

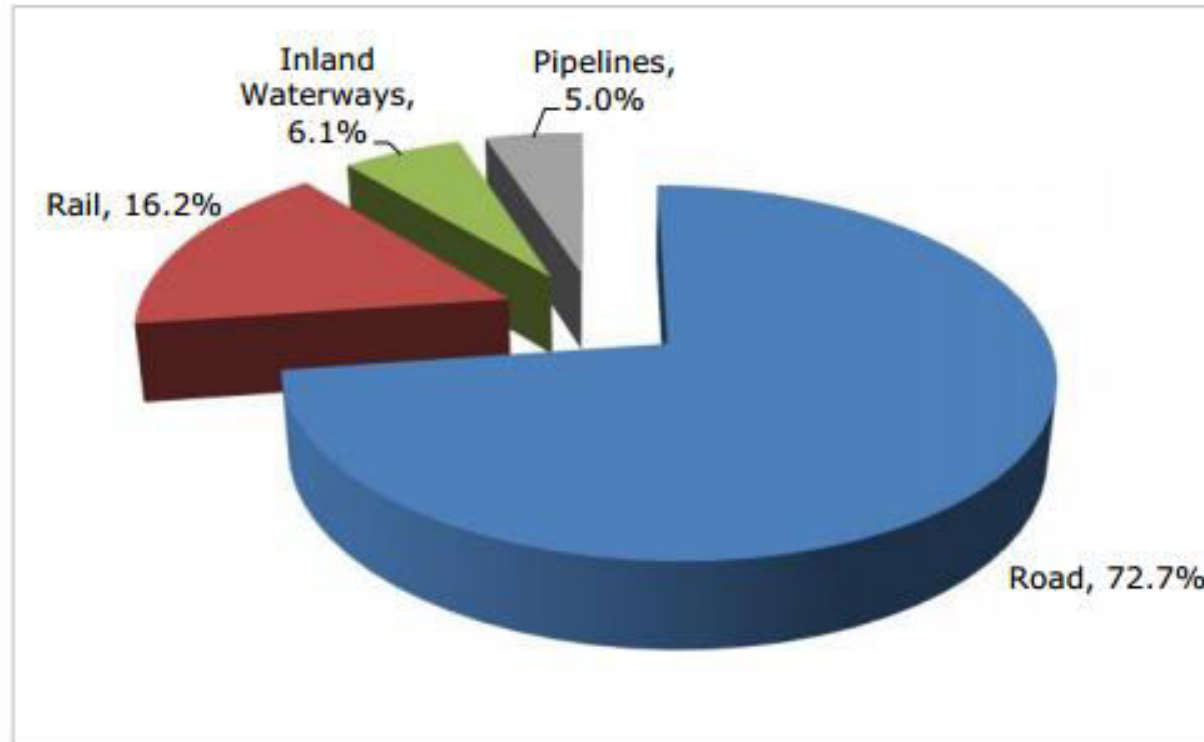


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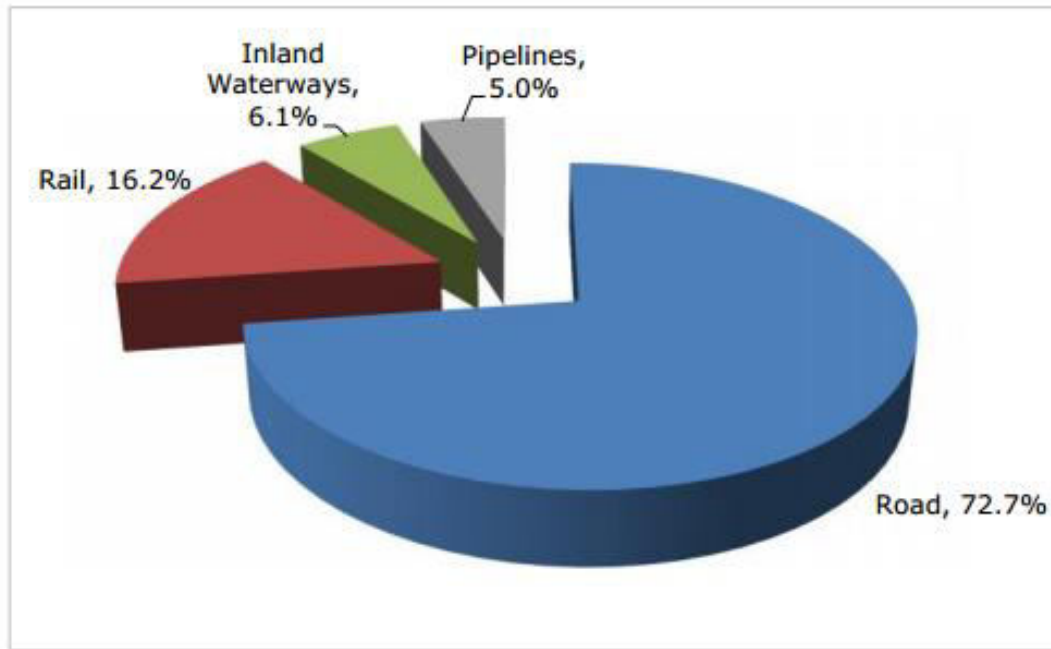
Optimization of Distributed Propulsion In Long Heavy Vehicle Combinations

The freight transport problem



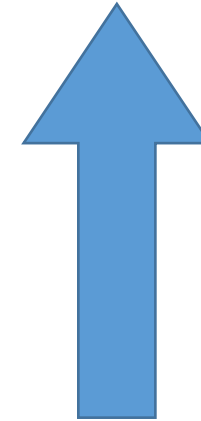
Source: SDG analysis of Eurostat data 2010 (2013).

