HASKAYNE SCHOOL OF BUSINESS

Alliance Pipeline Seminar Series

UNIVERSITY OF CALGARY

Airships: An Idea whose time has come

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UNIVERSITY OF MANITOBA

ASPER SCHOOL OF BUSINESS

If a transportation technology existed that could 1) lower freight rates, 2) expand international trade, 3) increase employment, 4) solve northern logistical problems, and 5) greatly reduce carbon emissions, who would not want to embrace the idea?

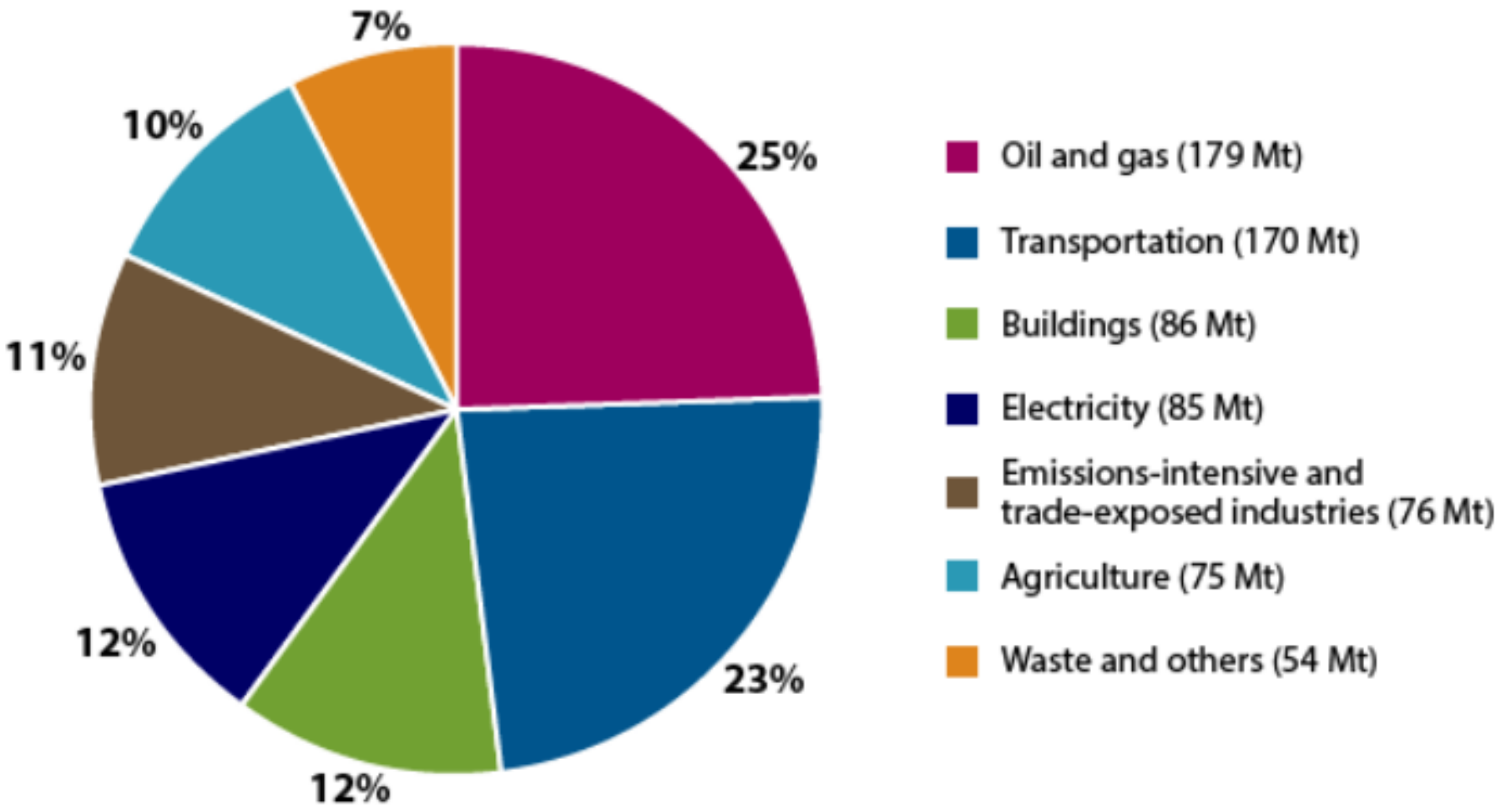
Triple Bottom-line Assessment

Environment: Can transport airships reduce environmental impact and cut carbon emissions?

Economy: Can airships increase trade, competitiveness and industrial growth?

Society: Can an airship industry create employment and investment opportunities, improve living standards and reduce risk?

Distribution of greenhouse gas emissions by economic sector, Canada, 2013



Airships can carry low pressure hydrogen fuel tanks without compromising the space available for cargo

Shipping Emissions Factors:

- Air cargo - 1.527 kg CO_2 per Ton-Mile*
- Sea freight - 0.048 kg CO_2 per Ton-Mile*
- H_2 Airship - 0.000 kg CO_2 per Ton-Mile

* Source: http://carbonfund.org

Buoyant Aircraft History

1670 Francisco de Lana

1783

Montgolfier brothers

1783 Prof. Charles & Robert

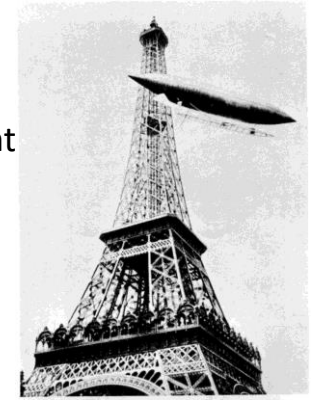
1784

Jean Baptiste Meusnier

1785 Blanchard & Jeffries
English Channel Flight

1854 Henri Giffard

1901
Santos Dumont
First dirigible
airship



1919 R.34 First Atlantic Crossing both ways

1926 *Norge* First flight across the North Pole

1929 *Graf Zeppelin* First
Circumnavigation of the world

1930 R100 – Flight to Canada

1935 *DZR* Regular air passenger
service across the Atlantic

1961 US Navy
ZPG-3W

1979 SkyShip

2000
Zeppelin NT

2006 LM *P-791* flight


Radio
FEH

- **Strength:**
  - **Robust, lightweight materials**
  - **Carbon fibre composites**
  - **All aluminum rigid designs**
- **Control:**
  - **Vectoring motors/engines**
  - **Modern avionics/hydraulics**
  - **GPS**
- **Safety:**
  - **Computer design tools**
  - **100 years of aviation research**
  - **Satellite weather information**
  - **No human contact during ground handling**
  - **Gas “sniffers”**
  - **Static electricity control**

P-791 (Lockheed-Martin)

Atlant-30 (RosAero-Systems)

Experimental Airships

DynaLifter

Airship do Brasil

Aeroscraft (Worldwide Aeros)

LEMV (Hybrid Air Vehicles)

Conceptual Designs

Euro Airship

Search for the Dominant Airship Design

- **Structure**
  - Rigid
  - Inflated
- **Buoyancy control**
  - Ballast
  - Compression of gas
  - Heating of gas
  - Venting of gas
  - Propulsion
- **Shape**
  - Cigar
  - Catamaran
  - Disk
- **Flight Control**
  - Fins
  - Thrusters
- **Lifting gas**
  - Helium
  - Hydrogen
- **Materials**
  - Metal
  - Composites
  - Nanotubes
- **Propulsion**
  - Turbines
  - Diesel
  - Electric
- **Human Factors**
  - Pilots
  - UAV
- **Manufacturing**
  - Robotics
  - Manual Assembly
- **Maintenance**
  - Inspection
  - Repair
- **Economics**
  - Cost
  - Performance

