E-Futures

Energy Saving Capabilities of Super-conducting Electrical Machines For Transport

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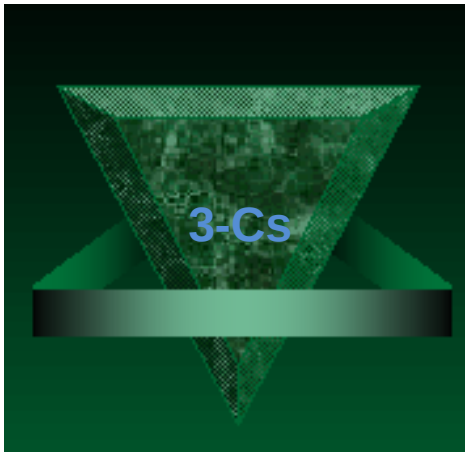
Introduction

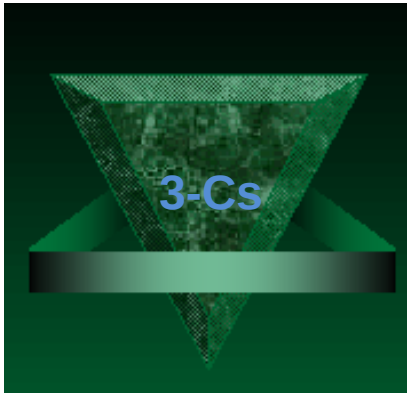
Energy saving applications of superconductors in transportation:

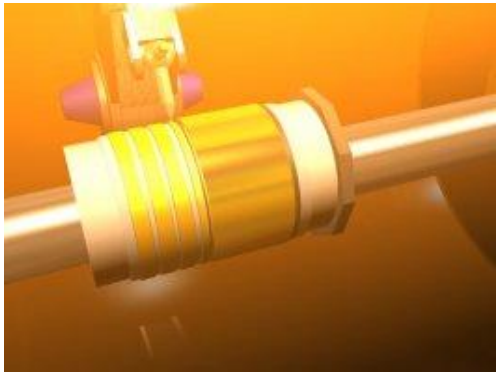


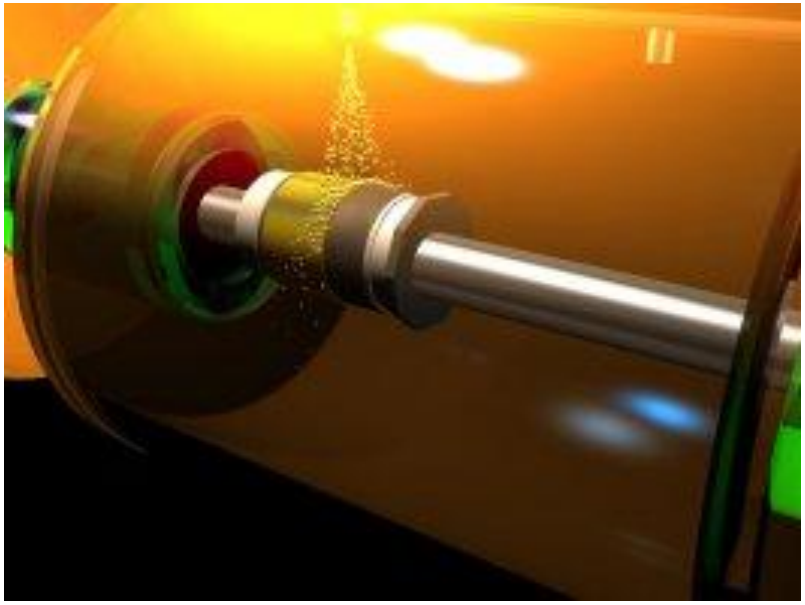
3-C's : Coated Conductor Cylinders

E-Futures

Company & Technology







Transportation

Transportation accounts for 24% of UK carbon dioxide emissions(Department for Transport.

Globally 13.1% of anthropogenic carbon dioxide
(IPCC Fourth Synthesis report)

Huge potential for energy saving technologies to make a real global difference

Project Outline

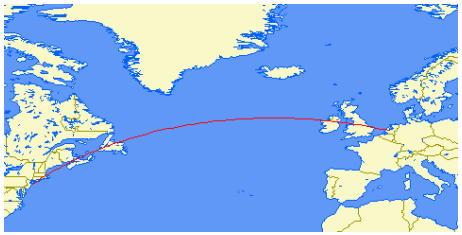
Rail journey:

London To Edinburgh

East Coast Mainline

Intercity 225, fully electric

Airliner journey



London Heathrow to Newark

6500 Kilometres

7hr45min

Boeing 777

Rail Model

Weight dependent energy usage mechanisms were identified.

