Eignung und Einsatz von Wasserstoffverbrennern in Schienenfahrzeugen

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10.11.2022

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Rangierlokomotiven - Markt

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- Bestand

  Ca. 4000 Rangierloks mit hohem Alter in Europa im Einsatz

  - davon bis zu 2000 Stück 3 Achs-Rangierloks mit niedrigen Buchwerten, hohen Wartungskosten/Emissionen, (350kW up to 700kW) / (v_{max} 40..80 km/h)

  - davon bis zu 2000 Stück 4 Achs-Rangierloks mit höheren Buchwerten, (zum Teil IIIa Motoren und Partikelfiltern) (700 up to 1.800 kW) / (v_{max} 80….120 km/h)

Warum ?

- Bekannte Produkte
- Geringe Total Cost of Ownership
- Schnellere Verfügbarkeit als Neufahrzeuge

Der Markt für adaptive preis- leistungsgetriebene Lösungen ist da

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Rangierlokomotiven – Generischer Ansatz für Emission Free Lokomotiven

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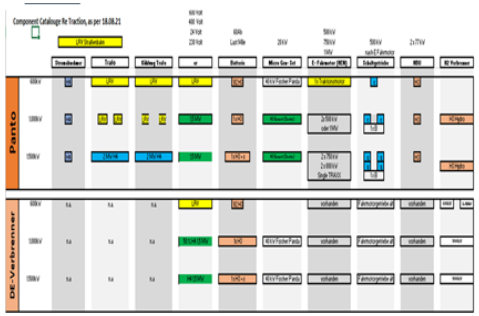
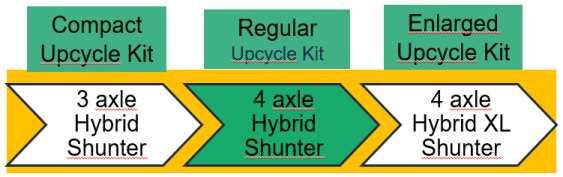
- Konsolidierung der Anforderungen
  - Evaluieren der Traktionsanforderungen (Tagesspiele)
  - Aufnahme betrieblicher Abläufe und Bewirtschaftungen
  - Untersuchung von Zulassungsfähigkeit

- Entwicklung der Lösungsansätze
  - Selektion / Erarbeiten von nutzbaren Komponenten
  - Aufbau des Re Traction Komponenten Katalogs
  - Abbildung der möglicher Konfigurationen von 350kw …1800kW
  - Selektion TCO orientierter Konfigurationen→ Kitting





Adaptive preis- leistungsgetriebene Lösungen sind möglich

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Rangierlokomotiven – Refurbishment Modell

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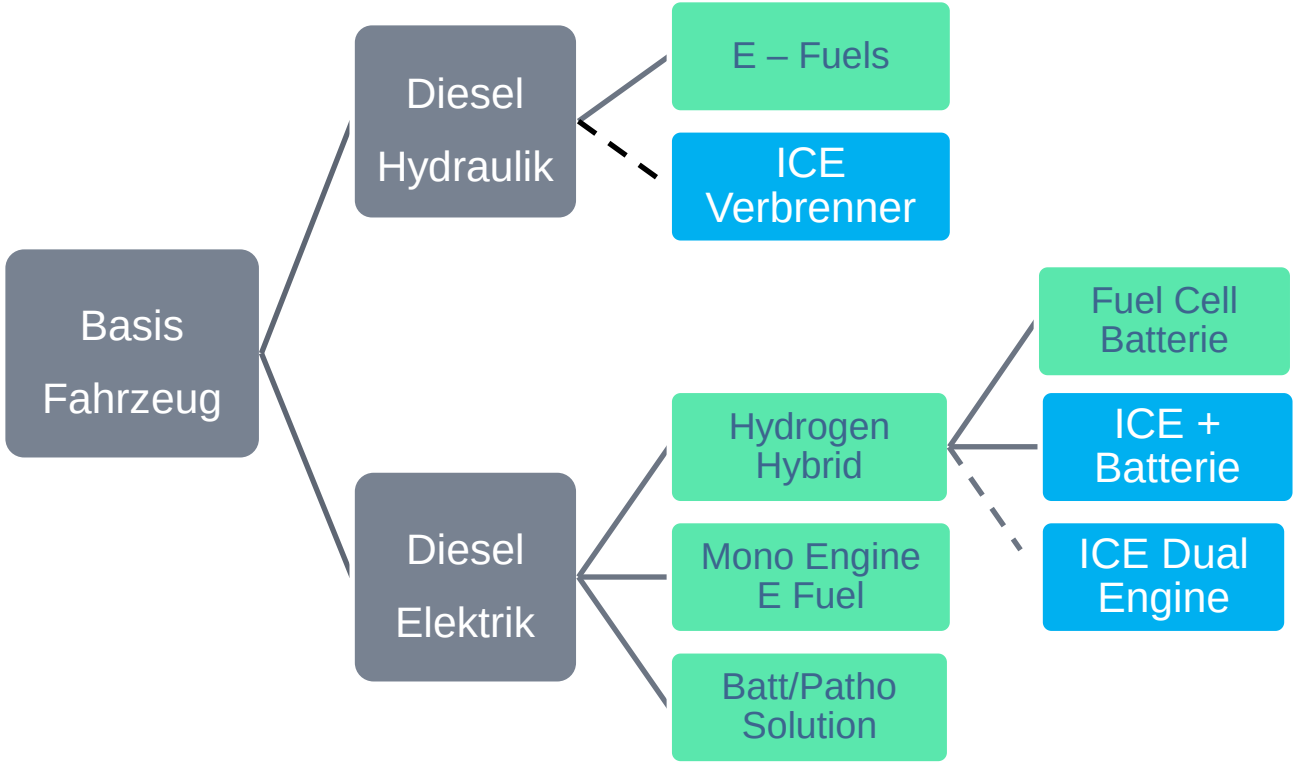

