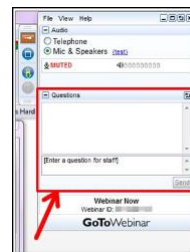
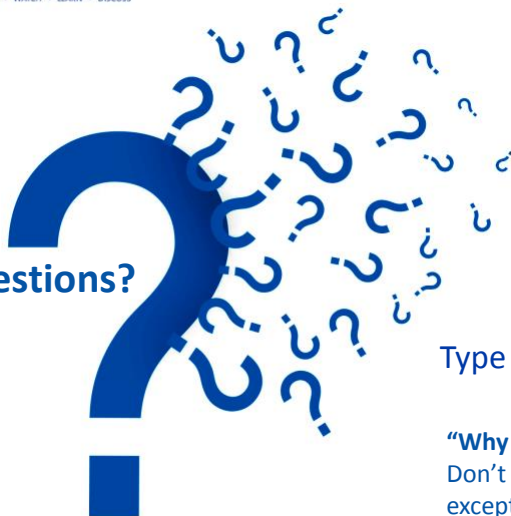




Have Questions?



Type them into questions box!

“Why am I muted?”

Don't worry. Everyone is muted except the presenter and host. Thank you and enjoy the show.

Contact ACS Webinars® at acswebinars@acs.org

1



Join a global community of over 150,000 chemistry professionals

Find the many benefits of ACS membership!

<http://bit.ly/ACSmembership>

2



Benefits of ACS Membership



Chemical & Engineering News (C&EN)

The preeminent weekly digital and print news source.



NEW! ACS SciFinder

ACS Members receive 25 complimentary SciFinder® research activities per year.



NEW! ACS Career Navigator

Your source for leadership development, professional education, career services, and much more.

<http://bit.ly/ACSmembership>

3



@AmericanChemicalSociety



@AmerChemSociety



@AmerChemSociety



<https://www.linkedin.com/company/american-chemical-society>

Contact ACS Webinars® at acswebinars@acs.org

4

How has ACS Webinars[®] benefited you?



"ACS Webinars is always providing interesting real world chemistry. I use examples learned from webinars when explaining chemistry to non-chemists."

Fan of the Week

Michael D. Berger, Ph.D.
Lead Patent Agent, ConocoPhillips Company
ACS member for 6 years strong!

<http://bit.ly/ChocChemVideo>

Be a featured fan on an upcoming webinar! Write to us @ acswebinars@acs.org

5



ACS Webinars[®]

CLICK • WATCH • LEARN • DISCUSS

LIVE | Thursdays at 2pm ET



Learn from the best and brightest minds in chemistry! Hundreds of webinars on diverse topics presented by experts in the chemical sciences and enterprise.

Recordings are an exclusive ACS member benefit and are made available to registrants via an email invitation once the recording has been edited and posted.

Live Broadcasts of ACS Webinars[®] continue to be available to the general public on Thursdays from 2-3pm ET!

www.acs.org/acswebinars

6

What is ACS on Campus?



ACS visits campuses across the world offering FREE seminars on how to be published, find a job, network and use essential tools like SciFinder. ACS on Campus presents seminars and workshops focused on how to:



- Publish in top journals
- Find a job
- Effectively use research tools like SciFinder® and ACS ChemWorx
- Communicate your science
- Write grant proposals
- Build industry partnerships
- Prepare for a changing employment landscape

<http://acsoncampus.acs.org>

7

#HeroesofChemistry ACS Heroes of Chemistry Award



Inspiring Hero Stories



The ACS Heroes of Chemistry Award is the Annual award sponsored by the American Chemical Society that recognizes talented industrial chemical scientists whose work has led to the development of successful commercialized products ingrained with chemistry for the benefit of humankind.