RIGID STRUCTURES

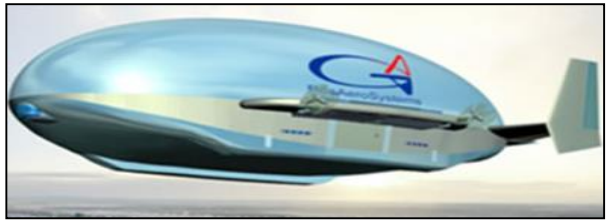
Catamaran

Aeroscraft (Worldwide Aeros)

Catamaran

LTA 10 (LTA Structures)

Catamaran



Atlant 30 (RossAerosSystems)

Cigar

Euro Airship

Cigar

ARH 50 (Varialift)

Cigar

MB 310 (BASI)

SEMI-RIGID & NON RIGID STRUCTURES

Catamaran SR

Aerocat 40 (Aeros Vehicles)

Cigar SR

Airship do Brasil

Cigar SR

Dynalifter (Ohio Airships)

Catamaran NR

Sky Tug (Lockheed -Martin)

Catamaran NR

Airlander (HAV)

Cigar SR

Voliris V930D

Hydrogen for Fuel and Lift

Helium	Hydrogen
• Inert	• Flammable
• Rare/finite	• Endless supply
• Expensive	• 1/100 cost of helium
• Unreliable supply	• 10% more gross lift
	• Zero GHG emissions

Hydrogen is not an acceptable lifting gas for use in airships.

Canadian Air Regulation 541.7

Daily Enterprise.

The Weather

TWO CENTS.

MASS., THURSDAY, FEBRUARY 23, 1922.

BREAKDOWN OF CONTROLS CAUSE OF "ROMA" DISASTER

LADIES' NIGHT AT MASONIC CLUB

TWO "SPECIALS" REINSTATED

Civil Service Commission Notifies Chief Conlon to That Effect.

Early Investigation Shows Definitely Cause of Crash of Army Dirigible, It Is Alleged—Inquiry, However, Proceeding Behind Closed Doors—Lieut. Fisher Says He Is Sure There Was No Criminal Negligence — Declares "Roma" Was All Right When It Left Newport News Last Tuesday.

[By the Associated Press]

NORFOLK, Va., Feb. 23.—Members of the army investigating board continued today their efforts to determine the definite and primary cause of the disaster which overtook the giant army dirigible Roma here, Tuesday, when 34 of her passengers and crew met death and the world's largest semi-rigid aircraft was demolished.

That the fatal crash followed a breakdown of the controls, regulating the altitude of the craft, appeared today to have been definitely established in the testimony thus far given.

The inquiry is proceeding behind closed doors. Meanwhile at Newport News, where the dead were taken, relatives and friends continued to arrive today to identify the bodies and make arrangement for their removal to homes for burial.

Roma Accident, 1922

Source of the US ban on the use of hydrogen as a lifting gas in airships

Fuel Safety Comparisons

	Hydrogen	Gasoline Vapor	Natural Gas
Flammability Limits (concentration in air)	4-74%	1.4-7.6%	5.3-15%
Explosion Limits (concentration in air)	18.3-59.0%	1.1-3.3%	5.7-14%
Stoichiometric Mixture (most easily ignited in air)	29%	2%	9%

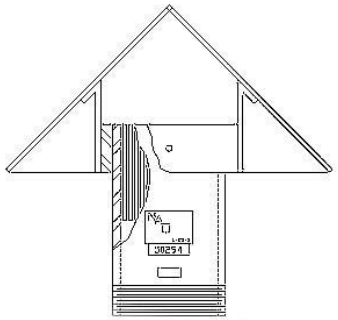
http://www.tc.gc.ca/eng/programs/environment-etv-vehicles-hydrogen-eng-435.htm

Source: www.HydrogenAssociation.org www.eere.energy.gov/hydrogenandfuelcells

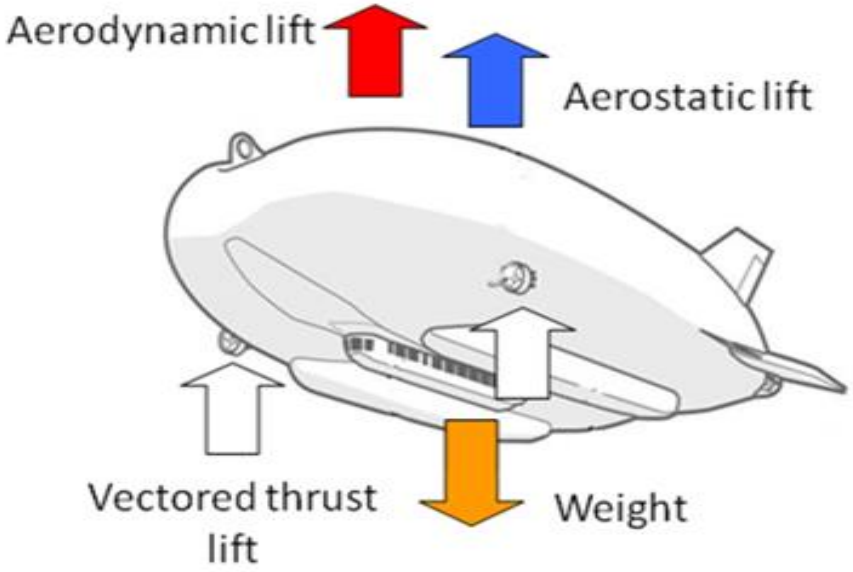
Vertical Control

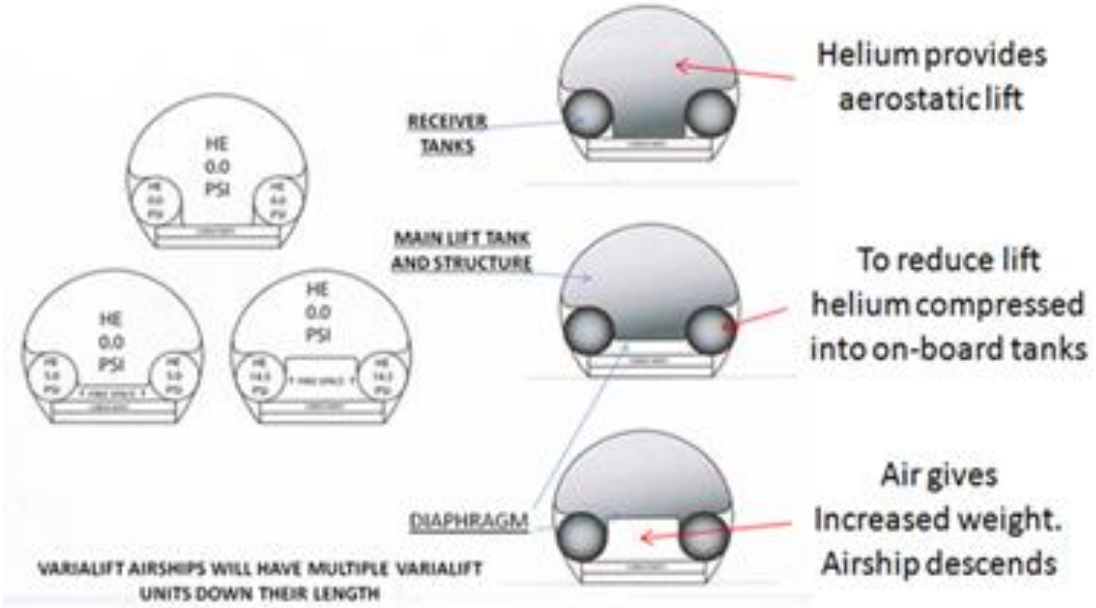
- **Changing weight**
  - ballast
  - cargo
- **Altering displacement of the lifting gas**
  - heating
  - compressing
  - venting
- **Engine propulsion (fuel consumption)**

