

ICELANDIC TRANSPORT AUTHORITY

ALTERNATIVE FUELS FOR AVIATION

Nordisk Arbeitsgrupp for Luftfartens Miljöfrågor

May 30th 2017

Flugröst, Reykjavik, Iceland

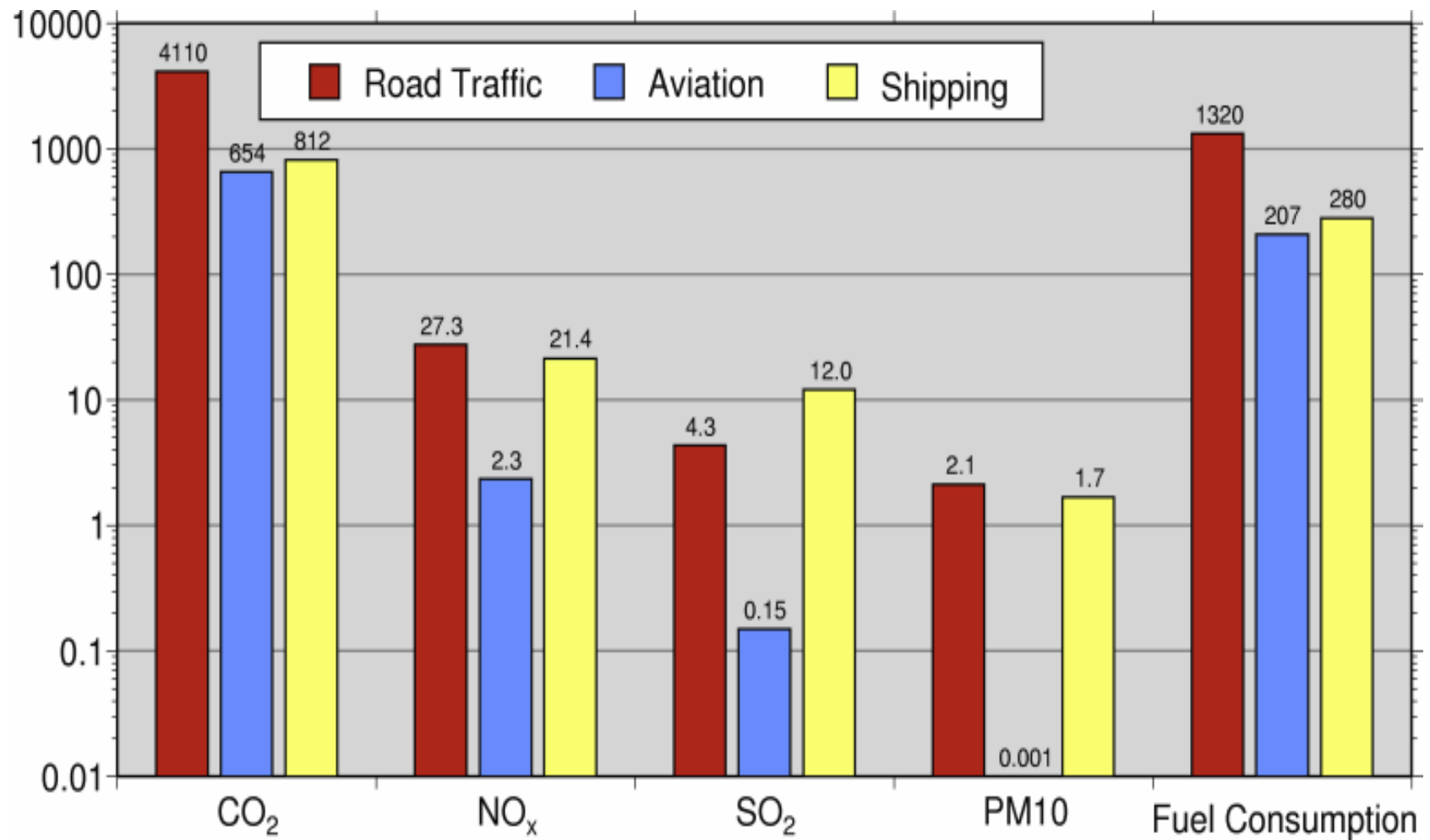
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Icelandic Transport Authority



Annual Emissions (10⁶ tons/year)