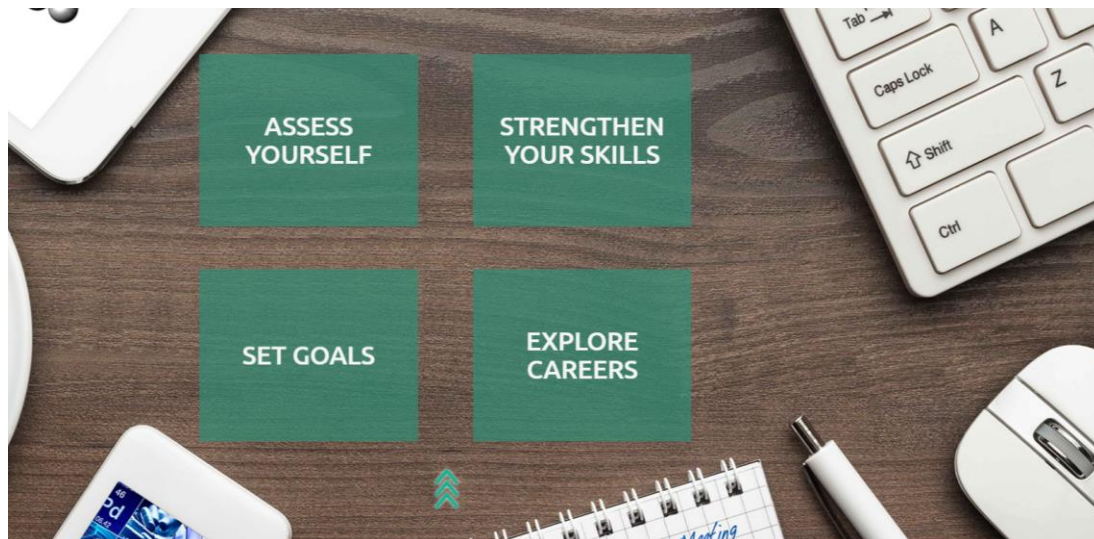
2018 Winners:



www.acs.org/heroes

8

An individual development
planning tool for you!



<https://chemidp.acs.org>

9

PHYSICAL REVIEW RESEARCH

NEW IN 2019

- Fully open access
- Welcoming the full spectrum of research topics of interest to physicists
- The experience you value, and quality you trust
- Opening for submissions soon

LEARN MORE AND SIGN UP FOR ALERTS

journals.aps.org/prresearch

[@PhysRevResearch](https://twitter.com/PhysRevResearch)



PUBLISHED BY THE
AMERICAN PHYSICAL SOCIETY



Meetings & Events

Publications & News

Programs & Outreach

Careers & Advancement

Advocacy & Policy



Advancing materials.
Improving the quality of life.

Upcoming Events

Apr 22 - Apr 26 2019

2019 MRS Spring Meeting

Apr
22

May 01 - May 01 2019

Webinar: Computational Design
and Development of Alloys

May
01

May 13 - Jun 13 2019

Abstract Submission—2019 MRS
Fall Meeting

May
13

<https://www.mrs.org>

Upcoming ACS Webinar

www.acs.org/acswebinars



ACS
Chemistry for Life®

JCI
JOURNAL OF
CHEMICAL INFORMATION
AND MODELING

aaps

ACS
Technical Division
Medical Chemistry (MED)

**EFFECTIVE EXPLORATION
OF CHEMICAL SPACE IN
HIT-FINDING**

FREE | Thursday, April 18 at 2pm ET

ACS Webinars®
CLICK • WATCH • LEARN • DISCUSS

<https://www.acs.org/content/acs/en/acs-webinars/drug-discovery/hit-finding.html>

12



He lium

**AN IRREPLACEABLE
RESOURCE AND WHY
WE MUST CONSERVE IT**



THIS ACS WEBINAR WILL BEGIN SHORTLY...

13



Helium: An Irreplaceable Resource and Why We Must Conserve It



William Halperin
Orrington Lunt Professor of Physics,
Northwestern University



Sophia Hayes
Professor, Department of Chemistry,
Washington University



Will Hartwig
Science Policy Fellow, American
Chemical Society

Slides available now! Recordings are an exclusive ACS member benefit.

www.acs.org/acswebinars

This ACS Webinar is co-produced with ACS External Affairs & Communications, American Physical Society, and Materials Research Society

14

Helium

An Irreplaceable Resource and Why We Must Conserve It

15

Why are we here today?

- **Supply** Now and in the future
- **Price** Now and in future
- **What can we do?**



16

Early warnings of a helium shortage to the **public**...

Save up to 75% off Sale & Clearance. [Shop Now](#) Shipping to Store Locator My Account

PartyCity ☰ Categories 🛒 Cart (0)

Global Helium Shortage

Helium supply has always been a little up in the air (pun intended). With only three sources producing 75% of the world's helium, any disruption causes a significant impact. Currently, helium supply is very low while demand is growing.