Europäische Rangieloks sind vielfach dieselhydraulisch geprägt…

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Rangierlokomotiven – Refurbishment Modell

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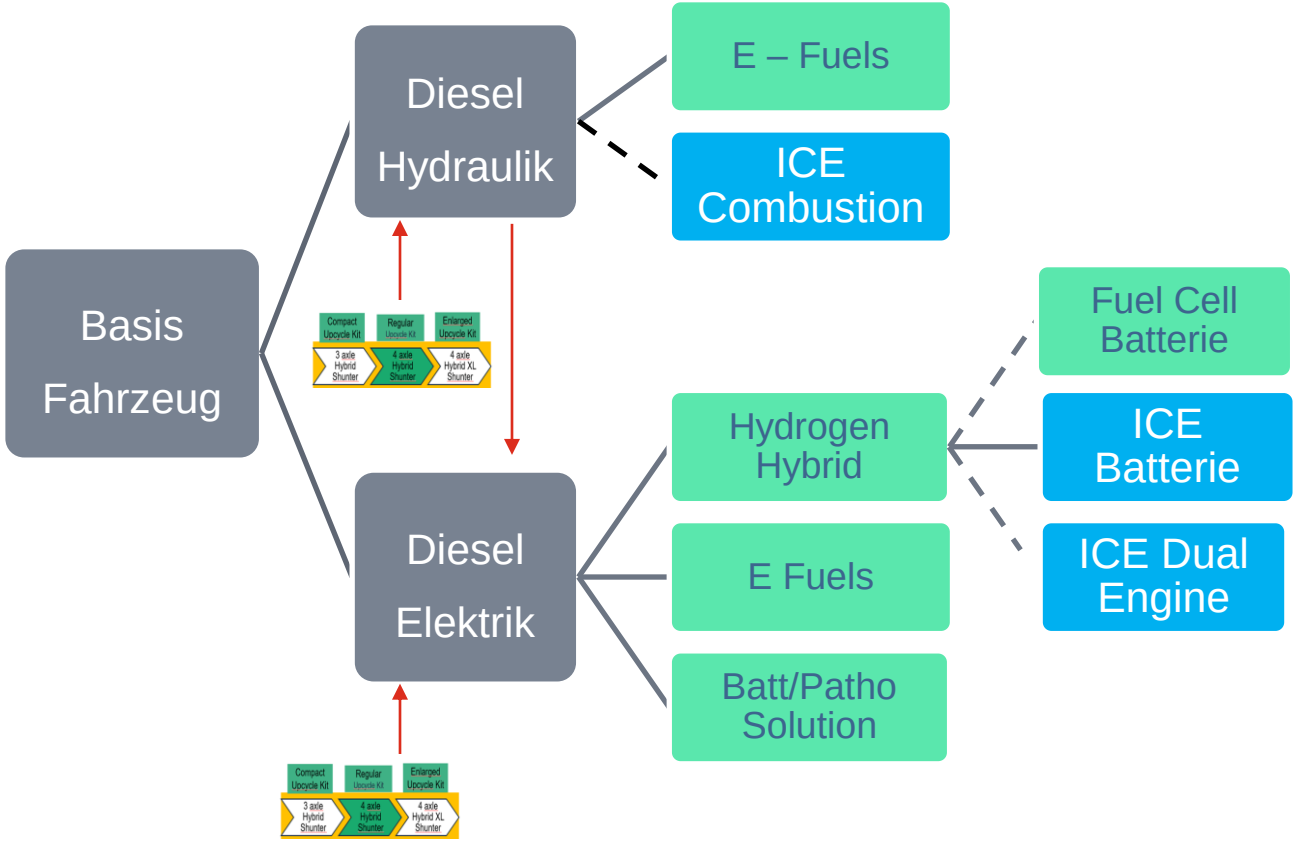