Engine Thrust



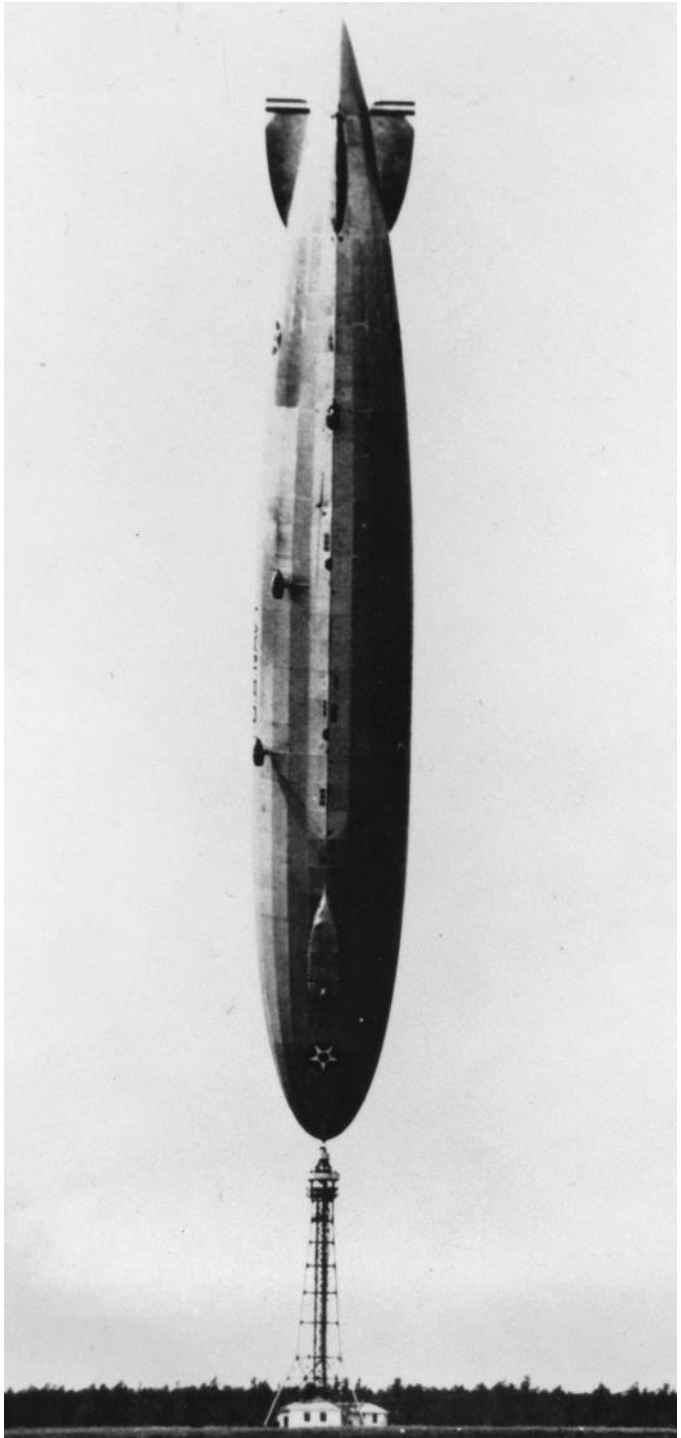
Gas Venting/Water Ballast



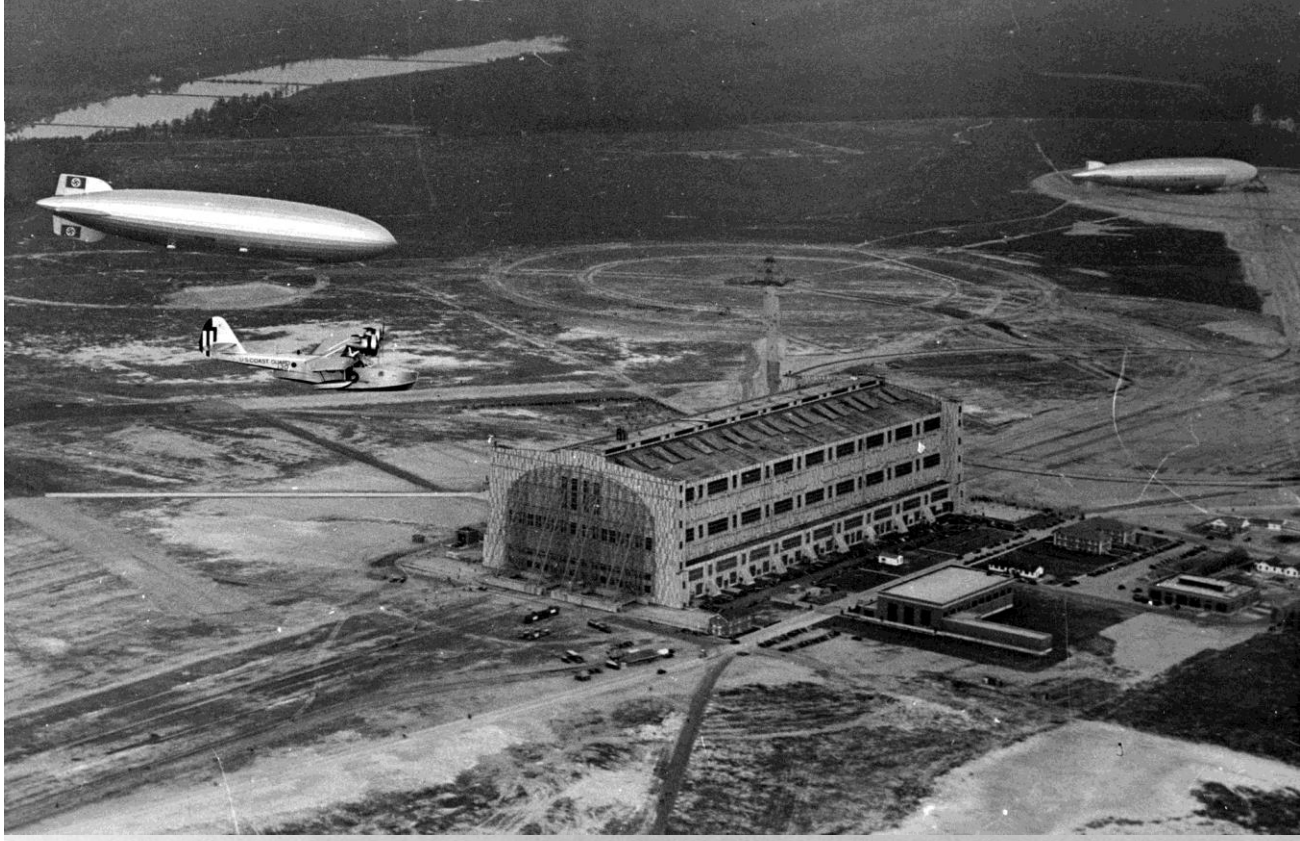


Gas Compression

Ground Handling
Landing
Mooring
Cargo Transshipment



Mast-and-Track Zeppelin Ground Handling System



Landing, Mooring and Cargo Exchange at a Turntable Airdock

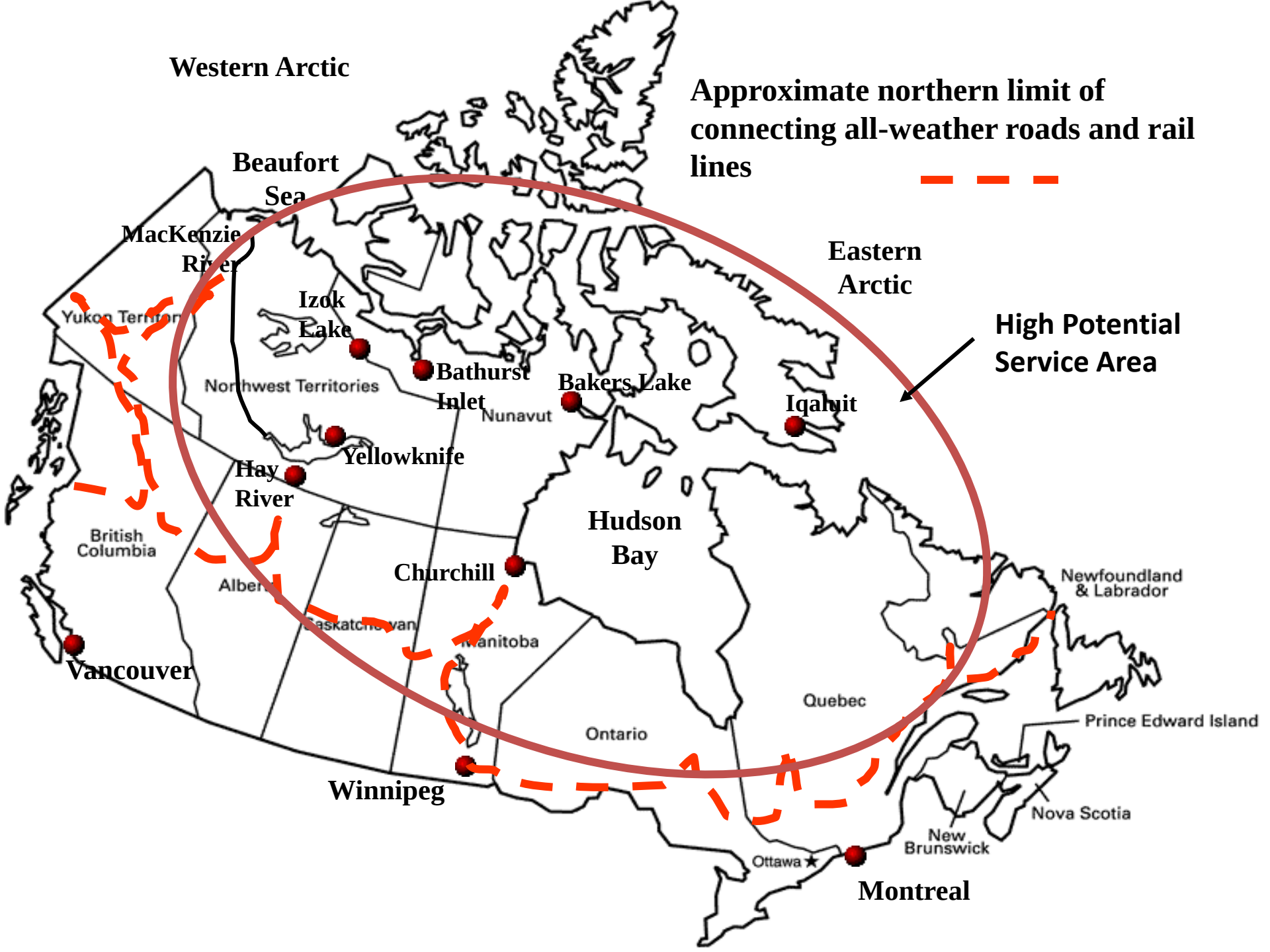
Mooring the airship MB 310 using winches

Rotating the turntable to point airship's nose in the direction of wind

Unloading the Cargo using a forklift trailer

Cold Weather Considerations

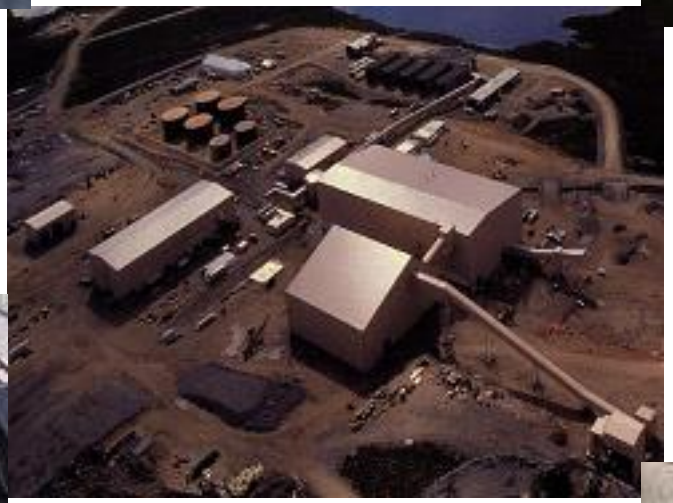
- Snow clearance
- De-icing/icing prevention for essential systems, e.g. valves
- Maintenance with heavy clothing and gloves
- Prevention of ice build-up in flight
- Cockpit windows de-icing/de-misting
- Pre-heat for starting
- Gondola heating
- Heating/anti-freeze for fluid systems and water ballast


Western Arctic
Approximate northern limit of connecting all-weather roads and rail lines
Beaufort Sea
MacKenzie River
Eastern Arctic
High Potential Service Area
Izok Lake
Bathurst Inlet
Bakers Lake
Iqaluit
Nunavut
Northwest Territories
Yellowknife
Hay River
Hudson Bay
British Columbia
Churchill
Newfoundland & Labrador
Vancouver
Manitoba
Quebec
Prince Edward Island
Ontario
Winnipeg
Nova Scotia
New Brunswick
Ottawa
Montreal