Energy Density Content / Heat Value

Comparison of the Energy Levels of several Fuel Sources

=> Fuel

=> Energy Carrier

Fuel / Carrier	MJ/litre	Equivalence	CO ₂ -Emission	Health Effects
Jet Fuel (Kerosene)	37.6	100%	3.160 kg	Toxic
Fossil Diesel	38.6	103%	3.160 kg	Toxic
Canola Oil (Raps)	37.1	99%	2.797 kg	Harmless
BioLiq (BtL)	36.3	97%	3.140 kg	Toxic
Biodiesel (RME)	35.1	94%	2.797 kg	Harmless
Gasoline	34.8	93%	3.160 kg	Toxic
Ethanol	23.5	63%	1.913 kg	Toxic ??
Methanol	17.9	48%	1.375 kg	Highly Toxic
Methane Gases	25.3	67%	2.750 kg	Harmless
DME	19.2	51%	1.913 kg	Toxic
Hydrogen	9.3	24%	0.000 kg	Harmless

Aircraft Total Weight

The total weight of an Airplane can approximately be divided in three main parts

- **1/3 of the weight is the Airplane body**
- **1/3 of the weight is the Jet-Fuel**
- **1/3 of the weight is the Piloting**



Comparison – Jet Fuel vs. Biodiesel

Properties	Jet Fuel (Kerosene)	Biodiesel (RME)
Density (kg/m ³)	775 - 840	860 - 900
Freezing Point (°C)	- 47	- 5
Boiling Point (°C)	176	200
Flash Point (°C)	38	120
Autoignition Temperature (°C)	210	210 - 250
Specific Energy (MJ/kg)	42,8	38,7
Energy Density (ML/litre)	37,6	35,1
Cetane Number	45 – 52	48 - 55
Carbon Dioxide (CO ₂) emission (kg/kg)	3.160	2.797

Necessary Additives

Additives for Jet-Fuel and Bio-Jet-Fuel

- 1. Antioxidants**
 - prevent gumming, copper and some metals
- 2. Antistatic agents**
 - prevent sparking and dissipate static electricity
- 3. Corrosion inhibitors**
 - prevent corrosion in tanks and pipes
- 4. Icing inhibitor**
 - prevent the fuel against icing
- 5. Biocides**
 - prevent bacterial and fungal growth



