL 8	Has an identical unit of the technology been successfully qualified under operational conditions (field tests)?		Field test
TRL 7	Has a system prototype, in a near final form, been successfully operated under expected conditions?		Project Builds/ Verification
TRL 6	Has a representative system prototype of the technology been demonstrated in the targeted environment (product/process)?		DMU/Virtual Verification
TRL 5	Has a representative system prototype of the technology been demonstrated in a relevant environment (product/process)?		AE Demonstrator/ Mule/System test bench or used by competitors
TRL 4	Has a prototype of the key elements of the technology been demonstrated in a laboratory environment?		Component test
TRL 3	Has analytical and experimental proof-of-concept been demonstrated?		Calculations/ Simulations and Experiments
TRL 2	Has key elements of the technology been identified and expected benefits formulated?	Technical Principle + Application = Expected Benefit	AE Proposal
TRL 1	Have basic principles been identified that could potentially form the basis of a new or improved technology?	Technical Principle	

# THE STARTING POINT: A PROVEN PLATFORM

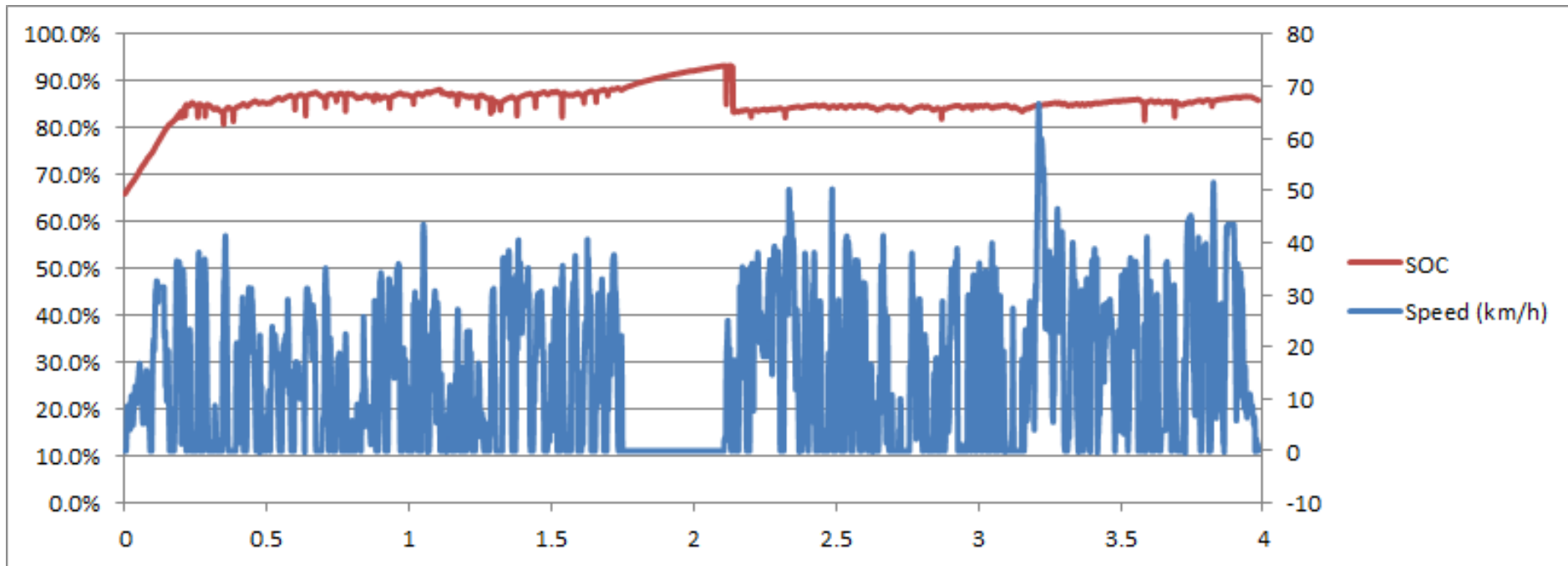


Display 8  
A348\_WCS\_4\_sept\_2013  
E.C. M\_STRESS\_3\_TOT\_57000\_LBS  
D:\Projets\PRV0720\workspace\_compart\_16\_15\PRV0720\_17.mtl  
STRESS Von Mises Unaveraged Bottom Shell  
Beam stress: Von Mises - maximum point  
Min: 0 BBar2 Max: 302007 BBar2  
E.C. 16\_DISPACEMENT\_1\_TOT\_57000\_LBS  
D:\Projets\PRV0720\workspace\_compart\_16\_15\PRV0720\_17.mtl  
DISPLACEMENT XYZ Magnitude  
Min: 0 in Max: 2.81  
Pat Coordinate System

