
EUROPE
ATMO
sphere

Market Trends & Opportunities Panel

Introduction

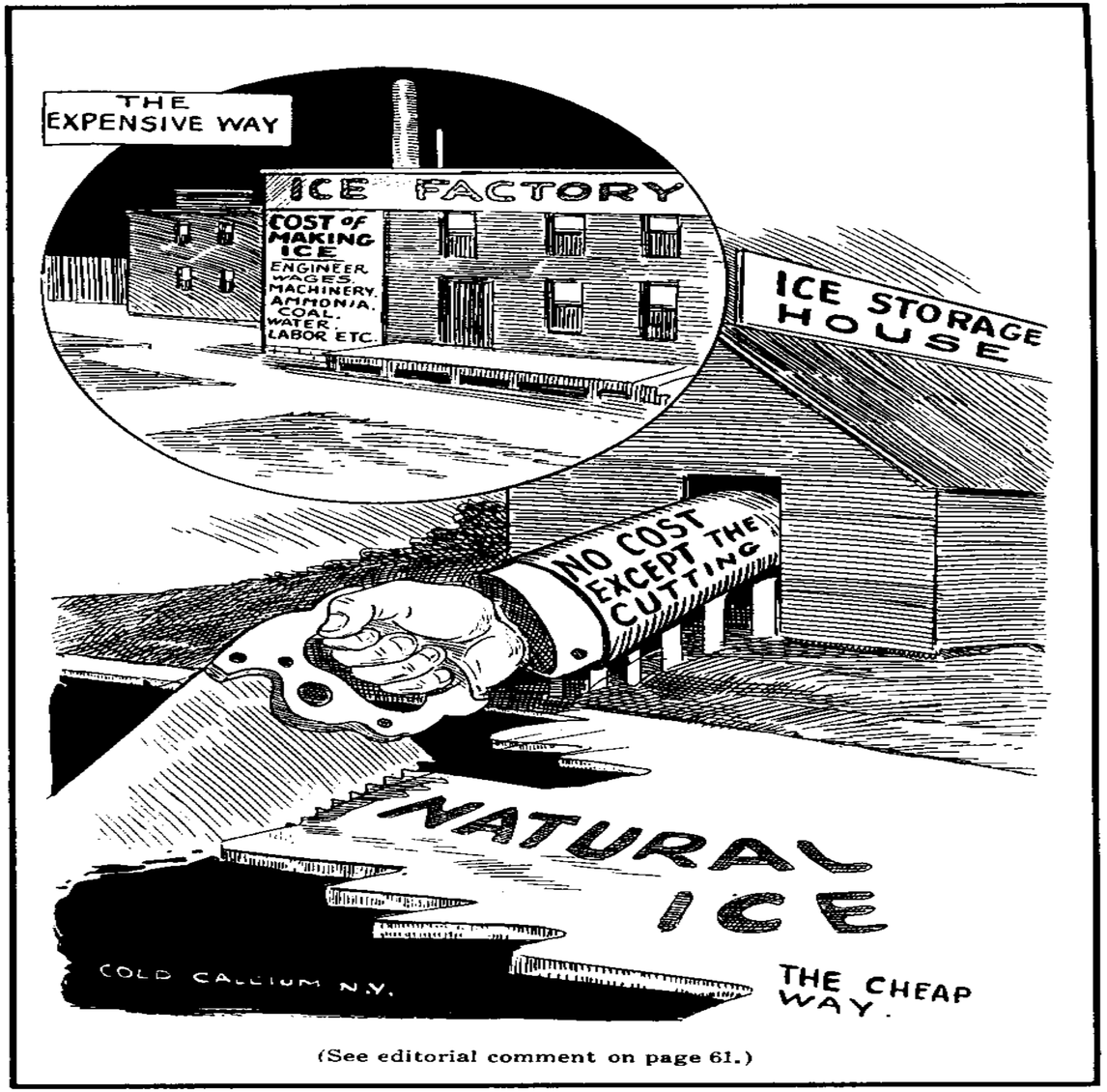
Content of intro

- How was refrigeration provided in the past
- What is the current situation
- Market perspectives for NWF:
  - CO_2 the only real and safe ‘A1’ fluid for commercial refrigeration
  - Hydrocarbons for small (500g) and industrial systems
  - Ammonia, reliable since 1875 for industrial applications
  - others (air, water) filling niches