The freight transport problem



Source: SDG analysis of Eurostat data 2010 (2013).

30%



27%

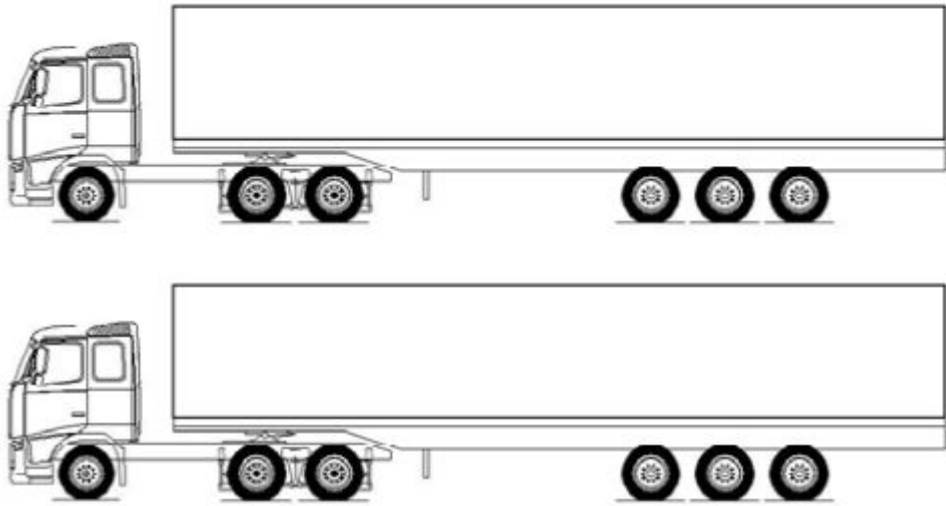


2020

2010



Freight transport today



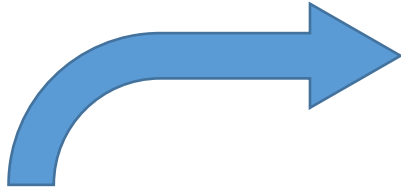
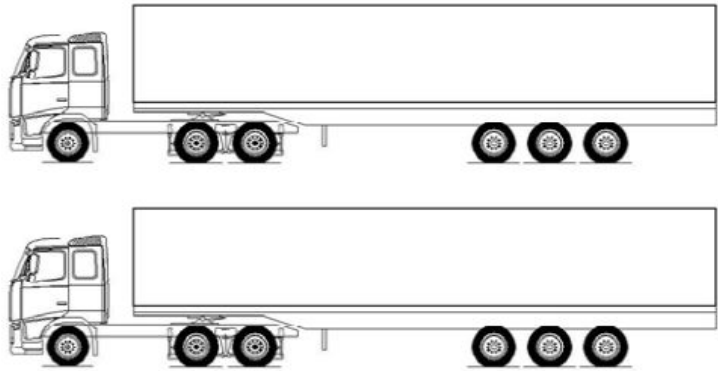
J. Aurell and T. Wadman. *Vehicle combinations based on the modular concept*. Tech. rep. Nordiska Vagtekniska Förbundet, 2007



- Increased traffic
- Higher emissions
- Burgeoning operating costs

2014

The way ahead



Technology

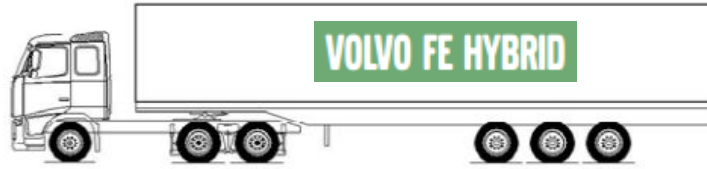
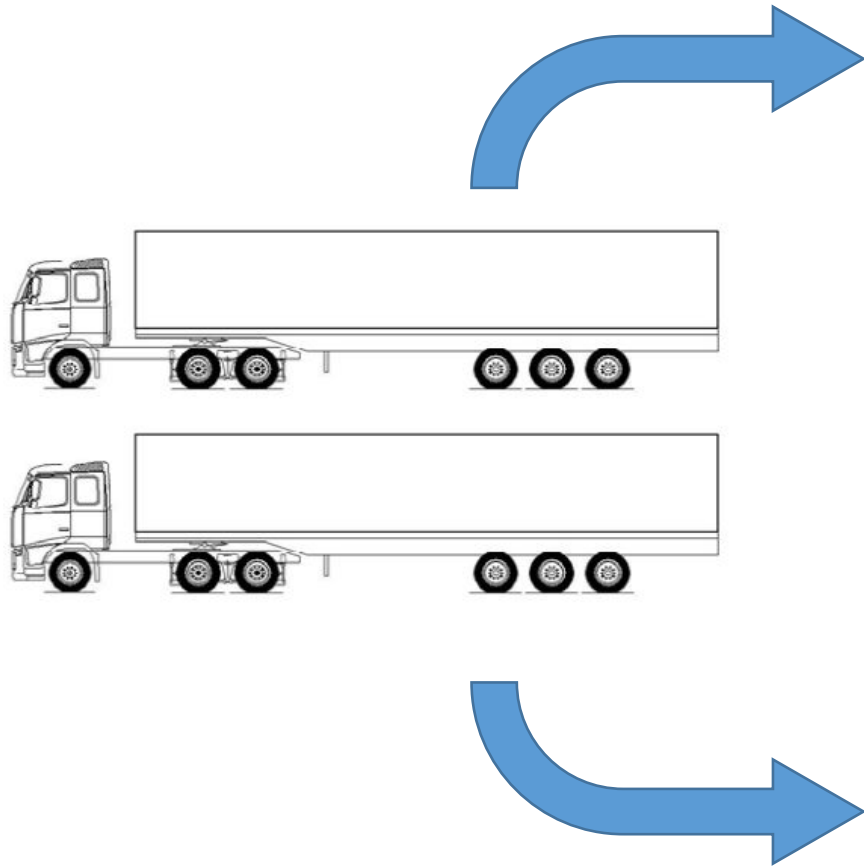
VOLVO FE HYBRID