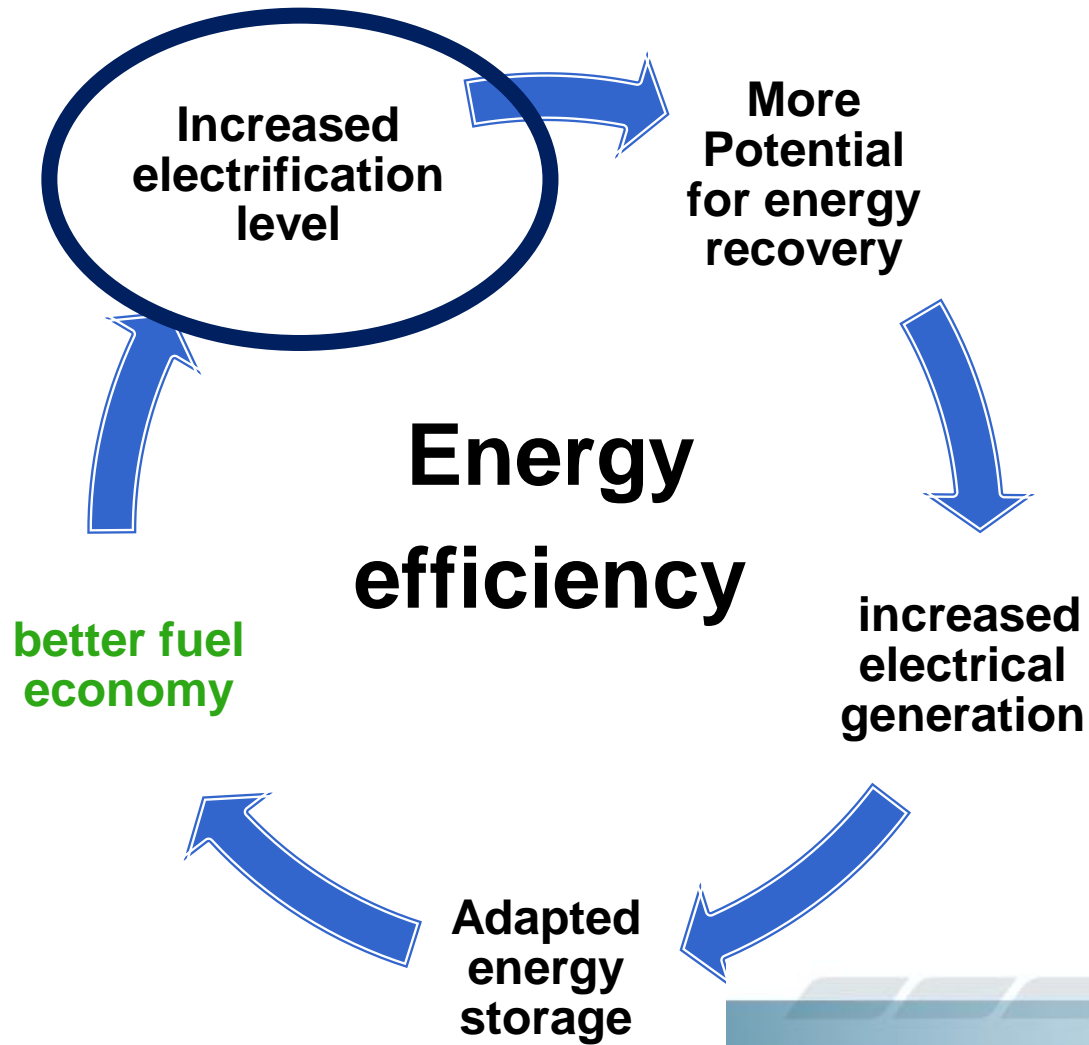




# ENERGY MANAGEMENT FOR SYSTEM ELECTRIFICATION



# THE ELECTRIFICATION CYCLE



**PREVOST**