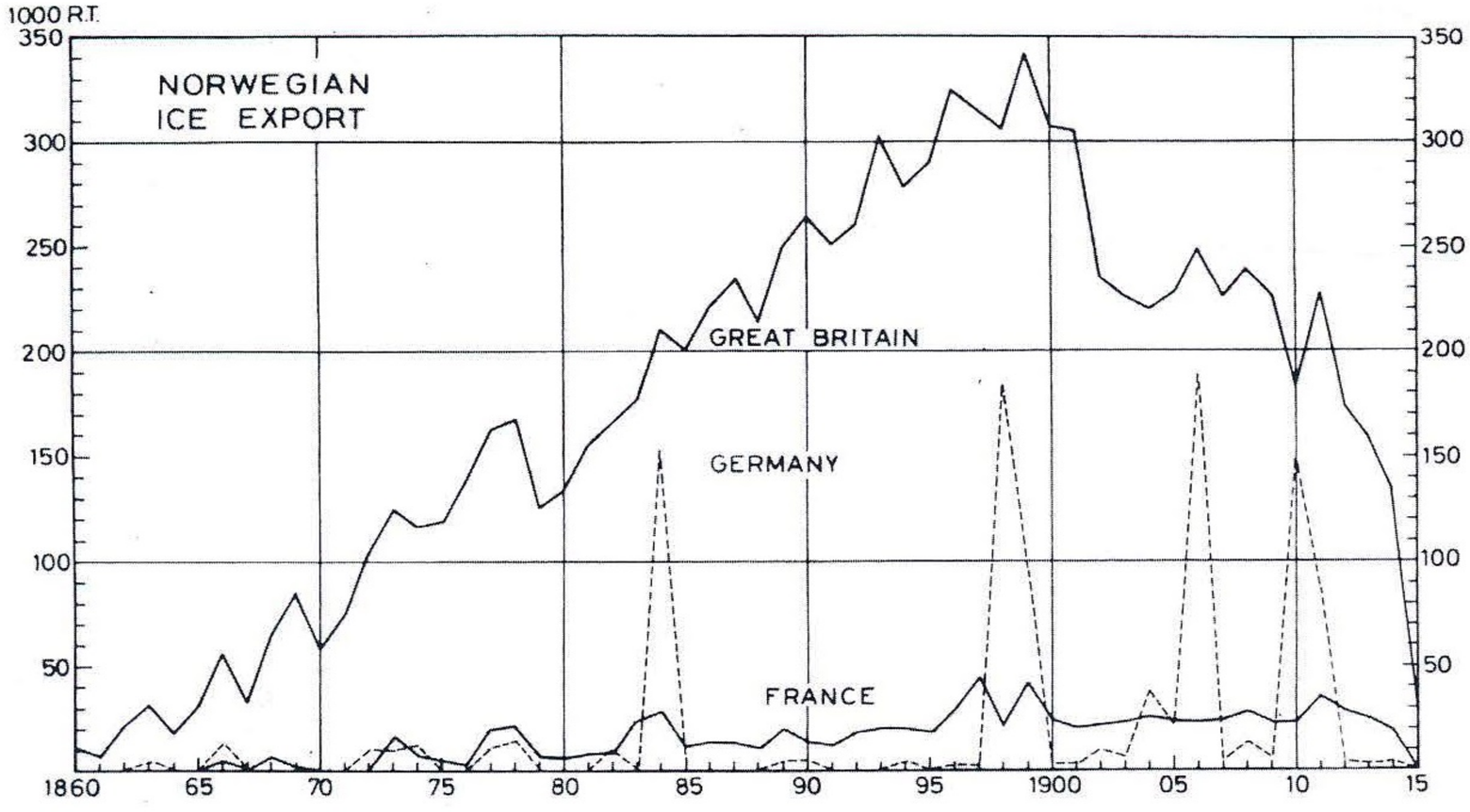
Refrigeration in the past

Factors pushing the development of mechanical refrigeration technology from 1850 →

- "Artificial" ice production
- Brewing of beer (all year long)
- Transport of meat