- Reduced fuel consumption and emissions
- Higher energy efficiency
- Improved time efficiency
- Sustainability

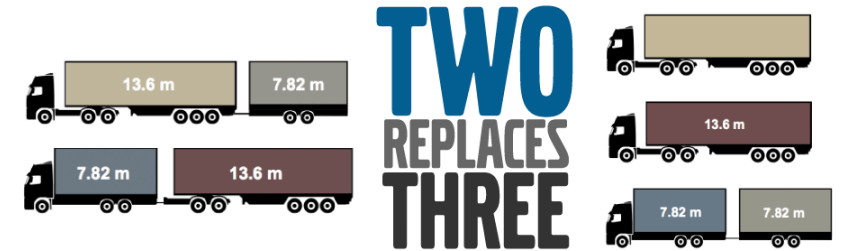
2014

2015

The way ahead



Policy

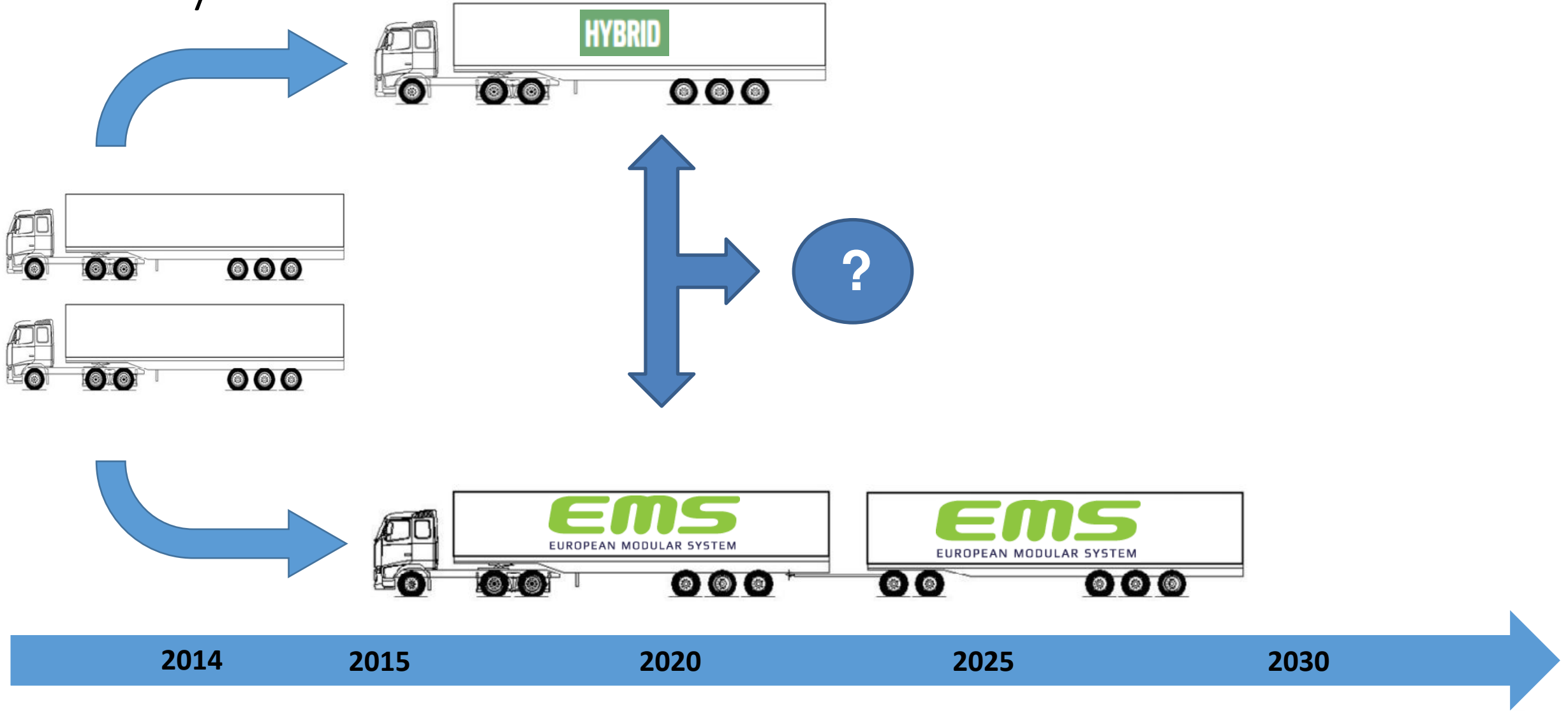


- Reduced fuel consumption and emissions
- Higher energy efficiency
- Reduced traffic and congestion
- Safer corridors

2014

2015

The way ahead



What combinations are possible?