**PRIME** Innovative Energy Management for Today's Needs

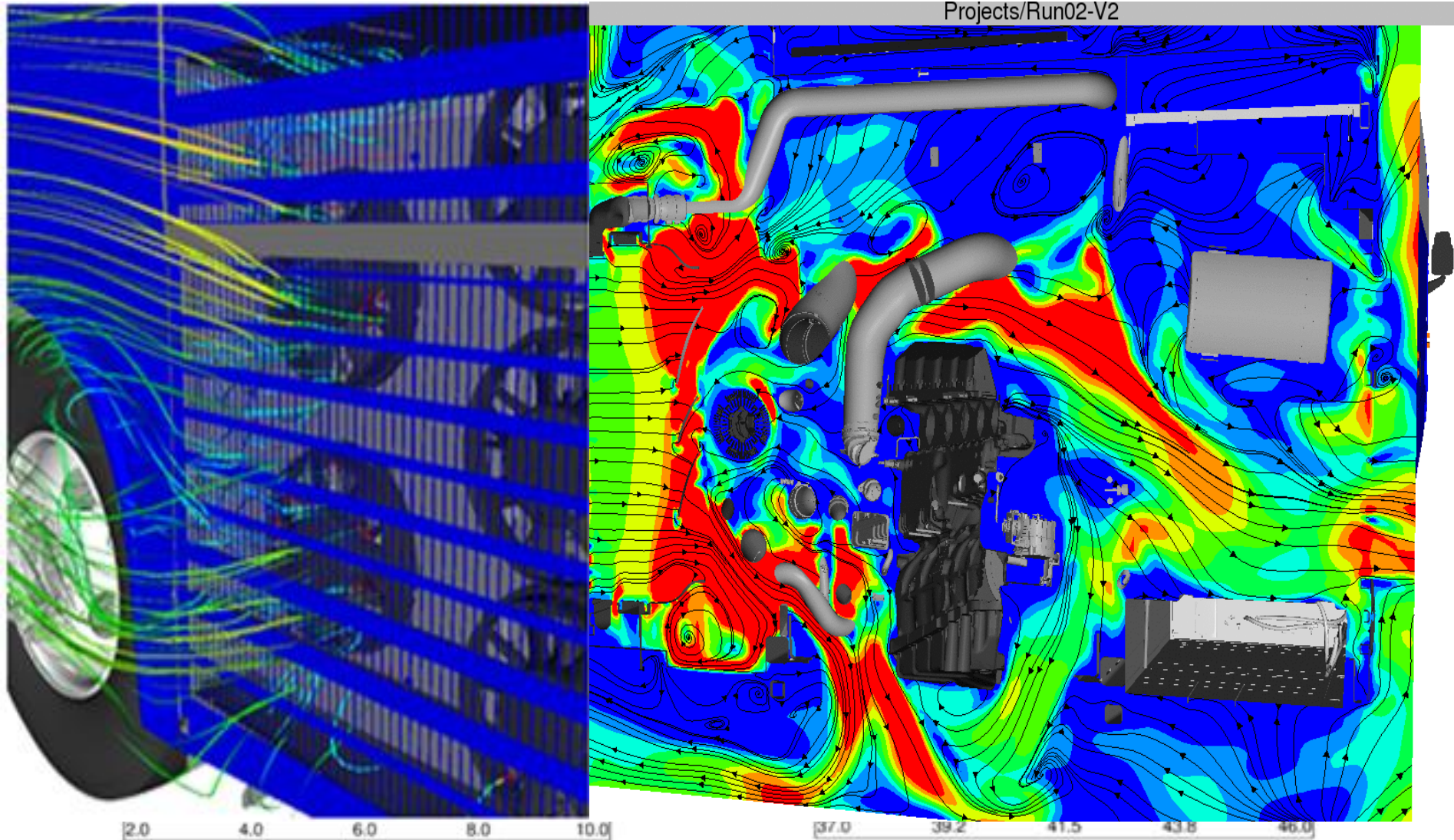
# WHERE WAS THE BEST OPPORTUNITY??