The most significant was the energy required to accelerate the mass of the train.

Model developed to calculate the acceleration and sum the energy required to produce that acceleration over the full journey

On Board Train Monitor data were kindly provided by East Cost Mainline

Aircraft Model

The problem was broken down into two parts,

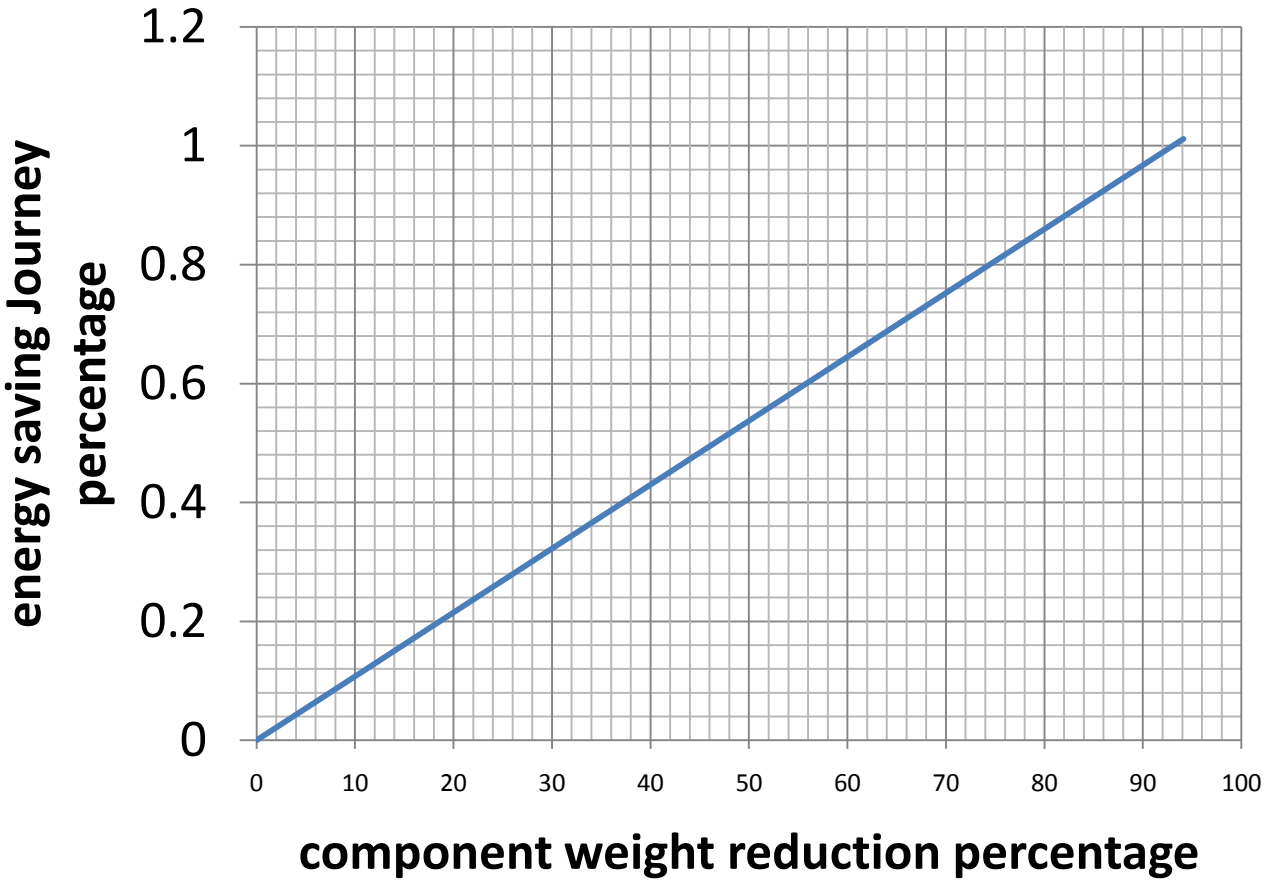
Energy required to keep the mass in the air – Induced drag

The change in gravitational potential lifting the mass to maximum altitude

The induced drag was calculated by first finding the coefficient of induced drag from the aerodynamic properties of the Boeing 777