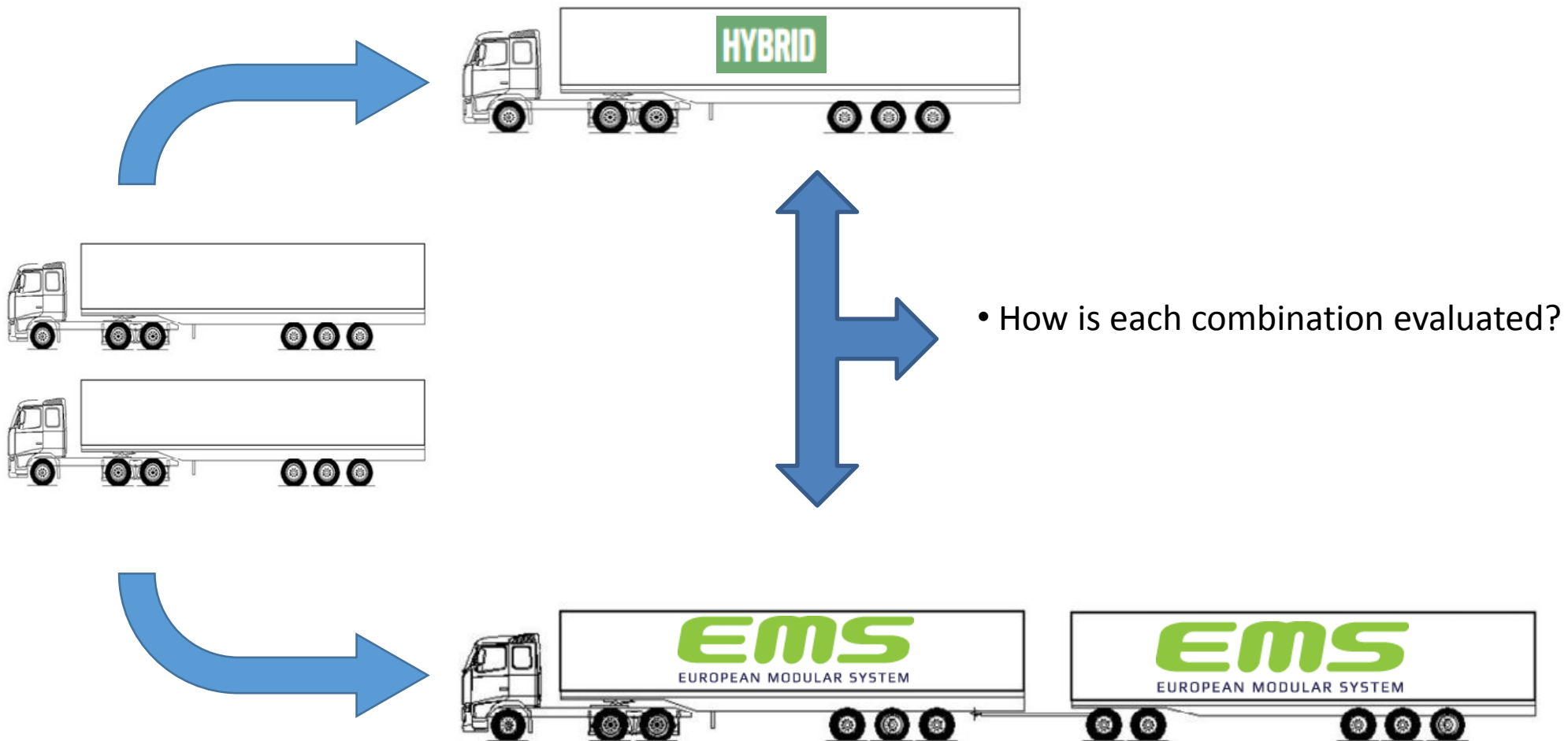
What combinations are possible?



What combinations are possible?