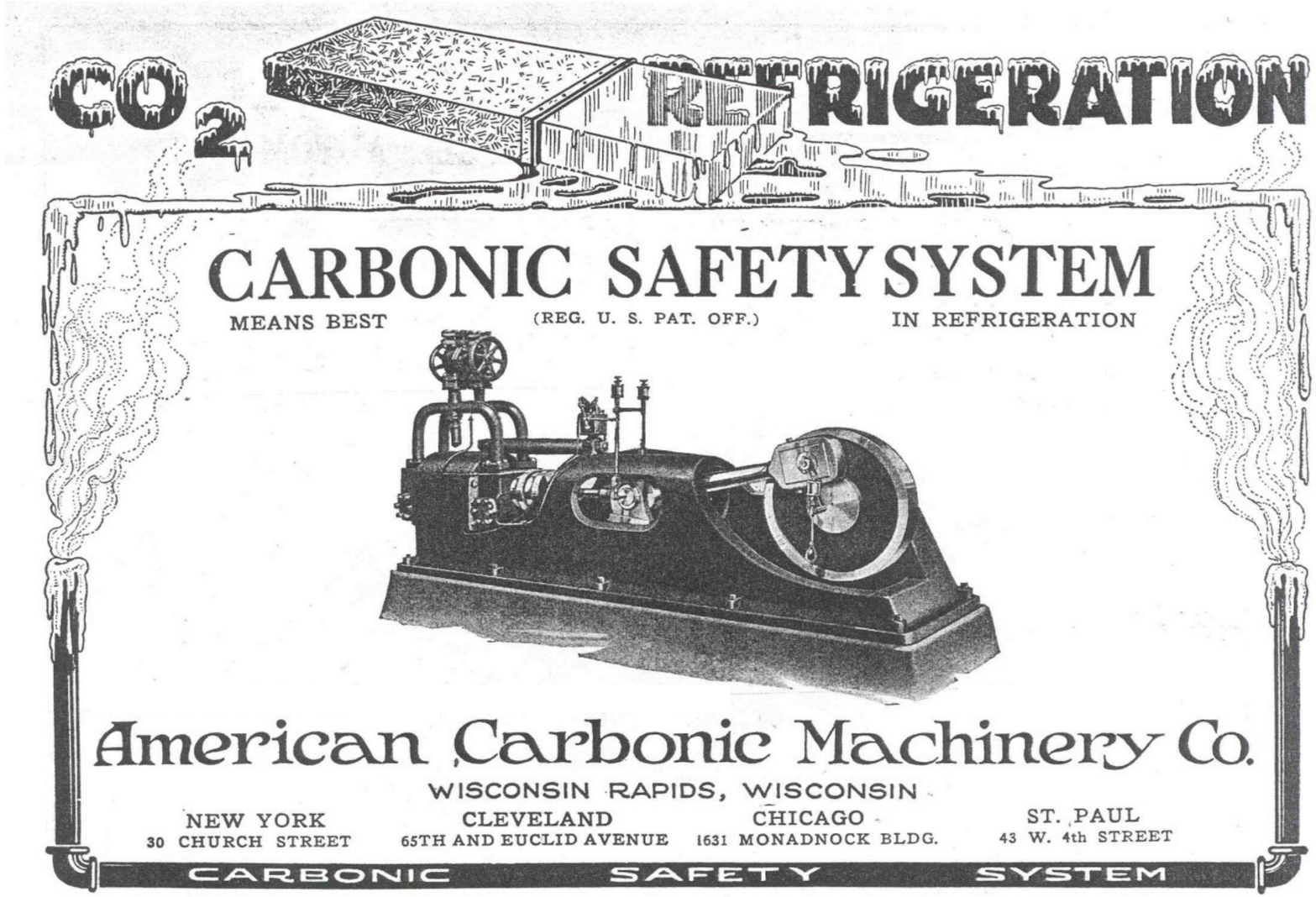
150 years ago: ICE = refrigeration



Norwegian Ice Export from 1860 to 1915

150 years ago: ICE = refrigeration

Natural working fluids also common in the US:



Advertisement in ICE and REFRIGERATION, 1922, vol. 63

Working fluids history

Until 1930	Use of natural working fluids – Air, ethyl ether, SO_2, methyl chloride, ammonia, propane, isobutane, CO_2, etc.
1930-50	Introduction of synthetic working fluids, like CFC12 and HCFC22
1987	*Montreal protocol* established, CFC and HCFC ozone depletion due to chloride/bromine. Phasing out CFC (1995) and HCFC (2010)
1987	Hydrogen-Fluor-Carbons (HFC) introduced
1997	*Kyoto protocol* established, HFC regulated due to high GWP factor
2006/2007	EUs F-gas directive – Phase down of high GWP fluids
2015 →	EU F-gas regulation
1990-now	Increasing focus on use of natural working fluids, especially ammonia, hydrocarbons and CO_2