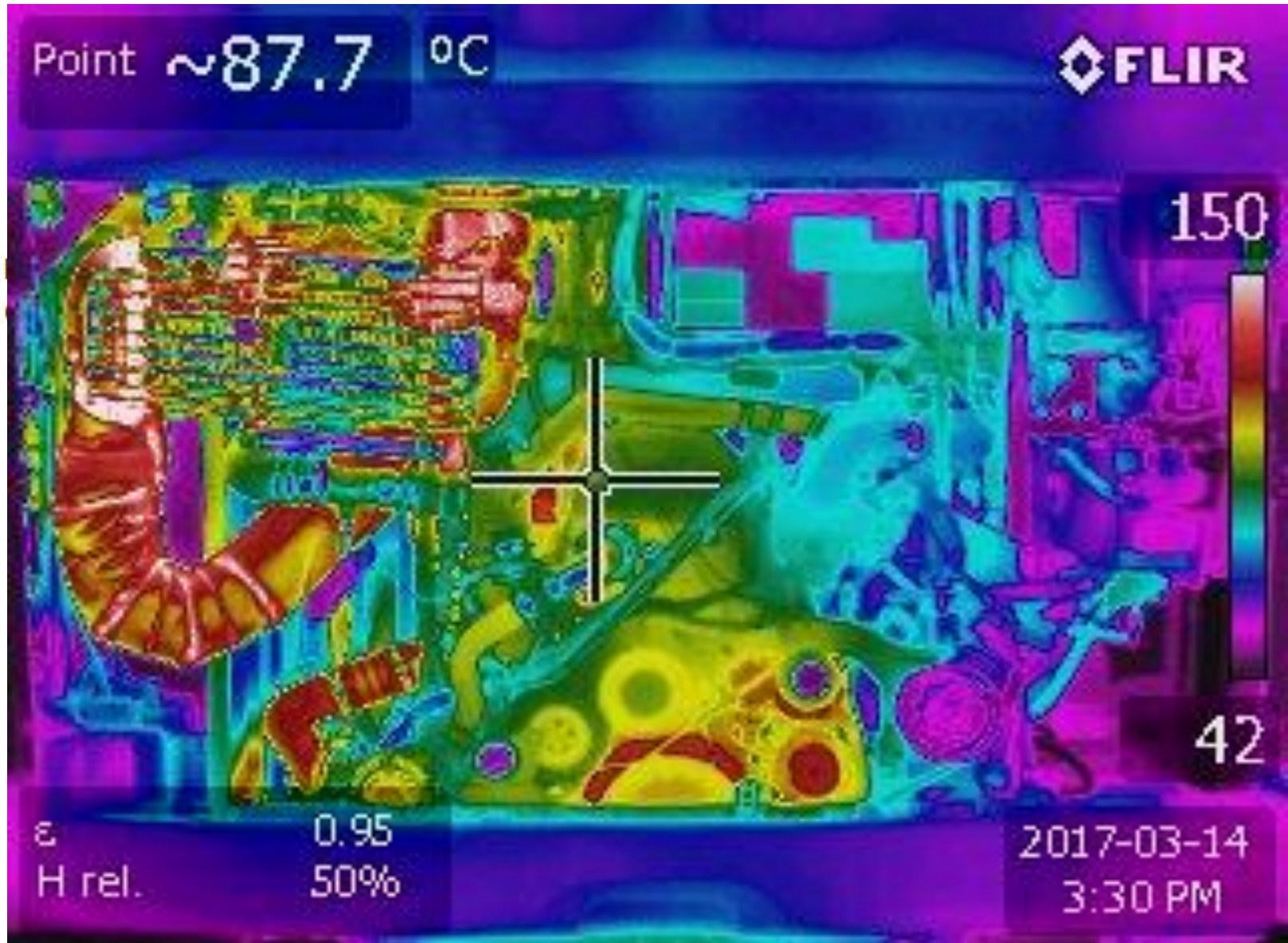
# INTRODUCTION OF ELECTRIC FAN COOLING SYSTEM