3 Engine Sizes X 3 Buffer Sizes X 3 Motor Sizes X 11 possible axles = 55296 combinations



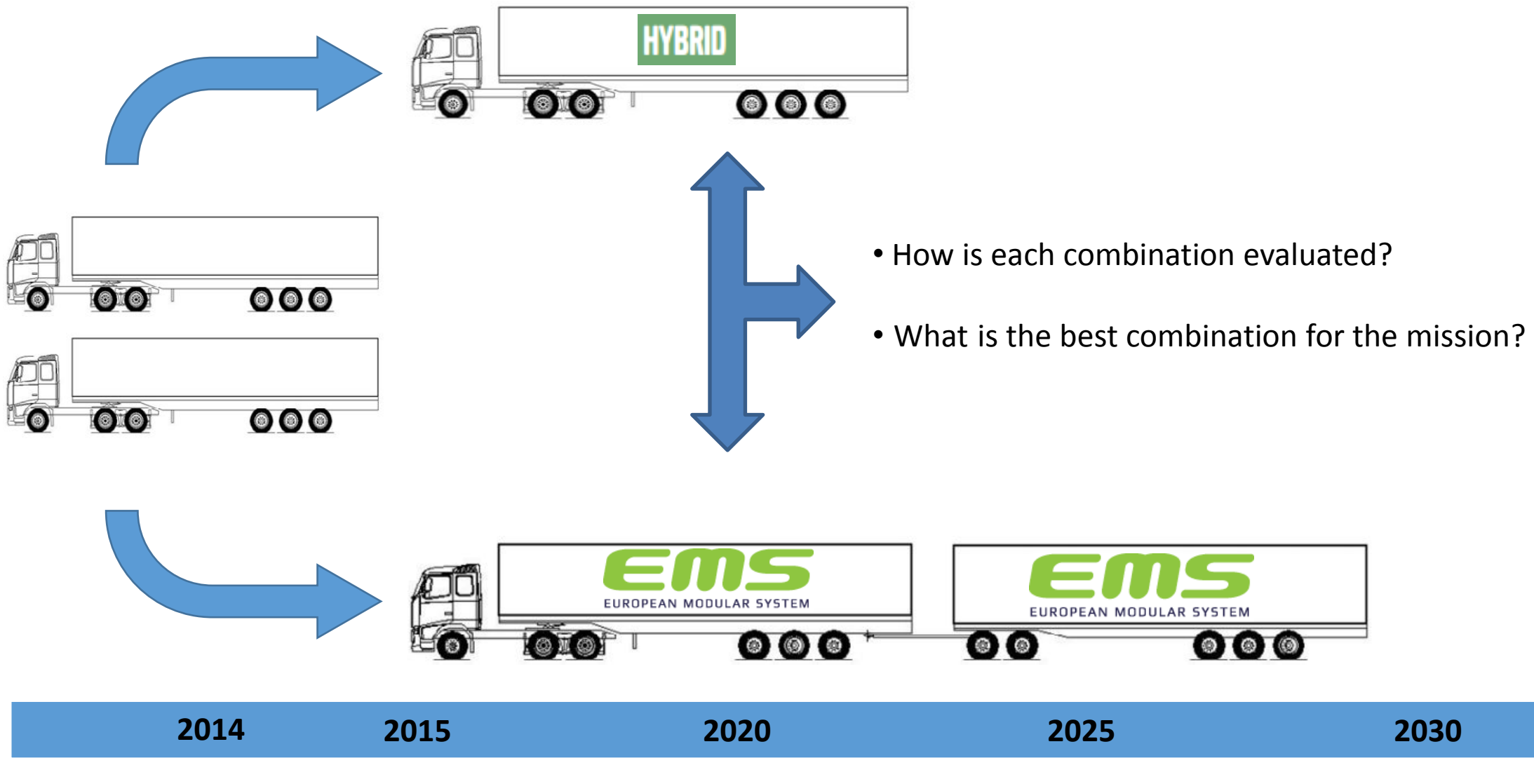
2014