…aber standardisierte Kits ermöglichen die Transformation zur E Traktion

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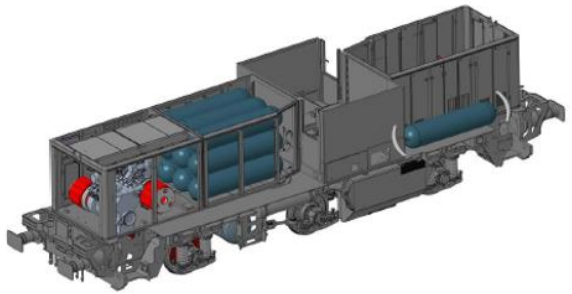
ICE (Internal Combustion Engine), Konfigurationen

- Standard Hybrid: 1 x V6 ICE Engine + Standard Batterie
  - ICE Verbrenner (370 kW netto) anstelle des Diesel Genset
  - 360 kW Batterie → Systemleistung bis zu 730 kW
  - Tanks außerhalb der Vorbauhauben

  → total of 32 kg H2 mit 350 bar oder 43kg H2 mit 700 bar

- Dual Engine: 2 x V6 ICE + 1/3 H3 battery
  - 2 x ICE Verbrenner (je 370 kW netto) anstelle Diesel Genset und 360 kW Batterie
  - “Last Meter” 120 kW Batterie anstelle des Diesel Tanks
  - H 2 Tanks: 12x 350l; 350 bar

  → total of 97 kg H2 mit 350 bar oder 120kg H2 mit 700 bar.



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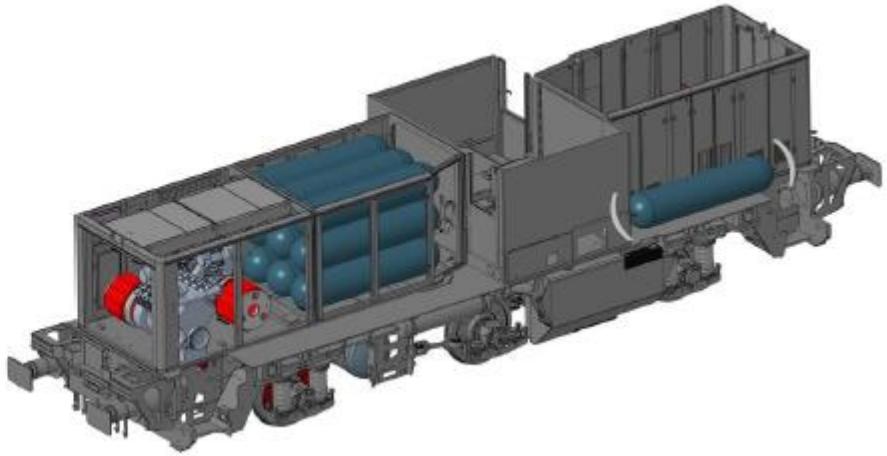
ICE Loco (Internal Combustion Engine)



Standard Hybrid:

- Vorteile
  - Gute Integrationsmöglichkeit
  - Nutzung des vorhandenen Diesels
  - Tanks gut erreich- und tauschbar
  - Nutzung des 95 % reinen Wasserstoffs möglich
  - Konfiguration nur auf 2 Systemen anzupassen
  - “One day” Betrieb ist möglich
- Risiken
  - Ggf weniger Motorleistung zu erwarten
  - Positionierung der Tanks nur mit Schutzsystemen