Wait, where does helium come from?
You might think we capture helium from the air, but it's actually extracted from the ground. It's typically found in small portions mixed with natural gas, then separated.

Who else uses helium?
Helium is very versatile. Besides making your voice sound like a chipmunk and filling up party balloons, helium is used in creating many electronics, medical devices, and even rockets.

Can I still use balloons at my party?
Of course! If helium is not available, we have other options. You can create a balloon arch or balloon wall with latex and foil balloons as seen below – no need for helium; just some tape and creativity.

Because of this global helium shortage, fulfillment of balloon orders may be affected at your store. We're working to replenish the helium at the affected stores as more supply becomes available. Despite this helium hiccup, Party City is committed to helping you to throw an unforgettable party.

Check out some unique balloon ideas that don't need helium.

Air-Filled Decorating Kits


Air-Filled Balloons

Twisted Balloons

Foil Balloons

Balloon Garlands

FEEDBACK



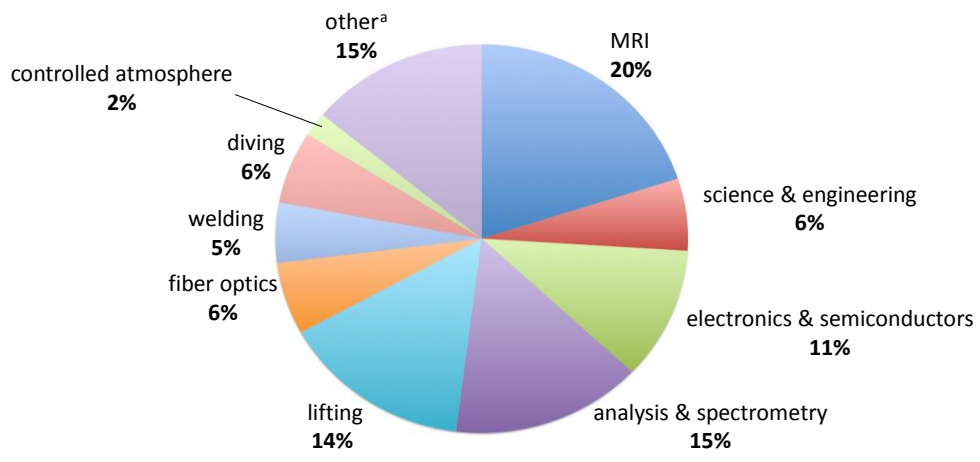
17

Early warnings of a shortage amongst **scientists**...

“Hey, are you guys getting helium? Our vendor just delayed all shipments.”

-- **AMMRL listserv** (Association of Managers of Magnetic Resonance Labs)

End-uses for Helium worldwide (2015)



Data provided by Intelligas Consulting in <https://www.aps.org/policy/reports/popa-reports/helium-crisis.cfm> ¹⁹
^a Includes leak detection, pressurization, purging and other uses.

Helium Touches Many Industries – and Lives

GASEOUS

Weather Balloons 	Blimps 	Optical Fibers 	Lasers 	Dilution Fridges
Party Balloons 	Semiconductors 	Plasma 		
Leak Testing 	Welding 	Rocket Engines 	Hadron Collider 	NMR
Gas Analysis 	Heliox Diving 		Fusion 	MRI Imaging

LIQUID

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



From where do vendors get their helium:

(choose all that apply)

- capture it from our atmosphere
- extract it from seawater
- collect it from nuclear reactors
- extract it from natural gas mining
- extract from the National Helium Reserve

** If your answer differs greatly from the choices above tell us in the chat!*

Answer Question 1:

The answers are:

- **extract it from natural gas mining**
- **extract from the National Helium Reserve**

Helium is refined from natural gases (methane, CO₂ etc.) at a concentration typically 1 to 3%. Helium is also extracted from the National Helium Reserve, slated for closure in 2021.



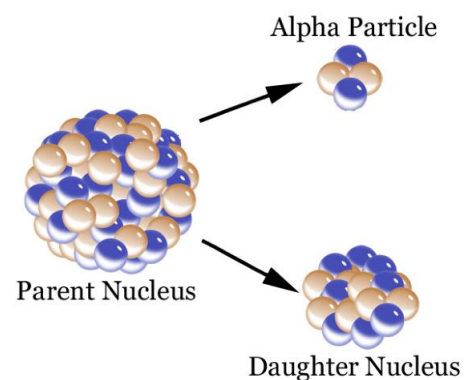
A little background on

Helium

23

How is Helium formed?