Resource Opportunities and Sustainable Development

Transportation Hazards

Heavy Equipment



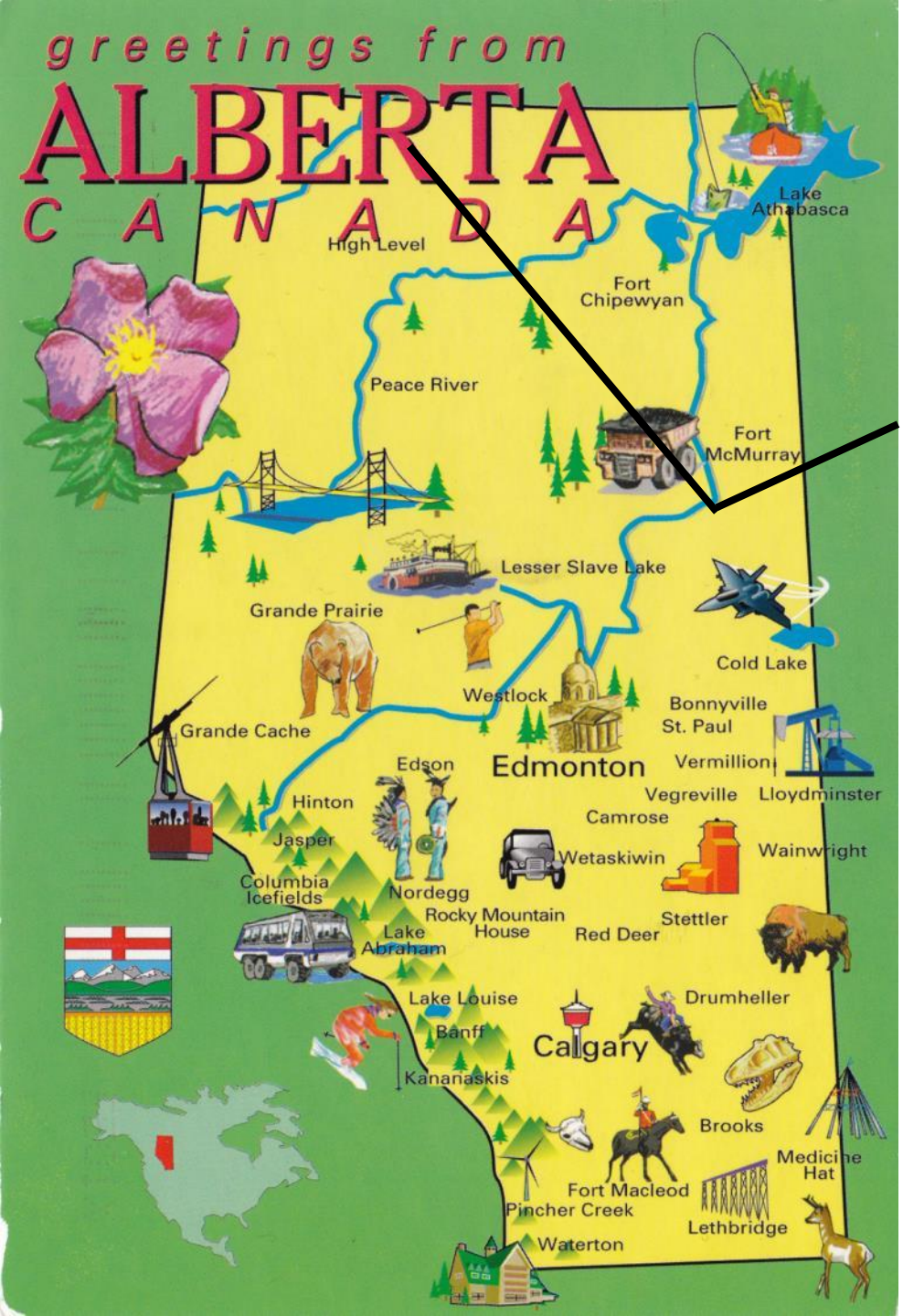
Fuel and Camp Supplies

Large volumes

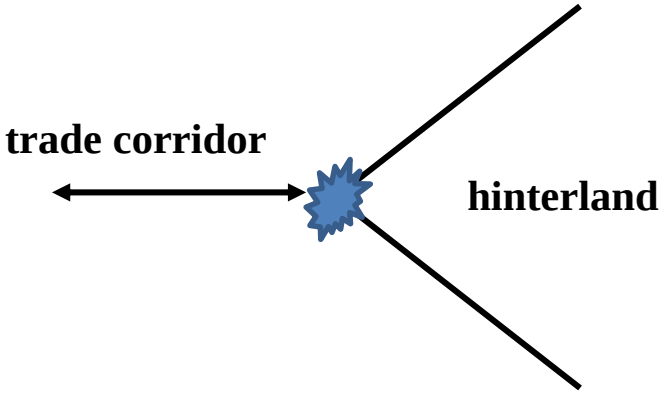
Indivisible Loads

Infrastructure Gaps and Transportation Cost Barriers

Limited Transportation Options for Northern Canada



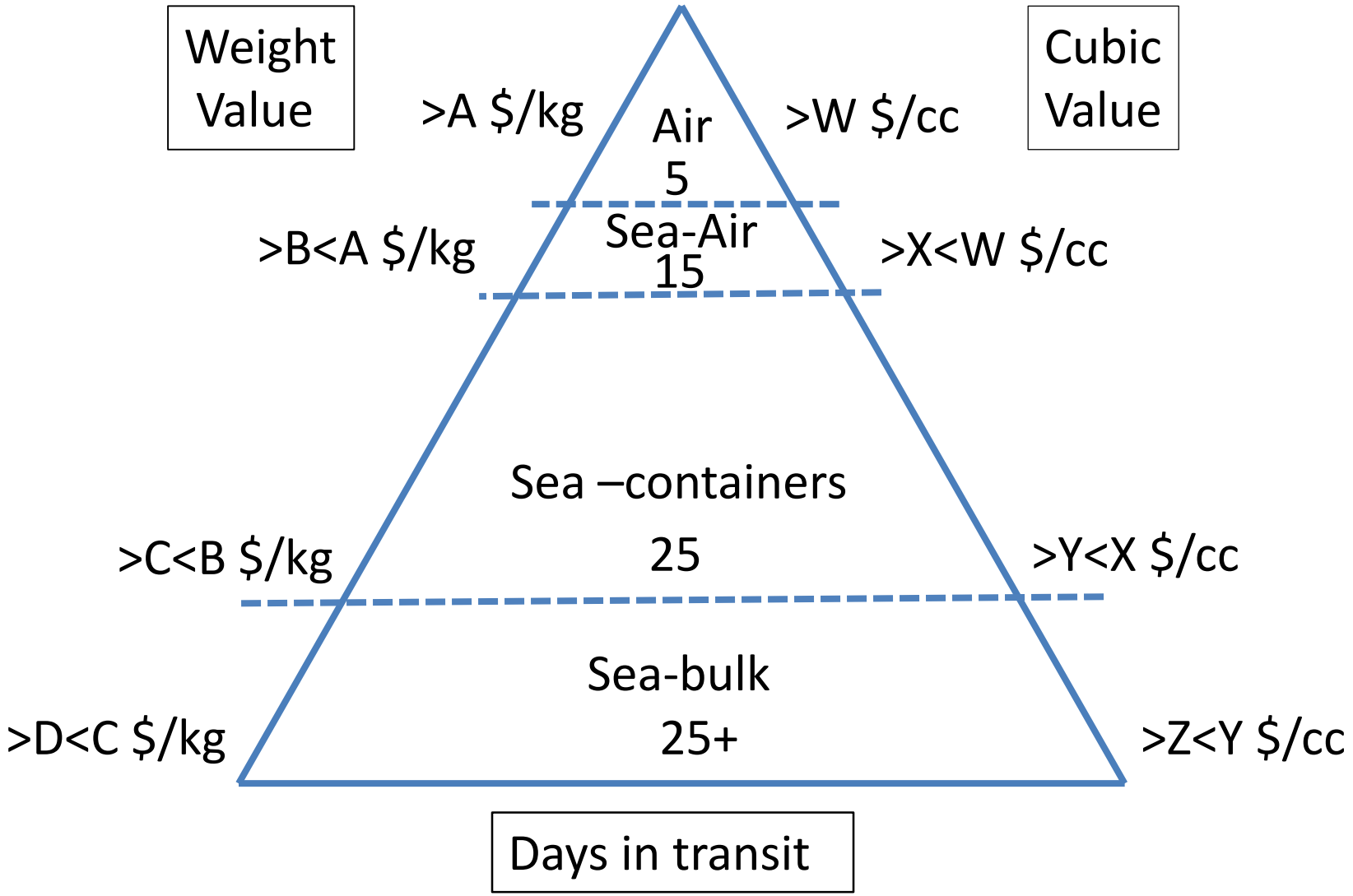
Fort McMurray Airship Gateway to the North