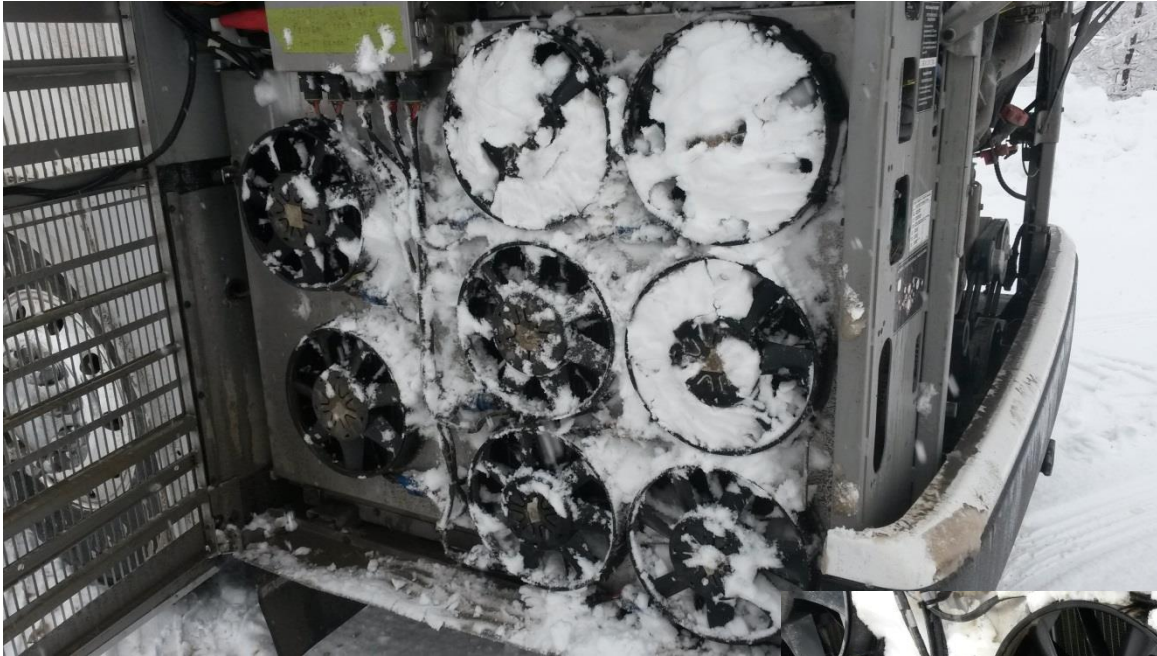
# STRONG DIGITAL VALIDATION PLAN



# STRONG PHYSICAL VALIDATION



# WINTER TESTING



# HIGH AMBIENT OPERATING CONDITIONS



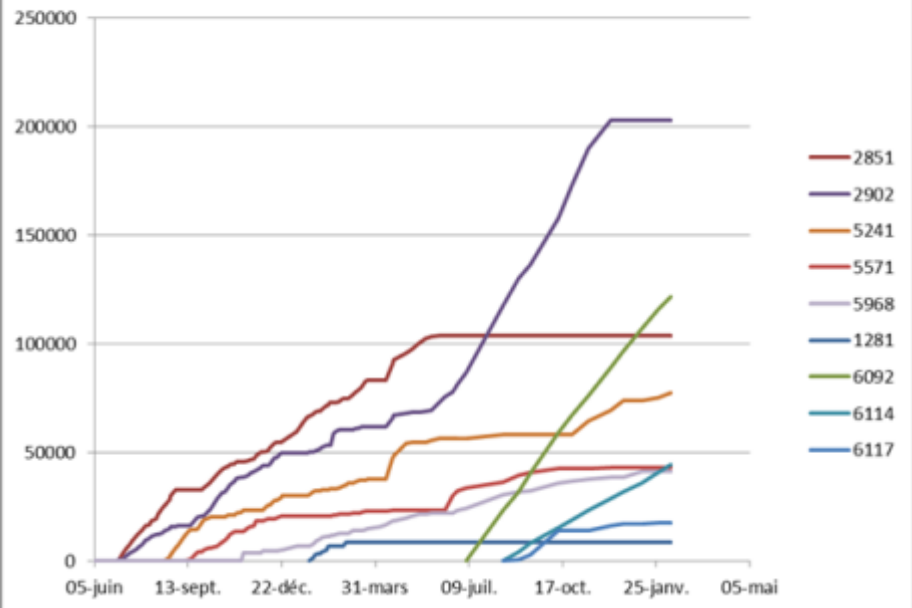
**Normal driving**

**Wide open throttle upgrade**

**Downgrade with retarder**