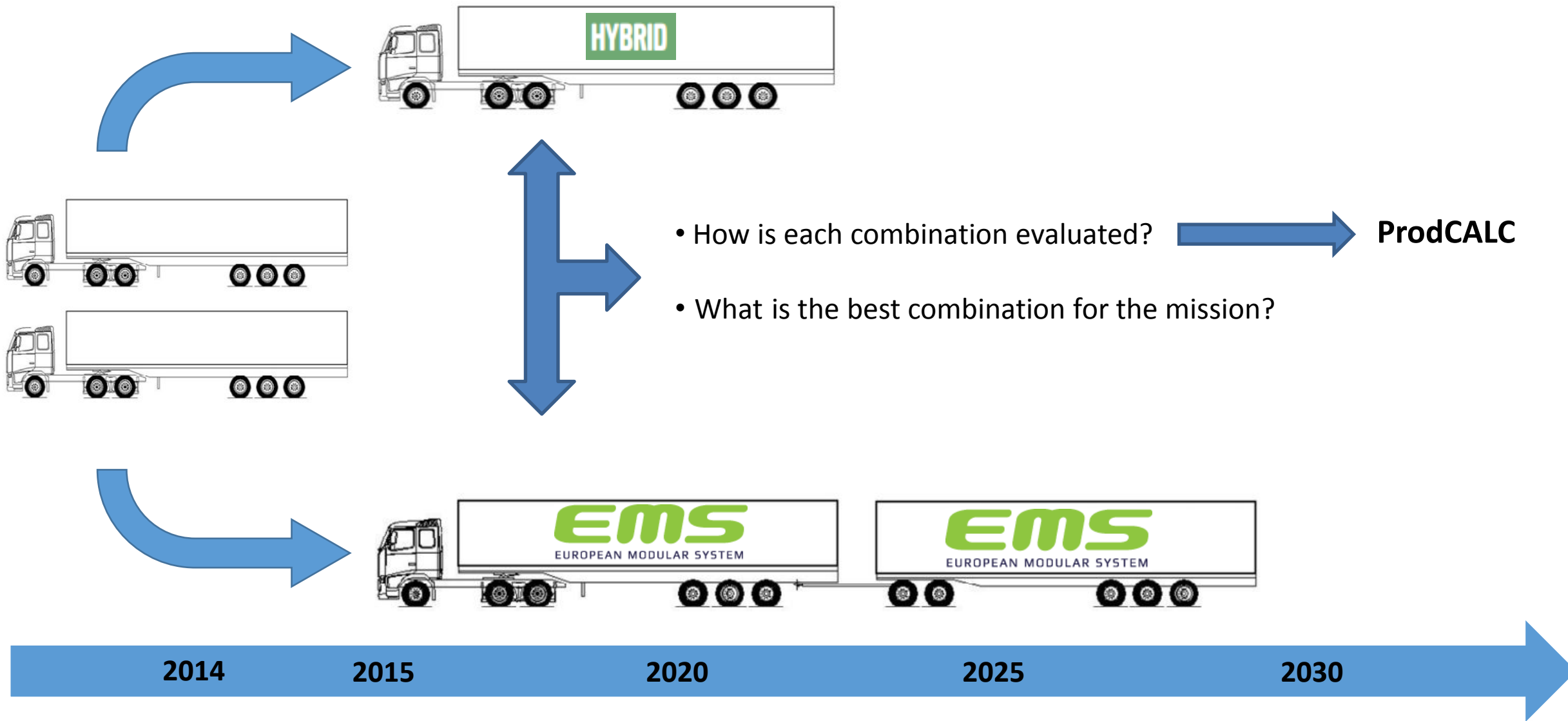
2015

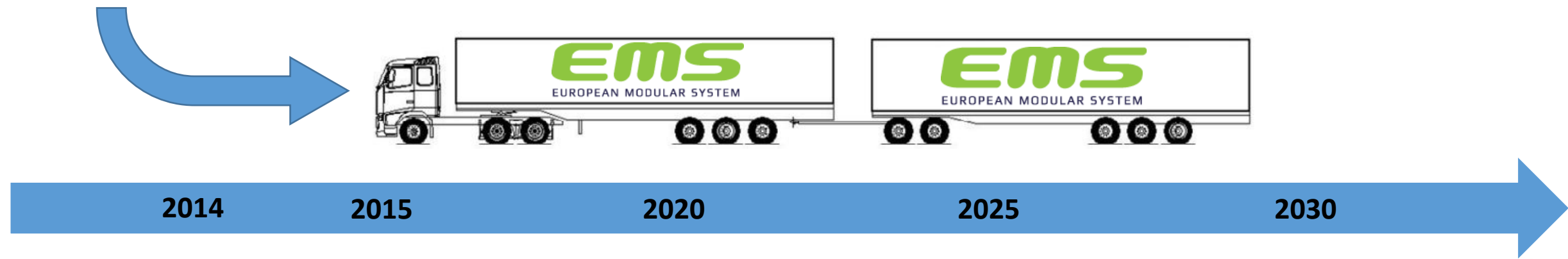
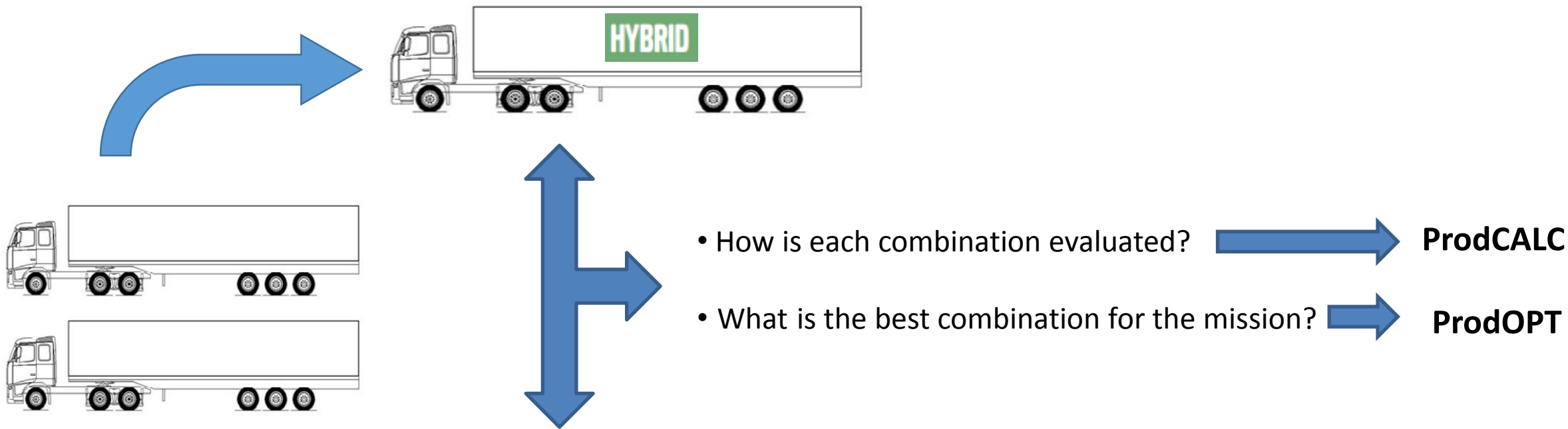
2020