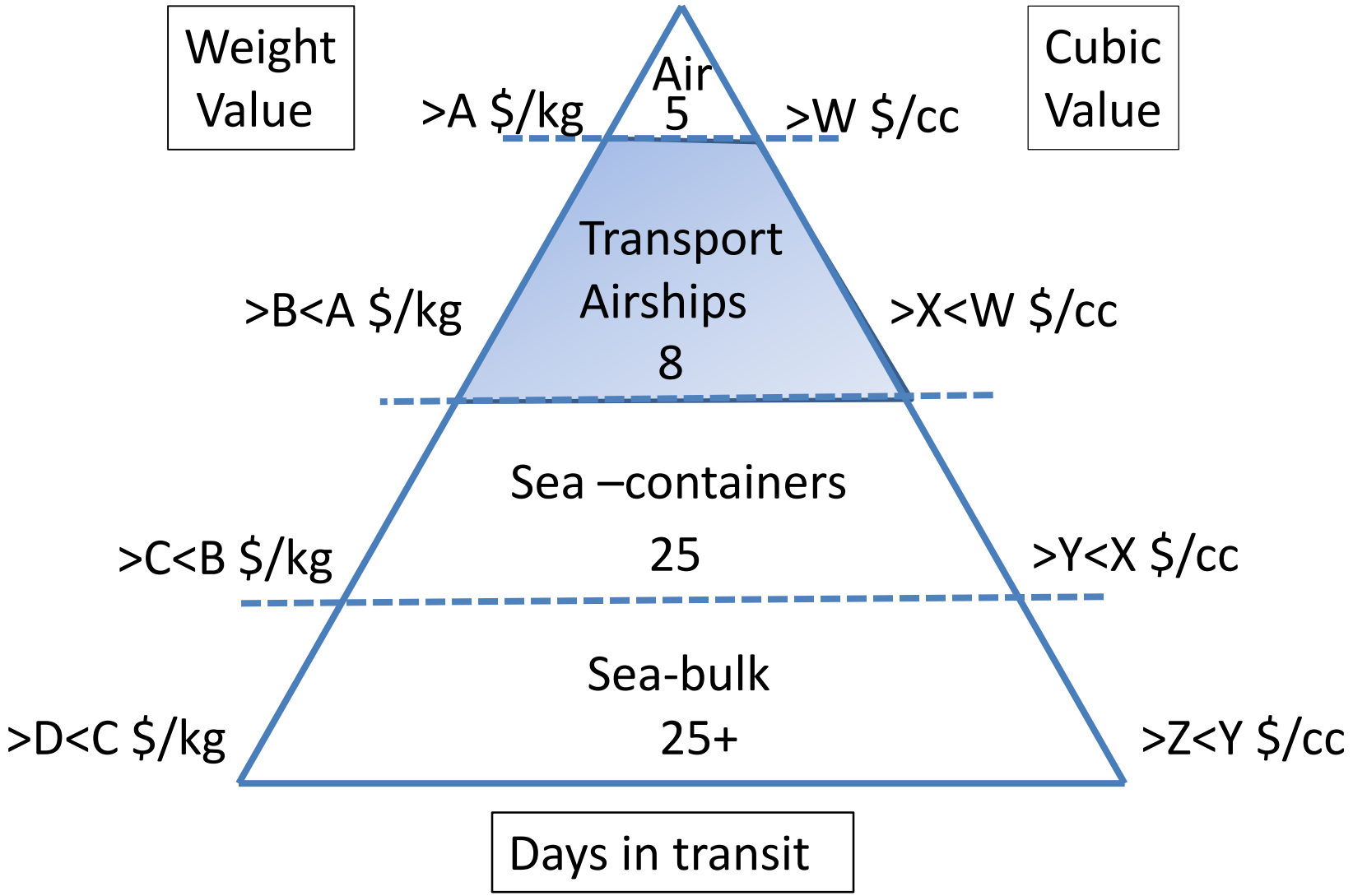
Gateways

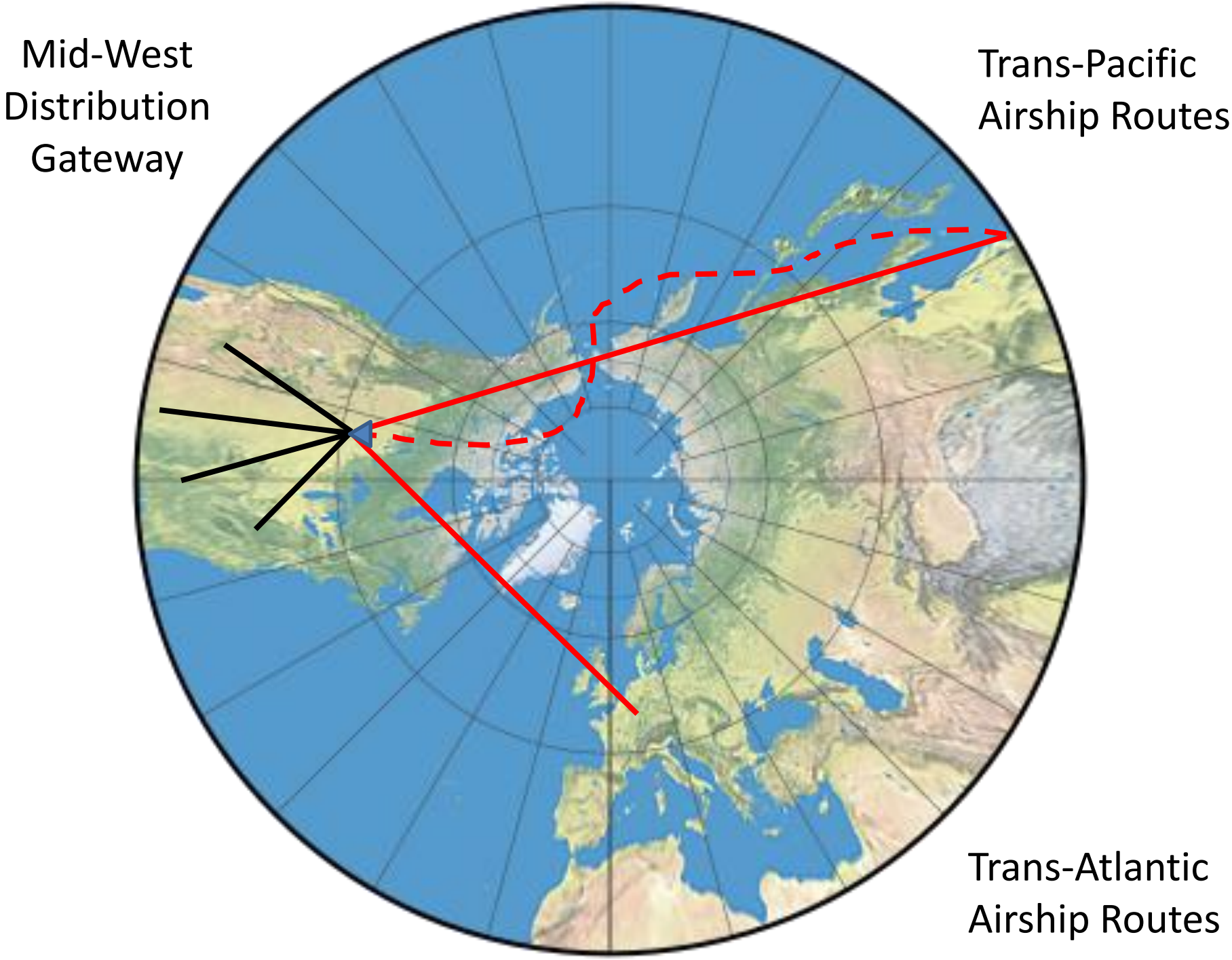
- Located at the edge of a region
- Offers some route advantage
- One-sided, funnel shaped hinterland
- Creates employment in transshipment and distribution services

Current Transoceanic Shipment



Transoceanic Freight Market with Transport Airships




Mid-West
Distribution
Gateway
Trans-Pacific
Airship Routes
Trans-Atlantic
Airship Routes