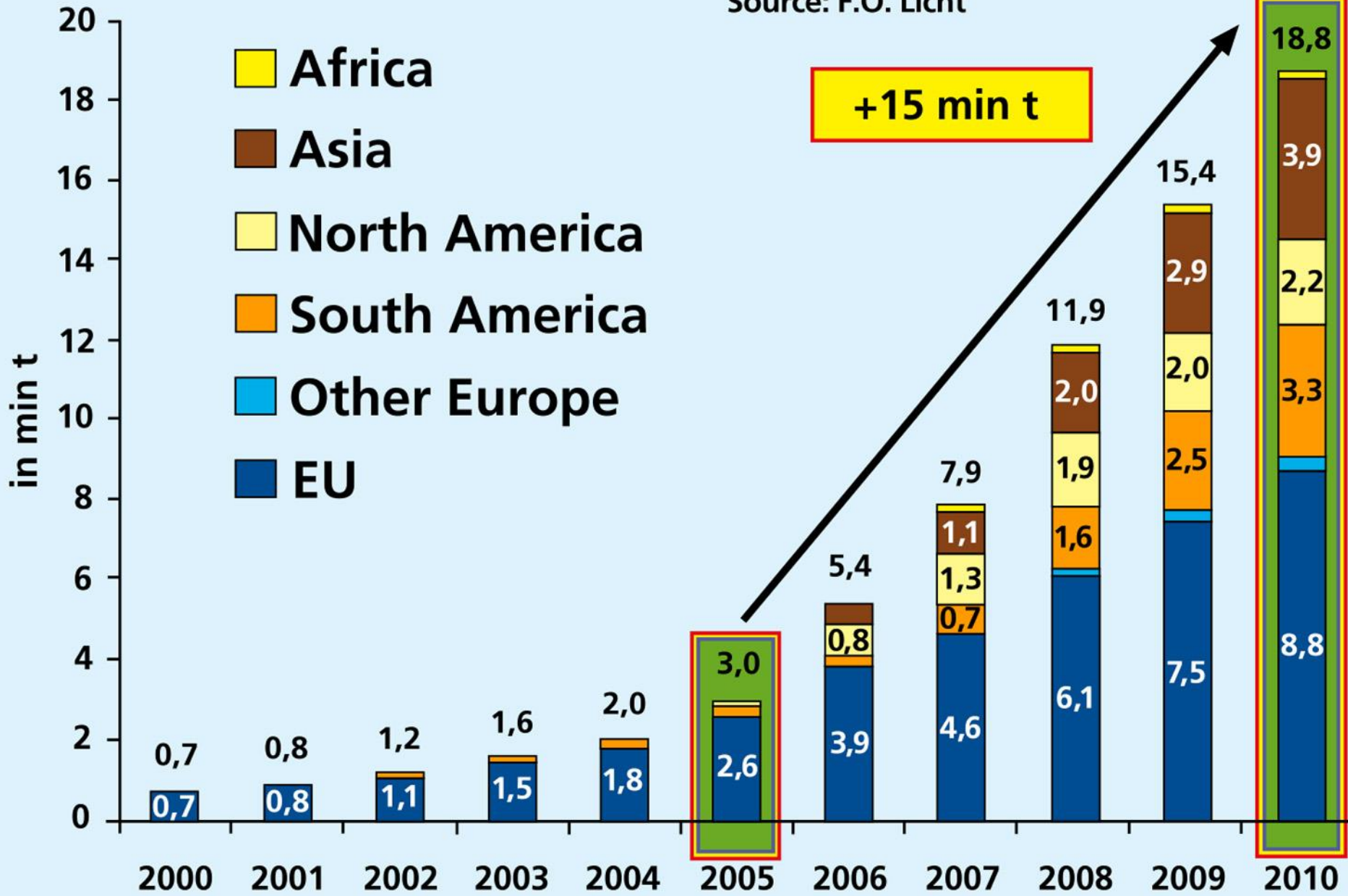
The Biodiesel Generations

- **1. Generation is Biodiesel from Rapeseed oil (RME)**
 - Land use => 50% Fertilizer, 35% Fodder and 15% oil
- **2. Generation is Biomass to Liquid**
 - Liquid from biomass
 - Bio oil (pyrolysis oil) by temperatures between 350 – 550°C
 - Fischer-Tropsch-Process is used to produce synthetic fuels from gasified biomass
- **3. Generation is “Green Algae”**
 - Light
 - Carbon dioxide (CO₂)
 - Waste water
 - Yields 50 times more oil per hectare than rapeseed (1. Generation)



World Biodiesel Production Estimate

Source: F.O. Licht



Jet - Biofuel

- The air transport industry is responsible for **2-3 percent** of man-made **carbon dioxide** (CO₂) emitted.
- **Boeing** estimates that biofuels could reduce flight-related greenhouse gas emissions by **60 to 80 percent**.
- One possible solution which has received more media coverage than others would be blending **synthetic fuel** derived from **algae** with existing jet-fuel