### Cumulative Kilometer GHG17



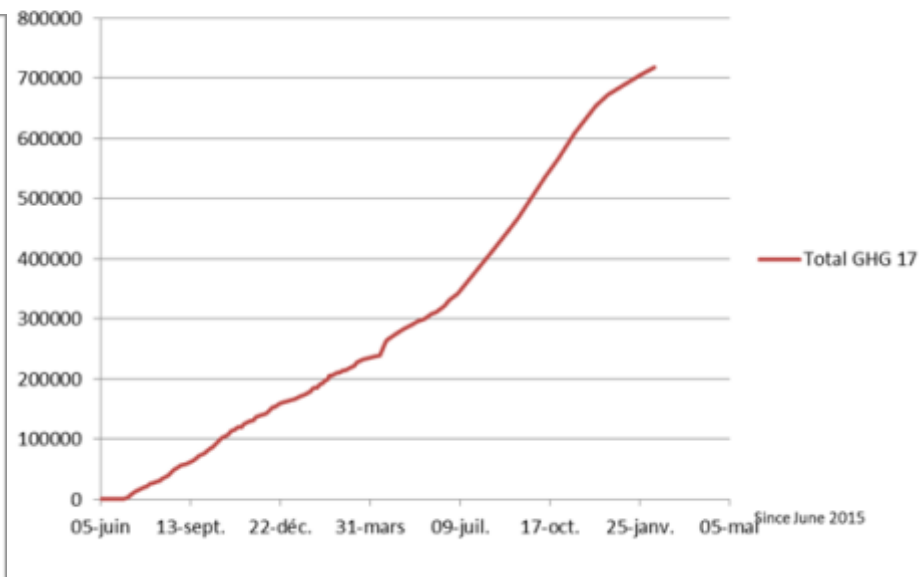
## Reliability Program

9 test units

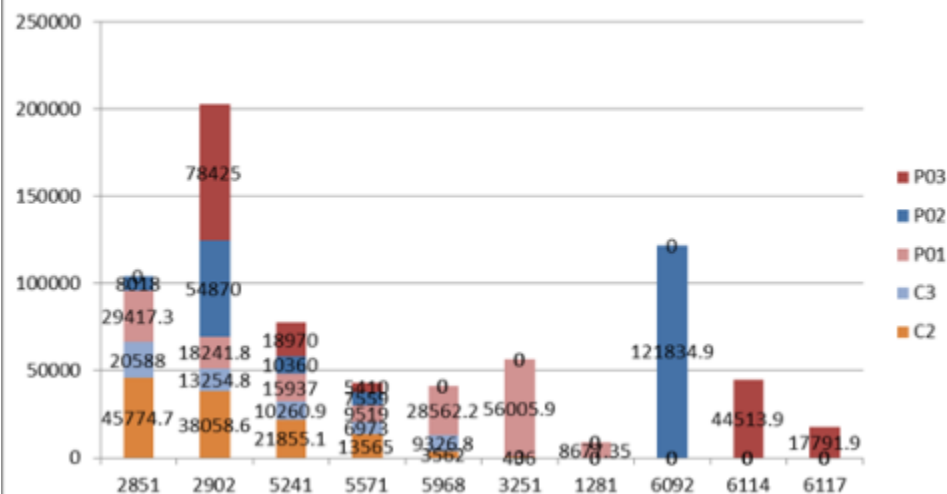
Over 500 000 miles

5 SW generations

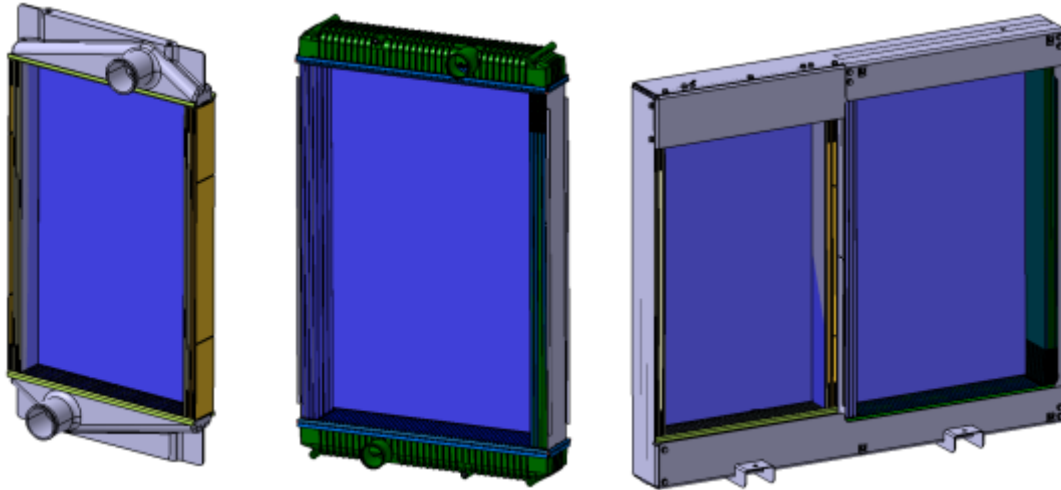
### Total GHG17 Program Kilometer



### GHG17 Kilometer