Agricultural Trade Opportunity

Transport South
beef, pork and
dairy products

Transport North
tropical fruits
fresh vegetables

Employment, Investment, Standard of Living and Risk

Hindenburg (1937)
Last Successful Zeppelin

AVRO C102 (1949)
First Jet Airliner in North America

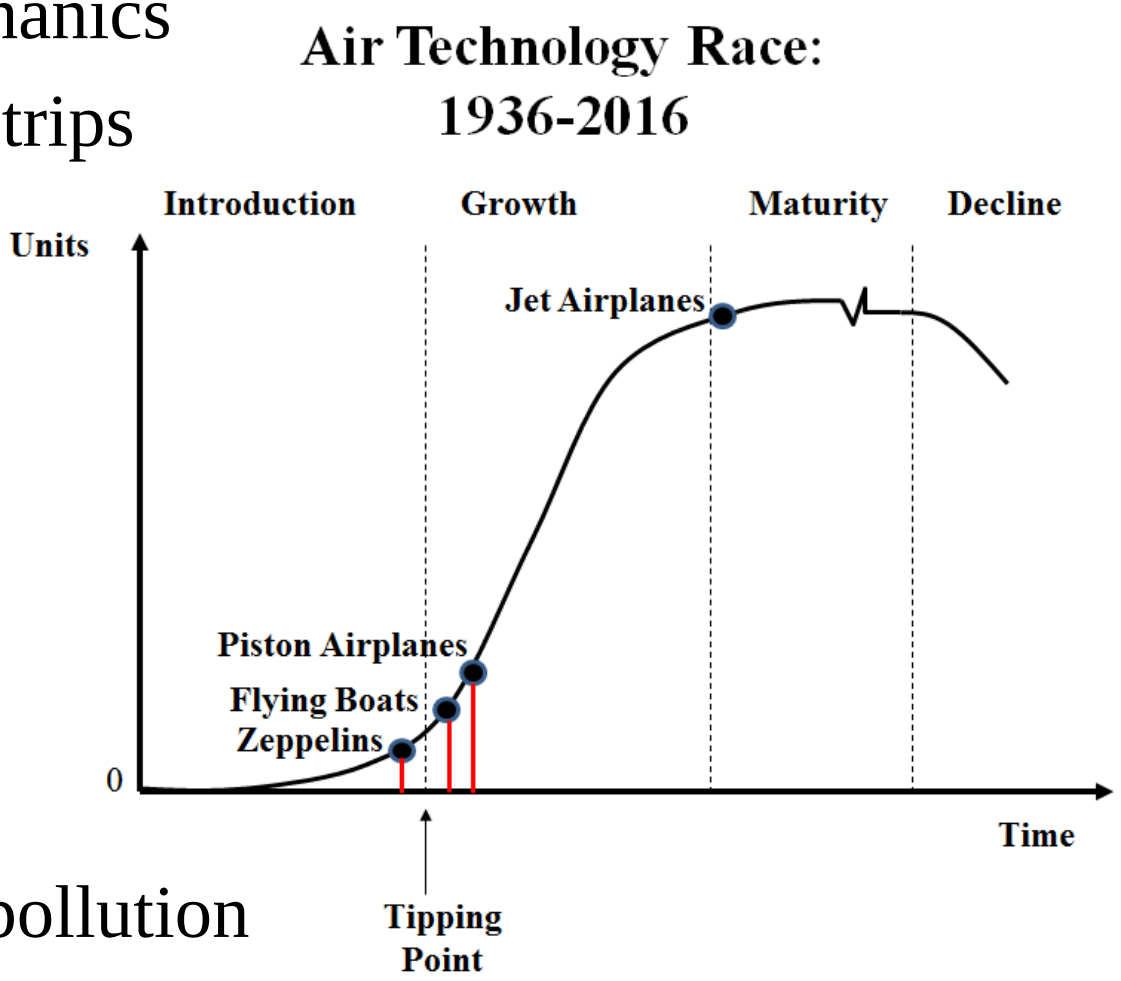
Advantages of Jet Airliners over Airships, Flying Boats and Piston Airplanes

Supply

- Surplus pilots and mechanics
- New concrete landing strips
- Cheap oil

Demand

- Desire for speed
- Lower cost fares
- Acceptable safety
- No concerns about air pollution



Reasons for Renewed interest in Airships

- Growth of Air Cargo demand
- Need for access to remote areas
- Concerns about climate change
  - Jet airplane carbon emissions
  - Unreliability of ice roads and melting permafrost
- New materials and airship designs
  - Stronger, lighter structures
  - Autonomous landing (GPS/vectored engines)

Employment/Investment Opportunity

Total Sales 36 airships at $30 million each:	$1.08 Billion
Direct Impact	
Manufacturing employment @400 per 12 airships:	1,200 FTE
Tier 1, 2 and 3 suppliers	600
R&D and Universities	200
Pilots, ground crew and mgt @ 8 per airship	288
Construction Airdocks @ 1 per 24 airships	300
Total	2,588 FTE
Induced Impact	
Transport costs (50% fixed and 50% variable)	$2 Billion
Transport costs are about 5 % of product prices	$40 Billion GDP
Induced Employment	~ 40,000 FTE

Social Impact on Northern Communities

Basic Foods	St.Theresa Point	Winnipeg
• Milk 4 Litres	$ 12.19	$ 3.48
• Tomatoes	$ 3.80 lb	$ 1.99 lb
• Bananas	$ 2.31 lb	$ 0.59 lb
• Apples, Macintosh	$ 2.94 lb	$ 1.29 lb
• Head Lettuce	$ 2.69 each	$ 1.49 each
• Bread 60%	$ 2.49 each	$ 0.99 each
• Ground Beef	$ 9.19 Kilo	$ 4.29 Kilo
• Red Potatoes	$ 1.60 lb	$ 0.79 lb
• Cheerios	$ 8.45 box	$ 3.50 box
• Coke 2 Litres	$ 7.99	$ 2.09
• Coffee	$ 11.89 Kilo	$ 6.99 Kilo
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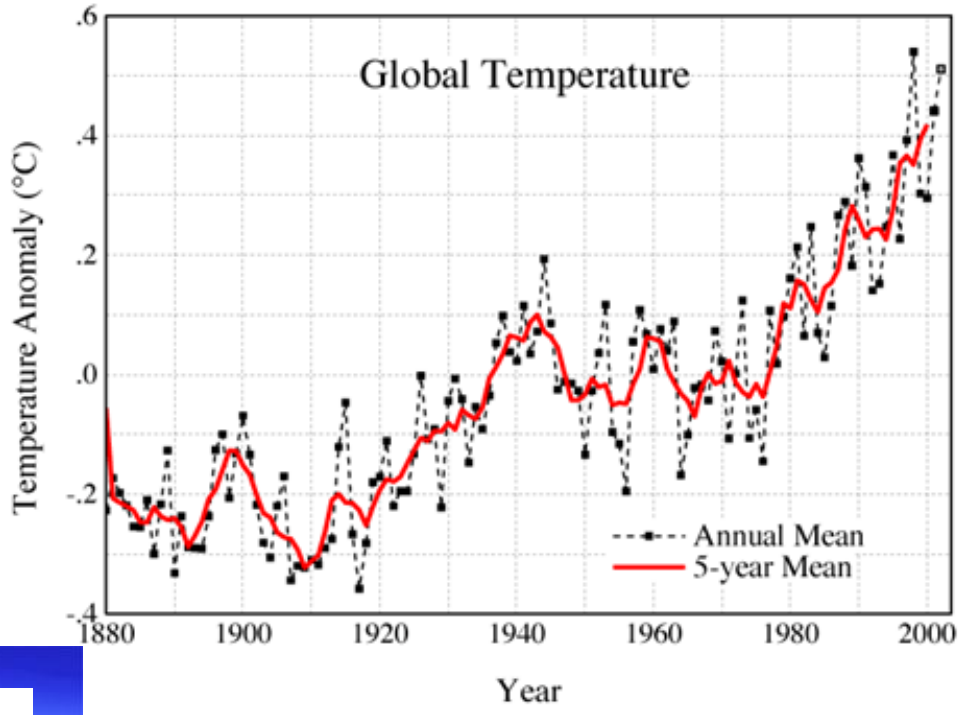
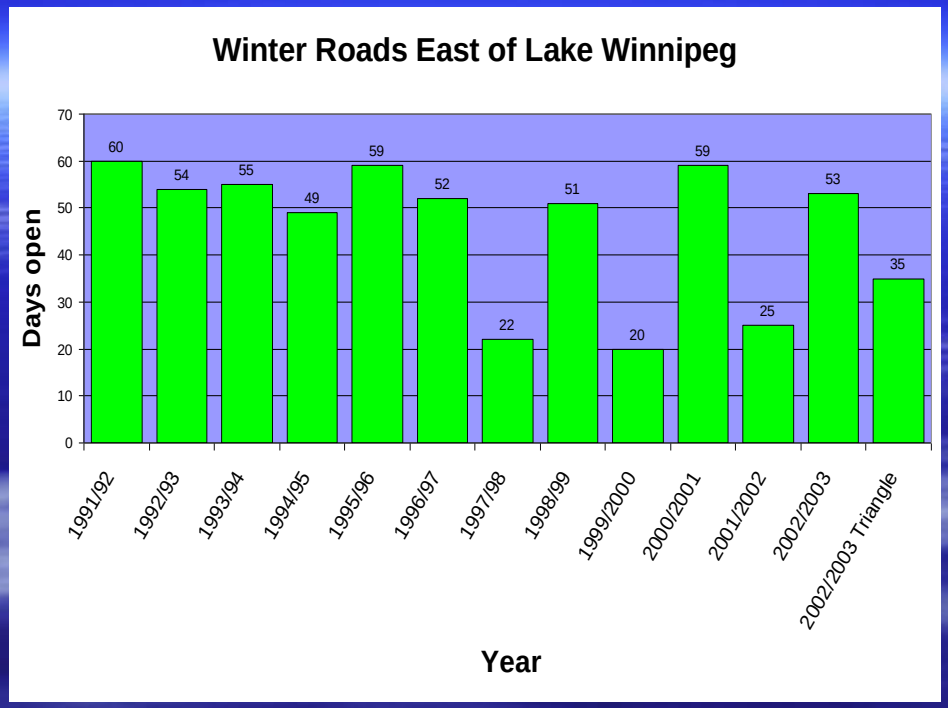
Total Basket	**$ 65.54**	**$ 27.49**