Dual Engine

- Vorteile
  - Gute Integrationsmöglichkeit
  - Minimierung der Batterie (Kosten) möglich
  - Komplexere Integration
  - “One day” Betrieb ist noch möglich
- Risiken
  - Weniger “Low Noise” Operations (kleine Batterie)
  - Mehr Systeme neu anzupassen
  - Bauraumverfügbarkeit noch nicht abschließend sicher
  - komplexeres Tank-Schnellwechselsystem
  - Reiner Verbrenner

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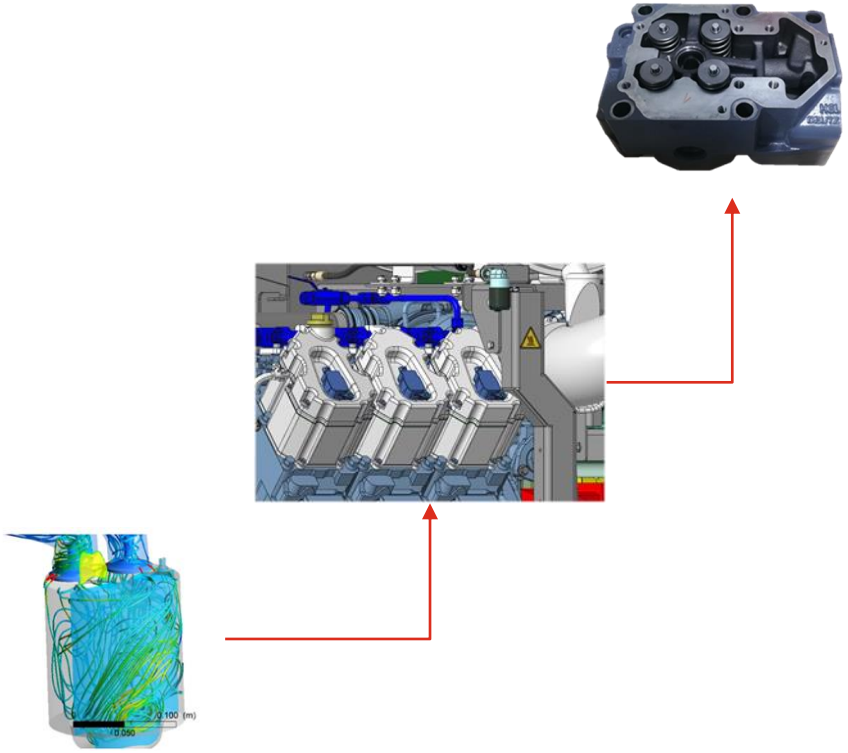
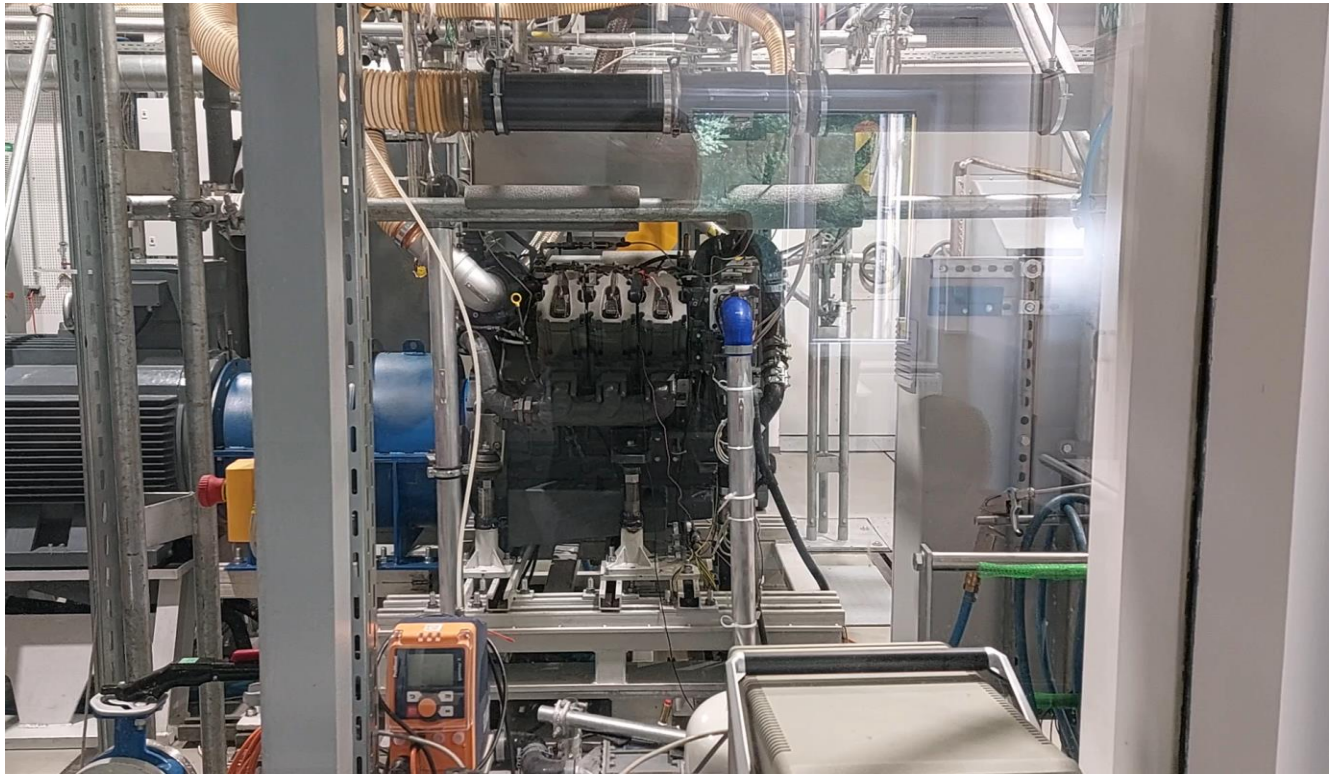
ICE Engine …von der Idee zur Vorstudie