- **Helium** is a byproduct of radioactive decay of **uranium** and **thorium** emitting an alpha-particle; half-life of $\sim 10^8$ years
- The alpha-particle – which is charged – obtains electrons from its environment to become ${}^4\text{He}$.
- What about ${}^3\text{He}$?



https://s3.amazonaws.com/ai2-vision-textbook-dataset/dataset_releases/rc2/train/textbook_images/radioactive_decay_as_a_measure_of_age_21060.png

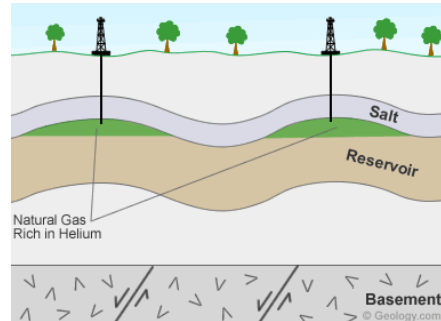
24

Where do we find Helium?

- Helium is a byproduct of natural gas extraction
- Helium must be present at sufficiently high concentrations to make it “worthwhile” to separate it from natural gas

→ usually around 2%

- Natural abundance in the atmosphere ~ 5 ppm



<https://geology.com/articles/helium/>

25

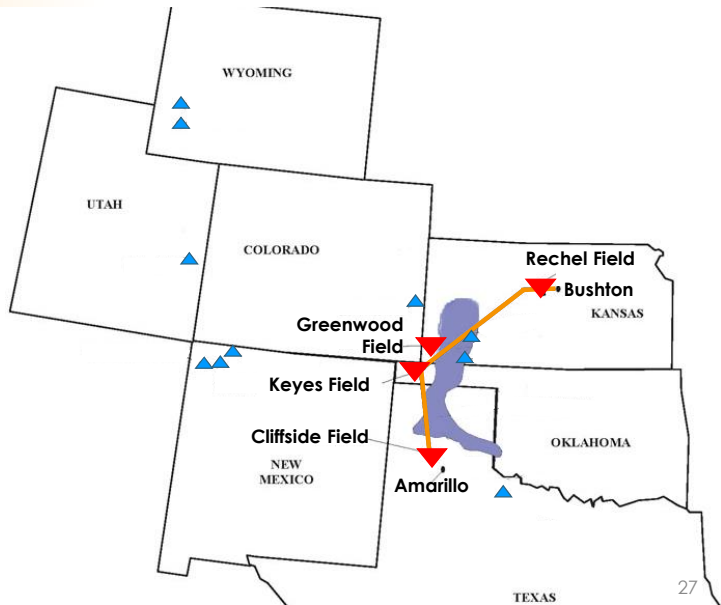
From where do we get Helium? (worldwide)



26

From where do we get Helium? (U.S.A.)

- Private plants & pipelines
- Bureau of Land Management (BLM) facilities



What causes supply shocks and price changes?

- Increasing demand for helium worldwide
- Political instability
- U.S.A. pipeline maintenance
- Market fluctuations of natural gases can influence helium
- Natural gas well depletion and discovery of new wells
- Shutdown of the Helium Reserve in 2021 that has provided 30 % of world supply for many years



Who is affected most by supply and price “shocks”?

End-users with fixed budgets:

(Researchers on federal grants.)

- 1) Low-temperature research in physics, chemistry, engineering
- 2) Astrophysics, accelerators, cryogenic detectors
- 3) Materials science and quantum information
- 4) Cryogenic instrumentation



End-users with critical cryogenic applications:

- 1) Superconducting magnets
- 2) NMR – nearly all ACS-accredited chemistry departments
- 3) NMR researchers in chemistry, physics, engineering
- 4) Mass-spectrometry