by vehicle for each software



# THE RESULT

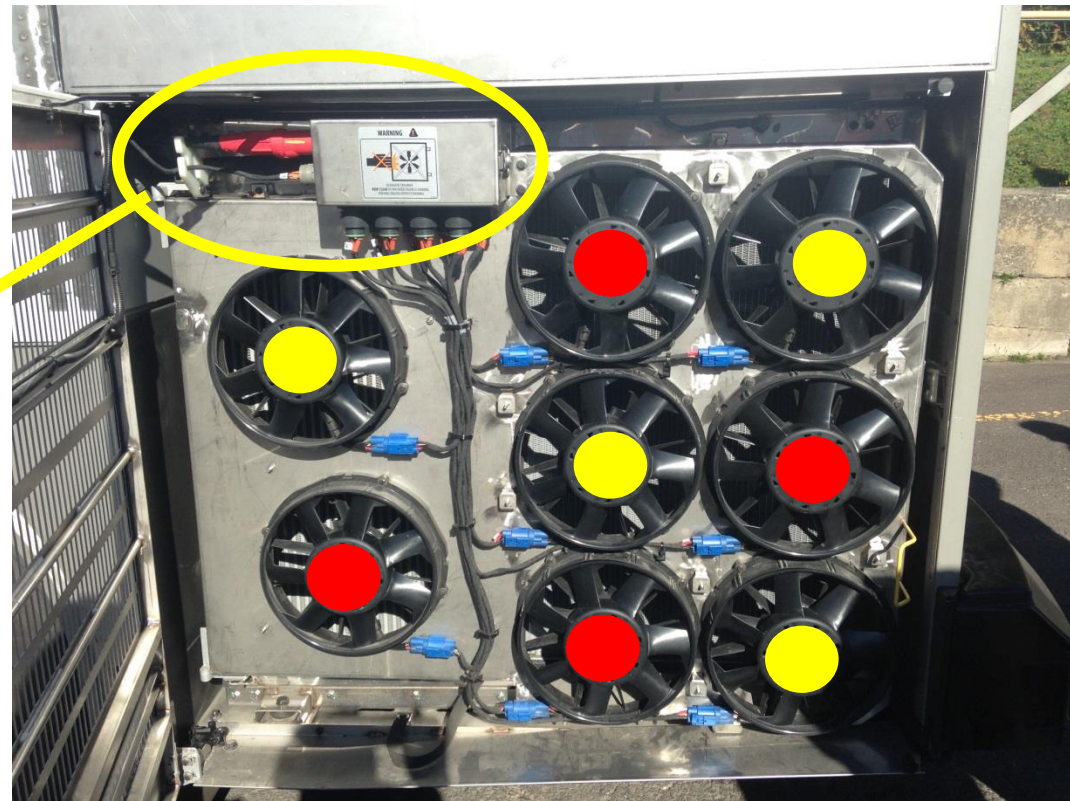


# SIMPLE SYSTEM – EFFICIENT AND EASILY MAINTAINED

CAC and Radiator fans work separately



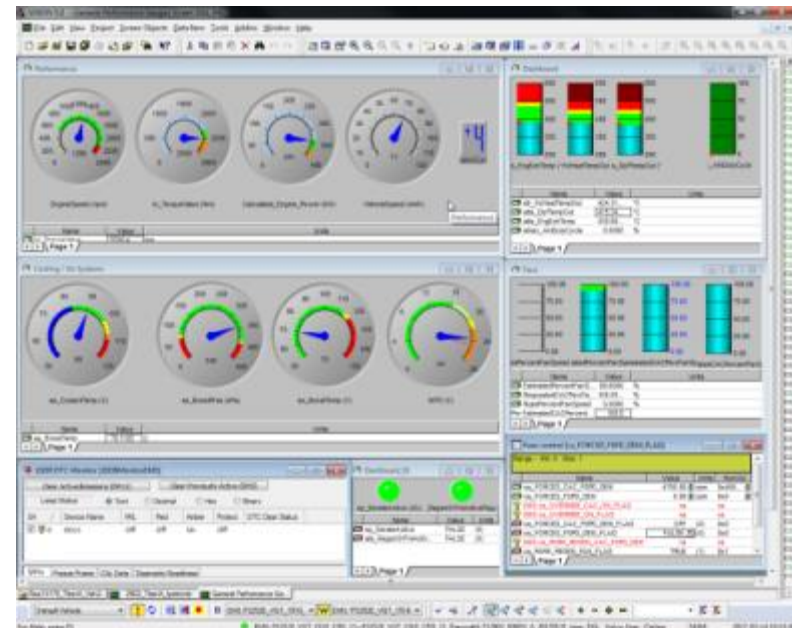
Each fan is individually protected  
Fans controlled in speed