2025

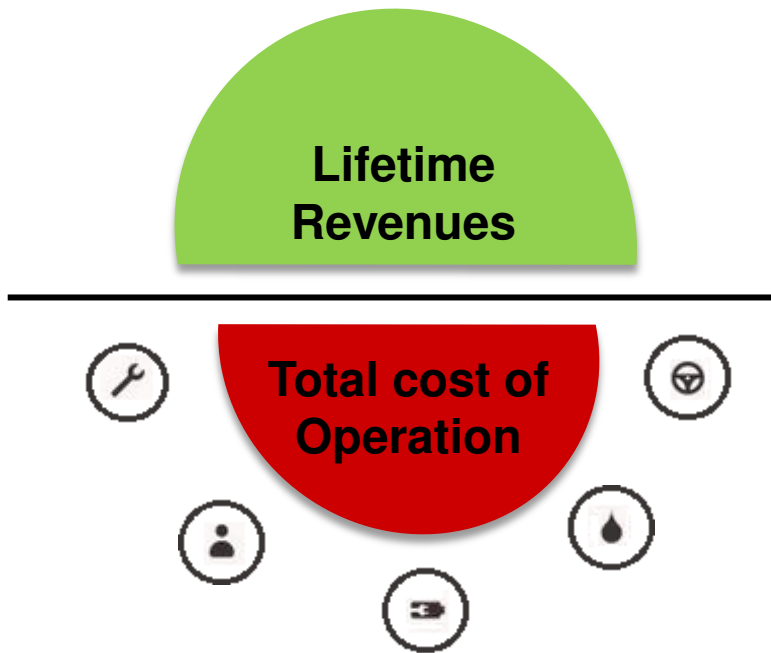
2030







ProdCALC

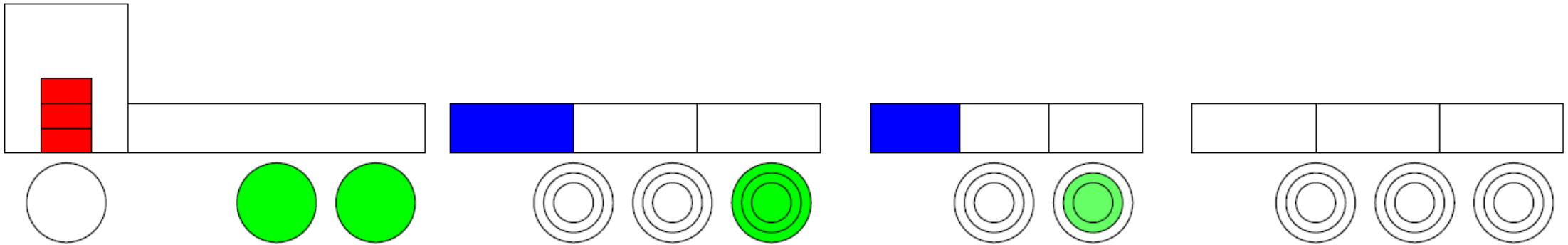
Mission Productivity = 

The diagram illustrates the formula for Mission Productivity. It consists of a horizontal line. Above the line is a green semi-circle labeled "Lifetime Revenues". Below the line is a red semi-circle labeled "Total cost of Operation". Surrounding the red semi-circle are five circular icons: a wrench, a person, a battery, a drop, and a gear.

ProdCALC

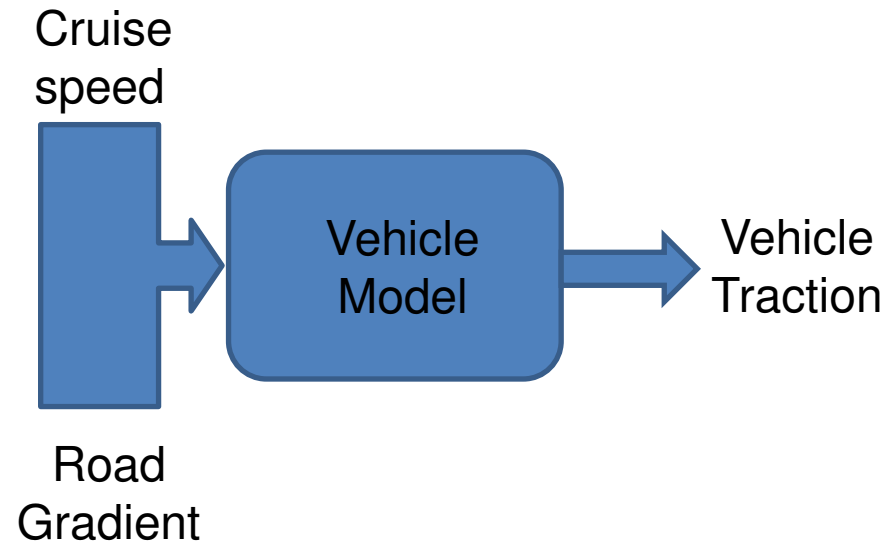
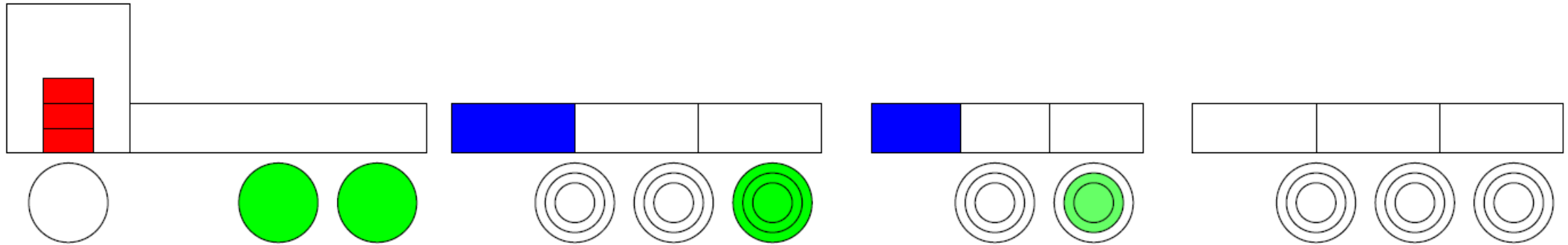