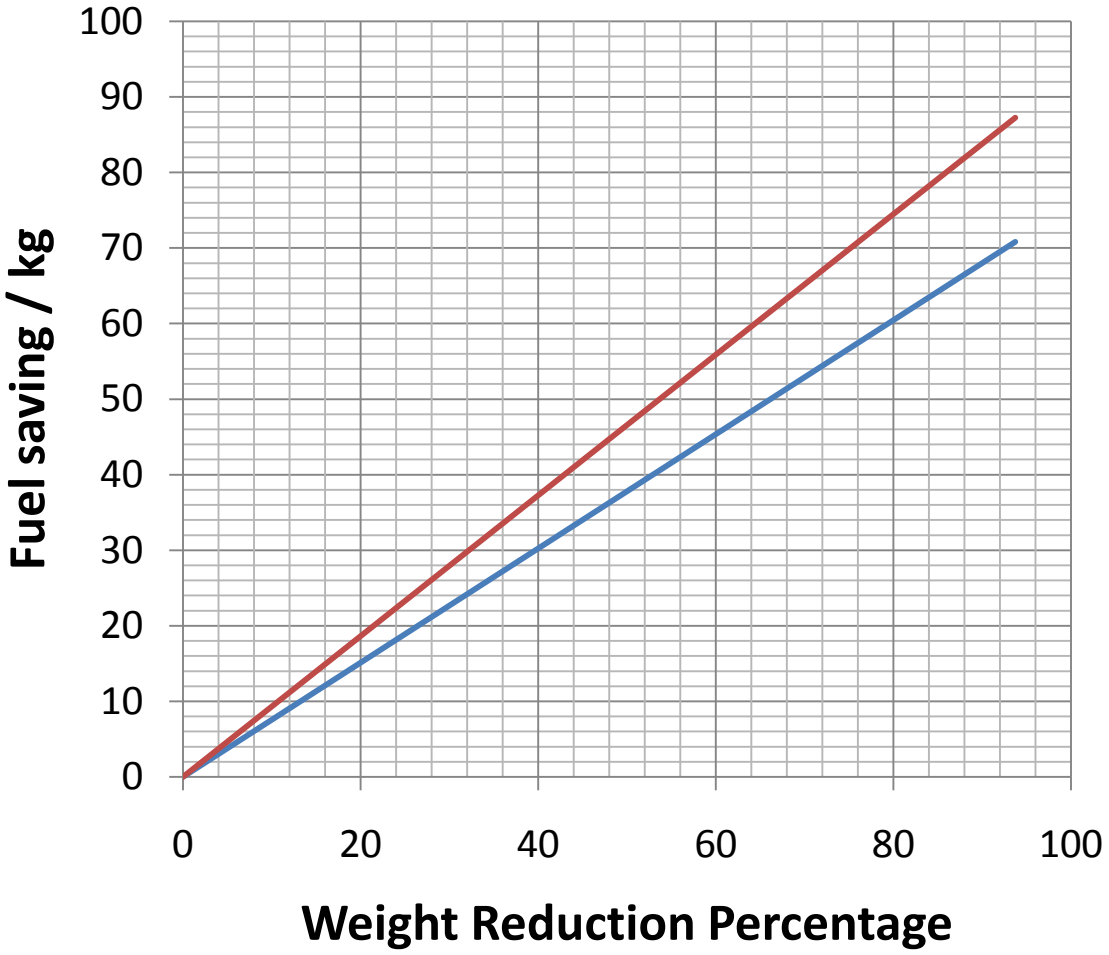
Compound fuel savings were taken into account, the fuel saved by not having to carry the fuel to carry the reduced mass. This was done by numerically integrating the fuel savings.

Rail Model Results



Component weight reduction of 50% gives ~0.55% journey energy saving

Airliner Model Results



A 50% weight reduction would result in a ~46kg fuel saving

Model Limitations

Rail Model

Due to low of resolution (integer speeds) of the train data

No account was made for traction, Class 91 Locomotive weighs 81.5 tonnes, electrical components make up ~10 tonnes.

Large weight reduction in traction engine weight would result in lower traction.

Airliner Model

Many potential variations in flight such as:

Altitude
Flight speed
Plane loading

Assumptions were made for a single flight, not averaged.

Conclusions

As very simplistic models of specific test journeys only order of magnitude checks can be made.

Rail Model suggests that even large changes in the mass of electrical components would give only small energy gains in a best case scenario.

Airliners show a much greater potential for lighter weight technology
This is therefore already a priority on aircraft. Further improvements difficult.

A more thorough examination of all aspects, including efficiency gains are required.

Technology should be developed, the case from a direct energy savings perspective may not appear great but there could be potential indirect benefits through potential design changes.

Further Work

Different models implemented to check validity of results

Life Cycle Analysis including manufacture, service lifetime and decommissioning

Examination of applications to other modes of transport

Integration of other factors including efficiency gains, size reduction allowing redesign, cryogenic requirements.

Questions?