Modellierung → Enginering → Operations → ….der Motor läuft !

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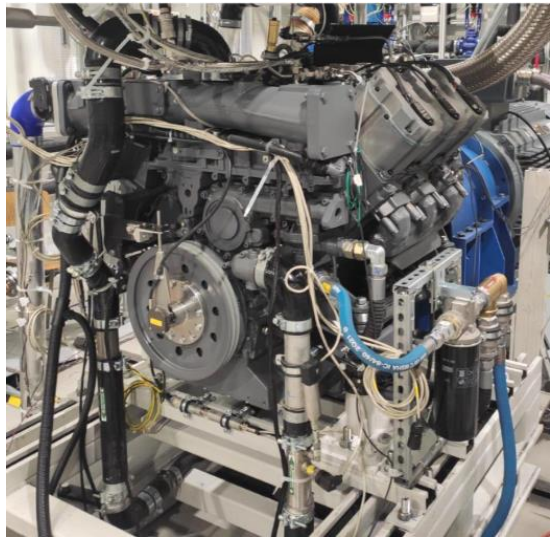
ICE Hydrogen Hybrid



Vorversuche→ Enginering → Integration → ….der Motor passt !

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Zero Emission….

…ja, dafür ist auch der Einsatz von ICE Verbrennern ein guter Schritt

Optimierte Rangierdiesel (Refurbish)

- Optimierung der Emissionen durch neue Motoren und Dieselpartikel-filter.
- Leistung 950kW - 1.350kW Diesel
- 20-30 Liter Diesel / Betriebsstunde, ergeben CO2-Emissionen pro Jahr von 150-250t/ Fahrzeug

Diesel Hybrid Lokomotive (Refurbish & Neu)

- Erste europäischer Hybrid in 2008 (203.7) Alstom Hybrid Familie BR1001 & Prima H3, 79 Fahrzeuge.
- Lokaler emissionsfreier Betrieb, System Leistung 700 kW, davon 340kW aus Dieselaggregat
- 7-10 Liter Diesel / Betriebsstunde, CO2-Emissionen pro Jahr 50-100t, ca. 50-60% nachgewiesenen Reduktion

Emissionsfreie Lokomotive

- Starke Nachfrage nach emissionsfreiem Rangierbetrieb von verschiedenen Kunden:
  - Häfen
  - Automobile
  - Chemische Industrie
  - Stahlfabriken
- Alstom Kit Angebote
  ICE / Batterie
  Batterie / Pantho
  Batterie

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