Vehicle Model in ProdCALC

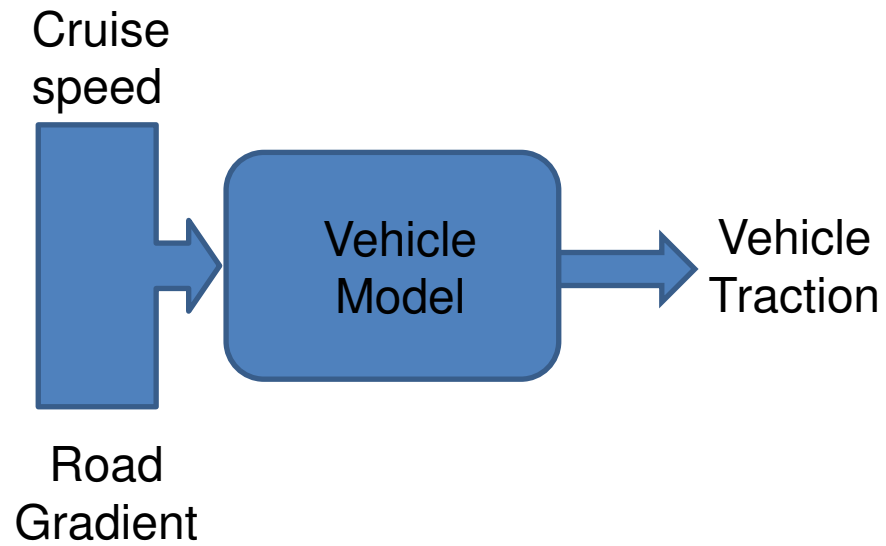
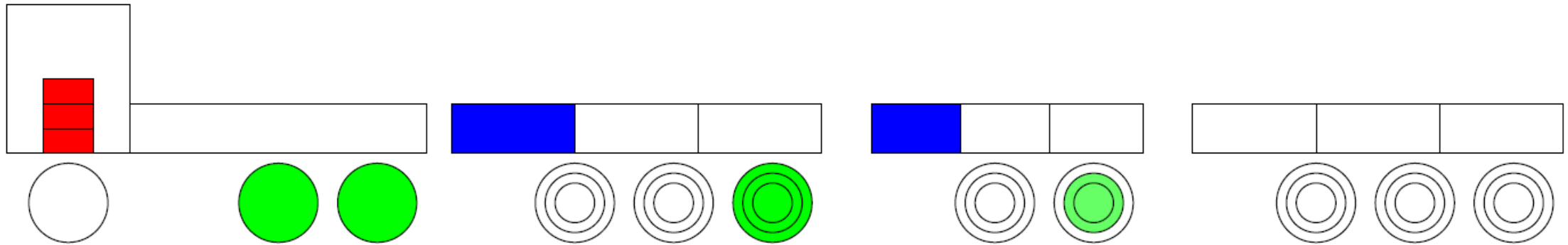


- Longitudinal vehicle dynamics
- Distributed propulsion – energy buffers on each unit
- 3 different engines – D11, D13 and D16
- 3 electric buffer sizes – 5 kWh, 50 kWh and 91 kWh
- 3 electric motor sizes – 125kW, 230 Nm;
175kW, 400 Nm and
175kW, 800 Nm
- Electric propulsion on any / all trailer axles

Vehicle Model in ProdCALC



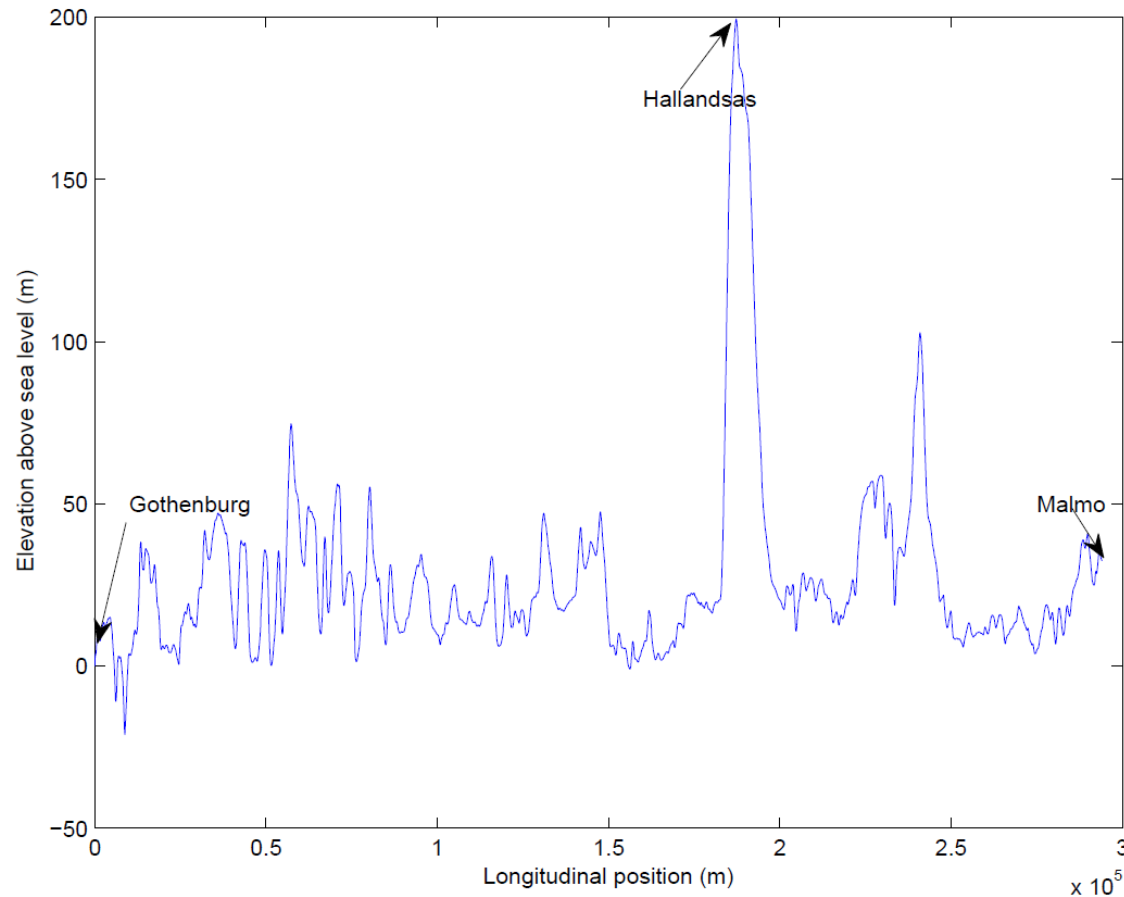
Vehicle Model in ProdCALC



- Battery energy management
- Hybrid power management

Vehicle Model in ProdCALC

Predictive Battery Management



Explanation, control allocation, GA and results follow....