2001 Children's Painting Competition by UNEP

Image taken from the 2001 UNEP DTIE **OzonAction Programme Children's Painting Competition**. Painting by **Mariam Salman Al Oraibi**, aged 12, Bahrain

Consequences of global warming ->

Far away…

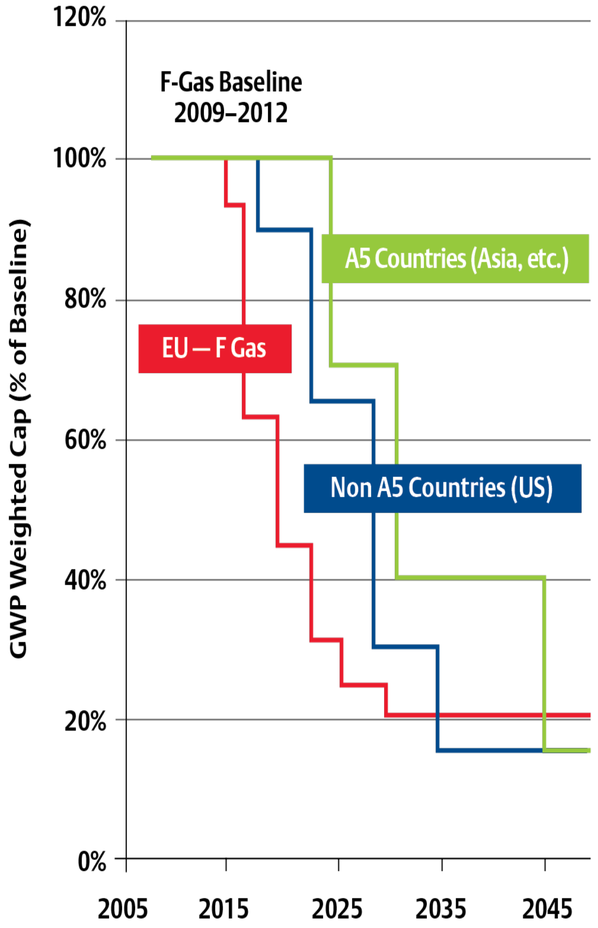
However, when the permafrost is melting…

Piz Cengalo
Switzerland
24th Aug. 2017

F-gas Regulation (in a nutschell)

Present conventional refrigeration systems **are not future long-term solutions:**

- Ban refrigerants GWP>150 from 2022 (centralized refrigeration system >40 kW, Primary Cycle in cascade configuration >1500)
- 79% Reduction of GWP related emission by 2030



Which options are available for stakeholders?

» **Business as usual** until 2020 and then usage of recycled gas until 2030;

- Availability/cost of the gas and equipment
- Future ban of service and maintenance
- Stricter leak detection and refrigerant recovery processes

» Convert/retrofit with **new synthetic low-GWP refrigerants;**

- **Total environmental impact un-known**, future regulation?
- Energy Efficiency + **Cost** of the refrigerant?

» **Natural Refrigerant** business orientation.

- **Long term solution**
- **Investment cost no longer higher than traditional HFC**

Example R-448A proposed as substitute for R-404A

Please have a close look into the material safety data sheets [MSDS]:

Provided by the Suppliers -> Responsibility is at your side!

WARNING! This product contains a chemical known to the State of California to cause cancer.
Dichloromethane 75-09-2

: WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.

WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm.
Chloromethane 74-87-3

Pennsylvania RTK : Difluoromethane 75-10-5

WHMIS Classification : A: Compressed Gas
This product has been classified according to the hazard criteria of the CPR and the MSDS contains all of the information required by the CPR.

SECTION 16. OTHER INFORMATION

Page 19 / 20

SAFETY DATA SHEET Honeywell

Honeywell Solstice® N40 Refrigerant (R-448A)

000000017419

Version 1.4 Revision Date 10/30/2014 Print Date 12/22/2014

ATMO sphere EUROPE

Art.-Nr. 56396624

Example **HFC-1234yf** (essential part of blend: R-448A & R-449A)