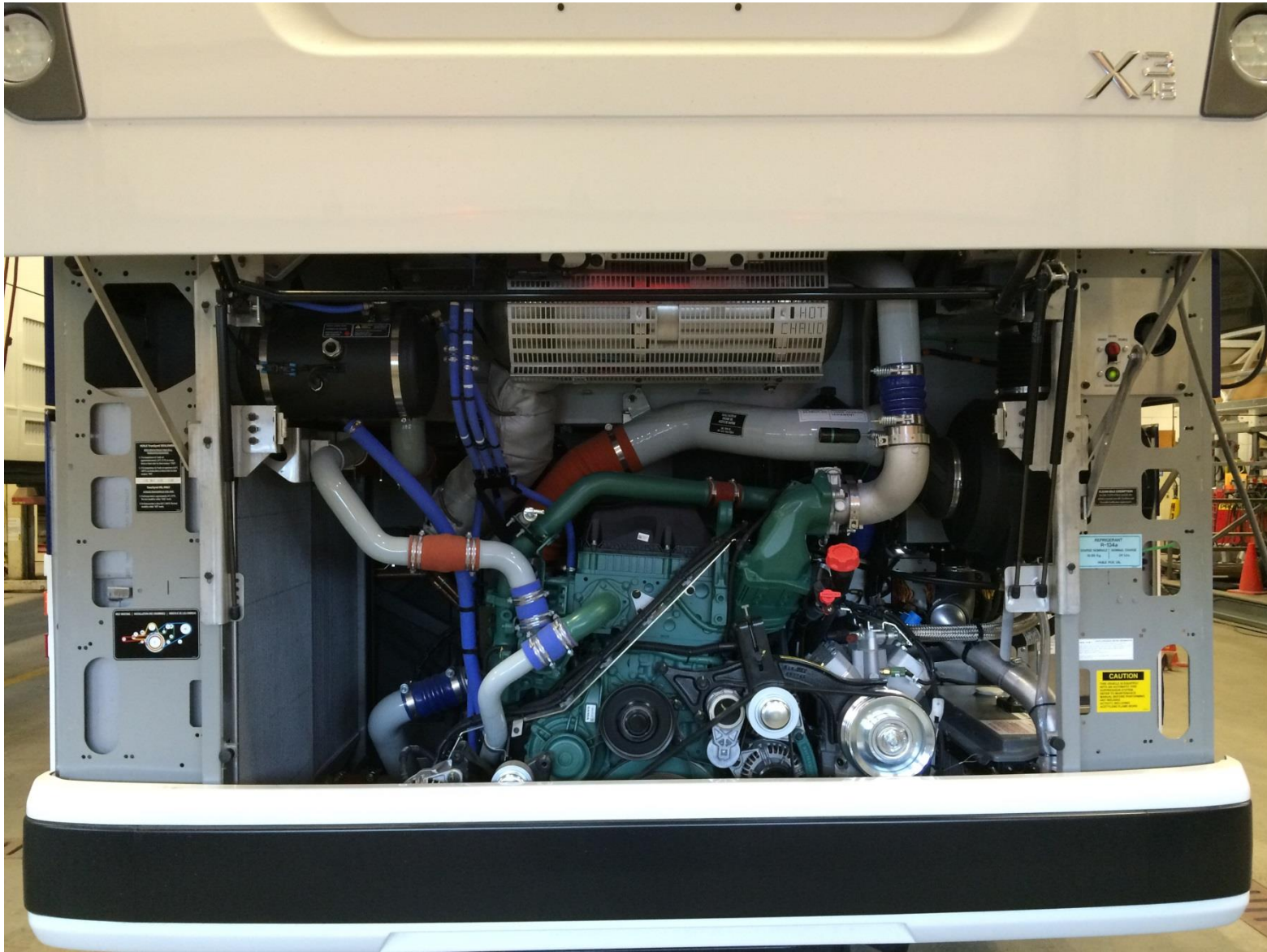
Red and Yellow fans in 2  
Independent circuits

# SYSTEM DIAGNOSTICS

- Cooling fans keep record of overheating history
- All fans are reset (homing) at startup for status check
- The radiators are kept automatically clean by the fan operation logic
  - Automatic fan Reversing at startup and depending of the season.
  - Minimal cleaning is needed
  - Radiator can be accessed by opening the fan panel
- Simple visual diagnostics can be performed without tools
  - From front instruments menu and straight visual inspection
- If needed a much deeper investigation can be performed.



# THE RESULT -



# KEY TAKEAWAYS



A solid **validation** plan with a **500hp** in mind makes the system reliable in any kind of conditions and maximizes up-time

The **integration effort** resulted in a simple system with easy maintenance.

The strong **collaboration** with the engine manufacturer resulted into reduced **operation cost**

It takes a lot of hard work to make something simple.

(Steve Jobs)



- Come see our coach outside
- Engineering experts: Christophe Lemarechal & Jeff Gagné