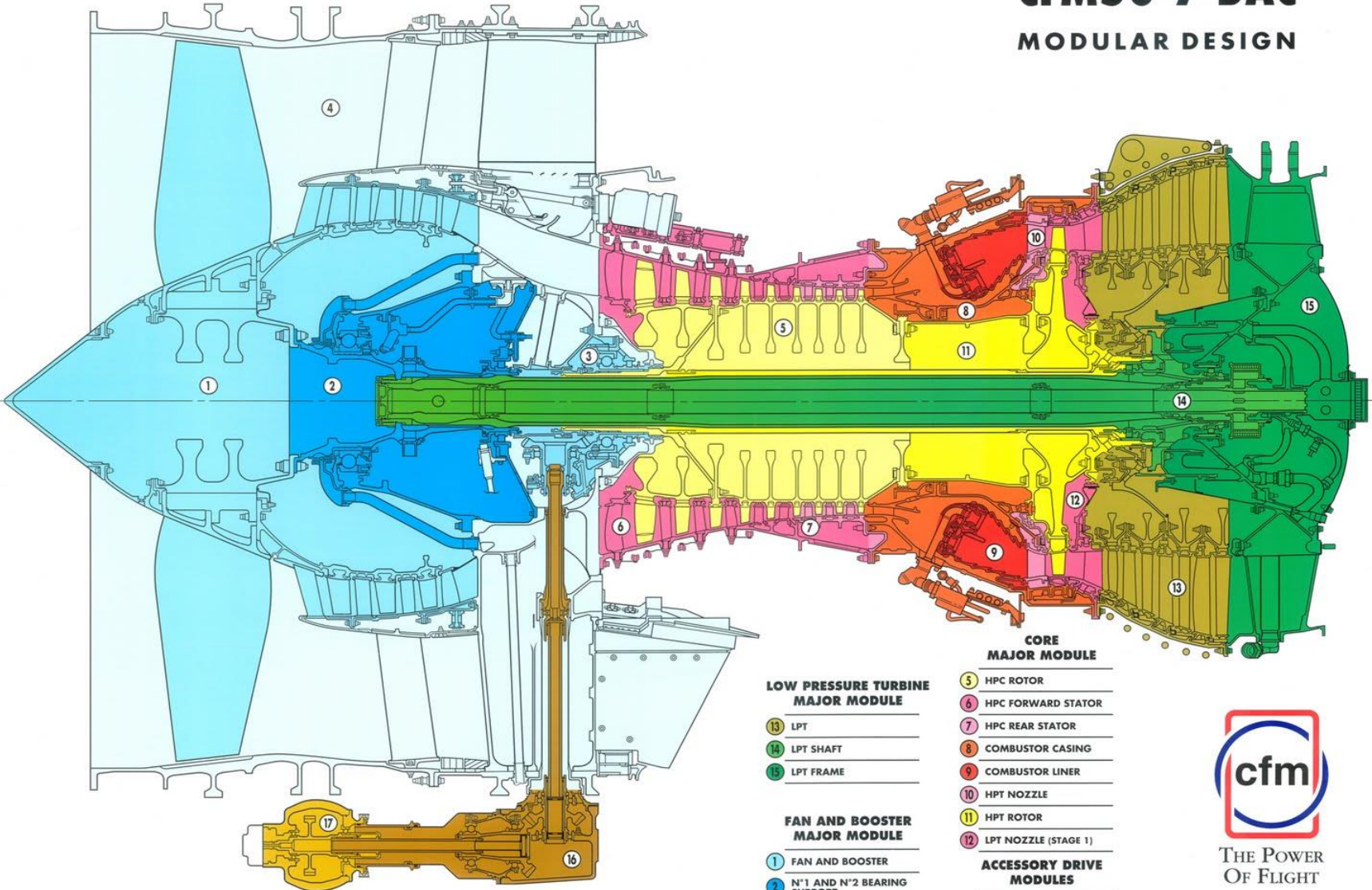
Jet – Biofuels (status)

- **Green Flight International** became the first airline to fly jet aircraft on **100% biofuel**. The flight from **Reno Stead Airport** in Stead, Nevada.
- **Boeing** and **Air New Zealand** are collaborating with jet biofuel developers around the world.
- **Virgin Atlantic** successfully tested a biofuel blend consisting of 20/80 percent which was fed to a single engine on a 747 flight from **London Heathrow** to **Amsterdam Schiphol**.
- A consortium consisting of Boeing, NASA's **Glenn Research Center**, **MTU Aero Engines** (Germany), and the U.S. **Air Force Research Laboratory** is working on development of jet fuel blends containing a substantial percentage of biofuel.
- **British Airways** and **Solena Group** are establishing a sustainable jet fuel plant in East London, UK as BA plans to use the biofuel to power part of its fleet from 2014.
- 24 commercial and military biofuel flights are using “**Green Jet Fuel**”.
- In 2011, **United Continental Holdings** was the first United States airline to fly passengers on a commercial flight using a blend of sustainable, advanced biofuels and traditional petroleum-derived jet fuel.



CFM56-7 DAC

MODULAR DESIGN



LOW PRESSURE TURBINE MAJOR MODULE

- 13 LPT
- 14 LPT SHAFT
- 15 LPT FRAME

FAN AND BOOSTER MAJOR MODULE

- 1 FAN AND BOOSTER
- 2 N°1 AND N°2 BEARING SUPPORT
- 3 INLET GEARBOX (IGB) AND N°3 BEARING
- 4 FAN FRAME

CORE MAJOR MODULE

- 5 HPC ROTOR
- 6 HPC FORWARD STATOR
- 7 HPC REAR STATOR
- 8 COMBUSTOR CASING
- 9 COMBUSTOR LINER
- 10 HPT NOZZLE
- 11 HPT ROTOR
- 12 LPT NOZZLE (STAGE 1)