G 3191 A

GEMEINSAMES MINISTERIALBLATT

HERAUSGEGEBEN VOM BUNDESMINISTERIUM DES INNERN

67. Jahrgang *ISSN 0939-4729* *Berlin, den 24. Juni 2016* *Nr. 24*

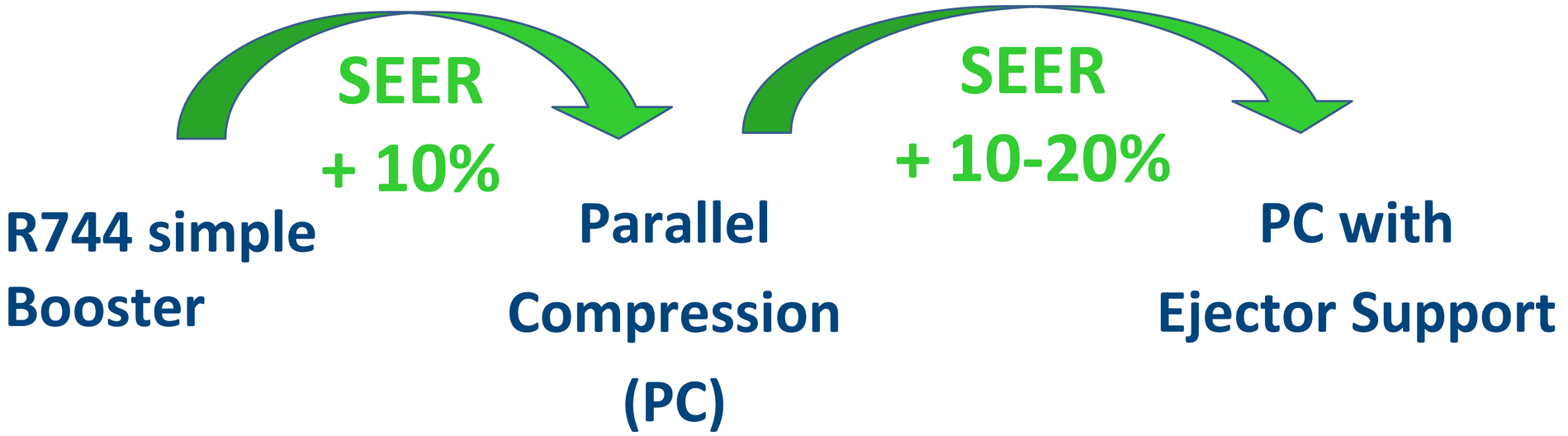
Stoffidentität			Arbeitsplatz-grenzwert		Spitzenbegr.		Änderung
Bezeichnung	EG-Nr.	CAS-Nr.	ml/m³ (ppm)	mg/m³	Überschrei-tungsfaktor	Bemerkungen	Monat/ Jahr
(+)-Weinsäure	201-766-0	87-69-4		2 E	2 (I)	DFG, Y	04/16
trans-1,3,3,3-Tetrafluorpropen	471-480-0	29118-24-9	1000	4700	2 (II)	DFG, Y	04/16
HFC-1234yf	616-220-0	754-12-1	200	950	2 (II)	DFG, Y	04/16
Ziram	205-288-3	137-30-4		0.01 E	2 (I)	DFG, Y, Sh	04/16

Commercial Refrigeration; Supermarkets

The average annual refrigerant leakage rates:

- in Europe: **15-20 % of the total charge,** mainly HFC-404A
- Worldwide about **30 % of the charge**, mainly HCFC-22

Evolution of R744 Commercial Refrigeration since 2003:



SEER: Seasonal Energy Efficiency Rating

Commercial Refrigeration; Supermarkets

In future: supermarket refrigeration system provides entire energy flow and demands in the building (and surrounding)

- ✓ **Air Conditioning** (direct or chilled water)
- ✓ **Heat recovery**: hot water production, space heating, ice protection
- ✓ **Heat pump function** & export of heat

CO_2 (R744) is the preferred alternative of the end-users across Europe for new installations

- ✓ Predictable – no restrictions -> **the only real A1 fluid with GWP=1**
- ✓ CO_2 booster units are proven technology with potential to further improve COP (parallel compression + ejector technology)
- ✓ **Training and support is key for success**

Promising global perspectives for a successful Phase-in

The end user decides!

- It's **<u>up to you</u>** to get initial costs down:

- if you don't focus and favour with different working fluids for new / to be refurbished supermarkets. → The high volume R744 systems/equipment which give cost reduction will not appear…
- You will pay the bill -> twice if you don't go for CO_2 in the first run.

Clever strategy after Paris COP, Kigali & Marrakech Meetings:

Companies focusing on

Natural Working Fluids

will face no risk to invest into technologies being on the **phase out agenda** in the future

<=>

Safe & sustainable investment


EUROPE
ATMO
sphere
Thank you very much!