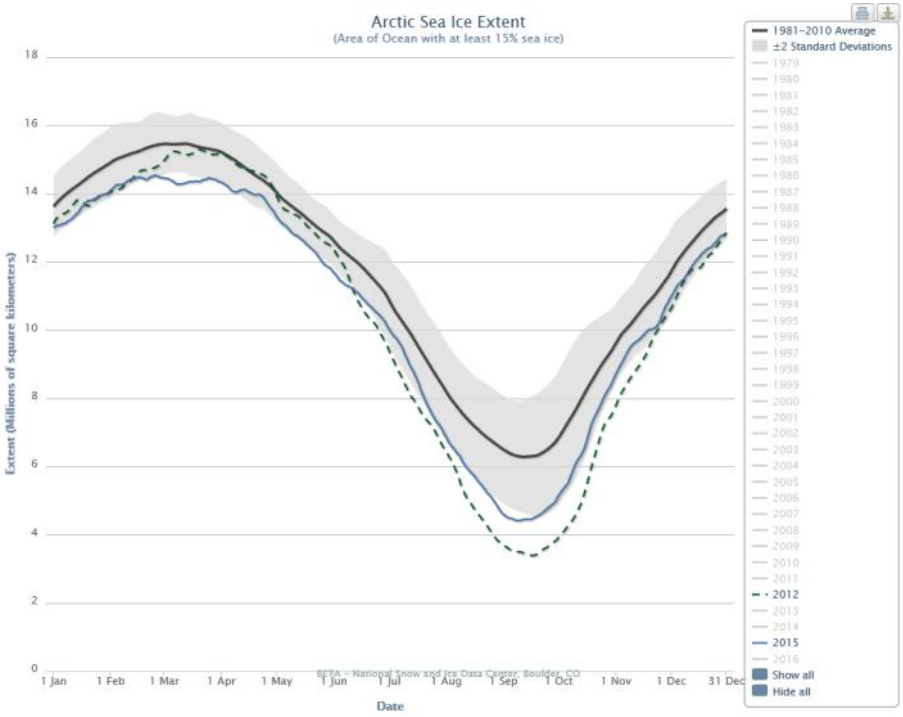
Food Prices, Health and Housing

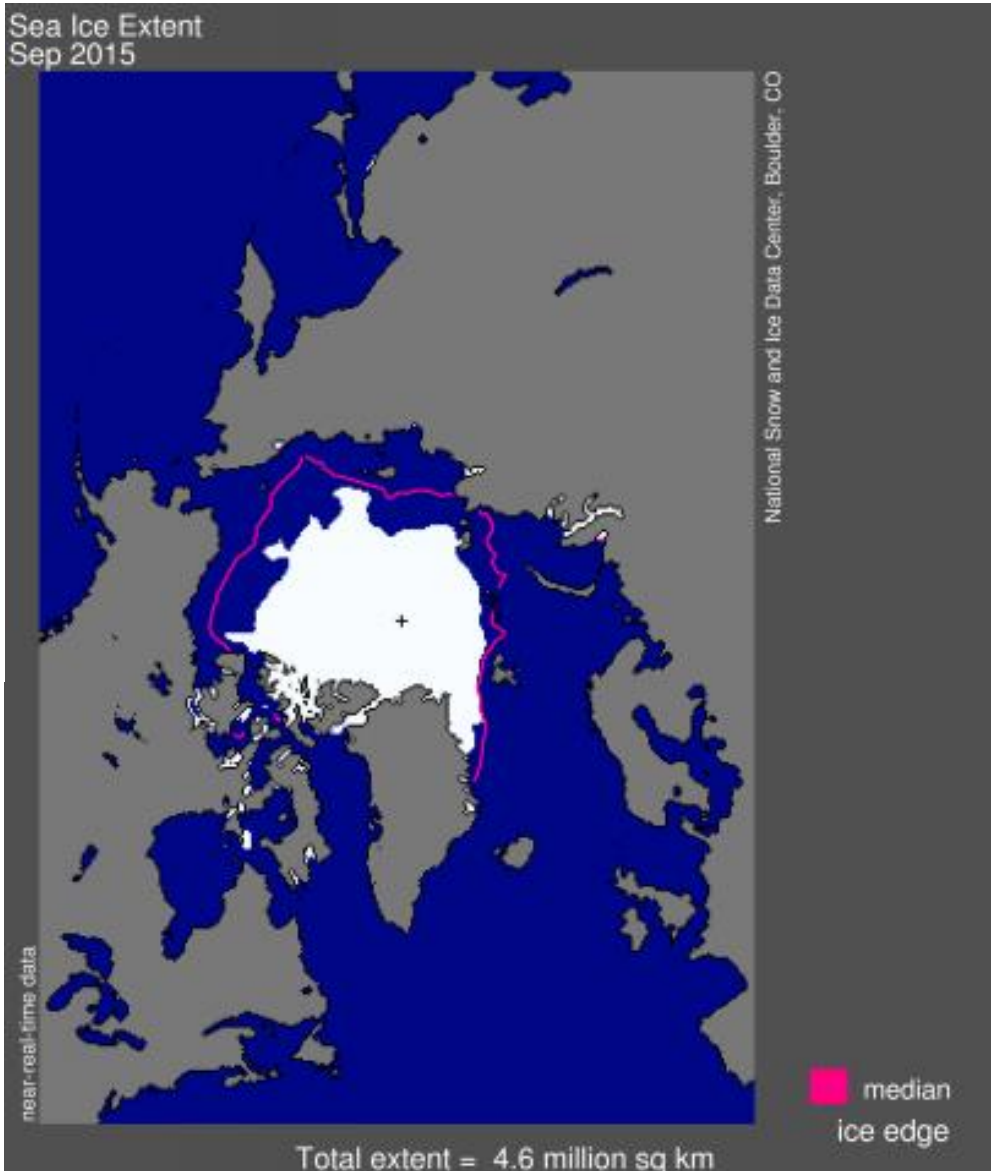
Risks of Climate Change to Ice Roads





Risks of Climate Change: Sovereignty and Pollution





Risks of Climate Change to Existing Infrastructure

Damage Caused by Permafrost Thaw in NWT

Source: Natural Resources Canada

The Case for H_2 Transport Airships

- Zero carbon emissions
- No impact on terrain
- Low infrastructure cost
- Large bulky load capacity
- Reduced freight rates
- Year-round service to the North
- Job creation (manufacturing, operations)
- Responsible resource development
- Increased international trade
- Mitigation of climate change risks

This is not rocket science.

It's just balloon science.

BASI

Golden Age of Aviation