ACCESSORY DRIVE MODULES

- 16 TRANSFER GEARBOX (TGB)
- 17 ACCESSORY GEARBOX (AGB)

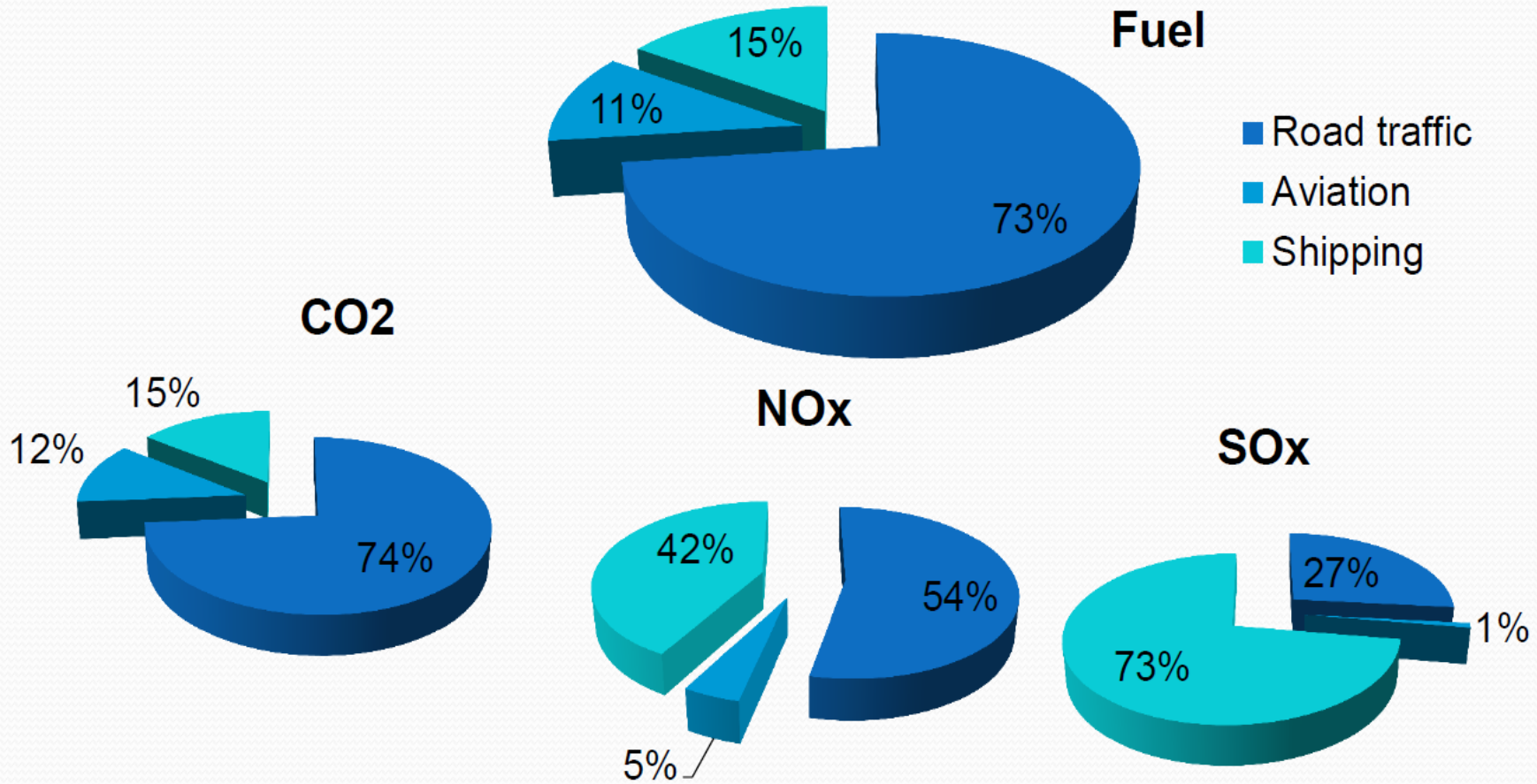


THE POWER OF FLIGHT

A JOINT COMPANY OF SNECMA, FRANCE AND GENERAL ELECTRIC COMPANY U.S.A.



Emissions



Data from Eyring et al. J Geophys Res 110 (2005) - Presented by Erik Fridell







PINGANES

HORNAFJÖRÐUR

ÞORLÁKSHÖFN

23 5 2017



Thank you for your attention