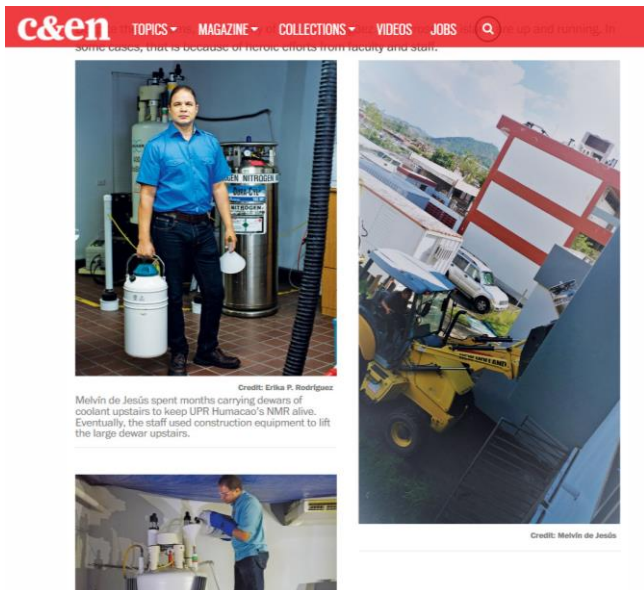


29

Stories from the “*front lines*” of researchers

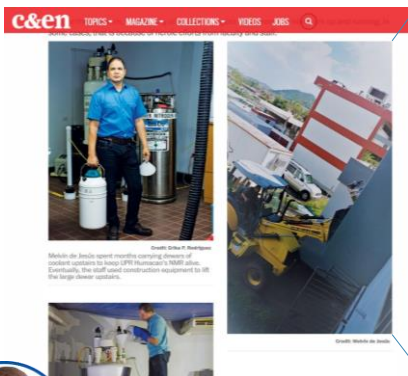
30

Magnet "rescue" in Puerto Rico (after Hurricane Maria)



31

Magnet "rescue" in Puerto Rico (after Hurricane Maria)



<https://cen.acs.org/education/Puerto-Ricos-universities-road-recovery/96/i37>



Is there a Helium supply problem?

Anecdotes from around the country – in people's own words...

"...we were scheduled to move our NMR system into our new building. We were told by the vendor we needed 400 L of LHE on hand ...but [our vendor] could not provide that much He. Our stockroom director did a lot of hunting around, but **there was not a single He supplier in the country that could provide that much He.** The delay caused us to lose our window ...we lost the use of the instrument at a time when we needed it for teaching and research. Lack of He was the only reason we could not move the instrument on schedule."

"In October we were told that we had reached our allocation and no Helium would be available for at least 6-8 weeks. We have a 900 MHz that needs 250 liters every 4 weeks. We went **10 weeks without helium** and have never quite got back to a complete fill. More importantly our Helium cost went up ~47% at that time. Our cost for the 900 alone are now \$56K/ year and that cost has to be passed on to our users."



33

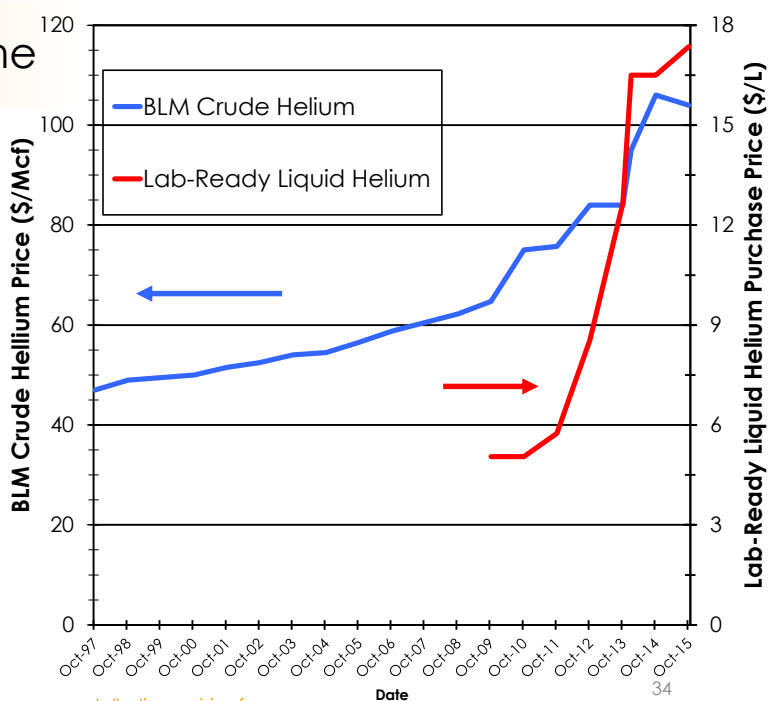
Helium price over time

Crude Helium:

70% helium + 30% natural gas

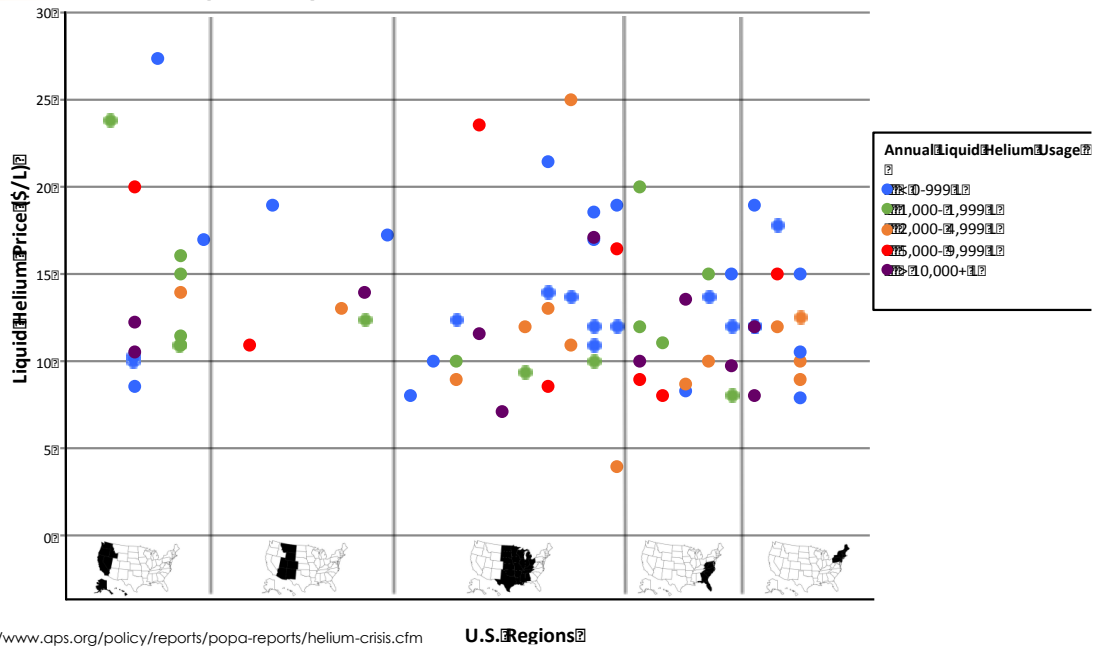
Conversion:

37.6 liquid He liters = 1 Mcf



<https://www.aps.org/policy/reports/popa-reports/helium-crisis.cfm>

Regional prices (2015)



36

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



Have you experienced shipment delay?

- Never had a delay
- One or more delays up to 2 weeks
- Longer delays
- Not applicable – I don't order / use helium

** If your answer differs greatly from the choices above tell us in the chat!*

What can we do?

37

Helium conservation and recycling

Liquefaction

- | | | | |
|--------------------|------------------|-------|-----------------------|
| • Large-scale | > 50,000 | L/yr. | National Laboratories |
| • Mid-scale | 30,000 to 50,000 | L/yr. | Universities |
| • Small-scale | 5,000 to 30,000 | L/yr. | A few laboratories |
| • Very small-scale | < 5,000 | L/yr. | One magnet/instrument |

Conservation

- Improved efficiency will reduce cost

Storage:

- Only available in gas form; like National Helium Reserve
1000 L liquid = 26,600 cubic feet gas (room temperature)
The Reserve will have 3 billion cubic feet in 2021



New directions (helium-free systems)

38

Helium liquefaction

Mid-scale

pluses

- On-site inventory: 4,000 to 6,000 L equiv.
- Technician support
- Immediate availability of liquid helium, 40-50 L/hr
- Pricing advantage for make-up helium (delivery in large dewars, 250 L)
- Pricing advantage for single site delivery
- Pricing advantage for "In-kind" helium

minuses

- Expensive capitalization: 2 to 3 M\$
- Cost of full time technician
- Institutional space
- Efficient helium transfers; efficient recovery from boil-off
- 7,500 L/year threshold for purchase from federal grants to qualify for "In-kind" helium



39

Helium liquefaction

Mid-scale Northwestern Univ.



40

Helium liquefaction

Small-scale

pluses

- Cheap capitalization: 150 to 250 k\$
- No technician required
- Some lab space is required, ~ 300 to 500 ft²
- Immediate availability of liquid helium: 20 to 40 L/day
- Very efficient, low cost

minuses

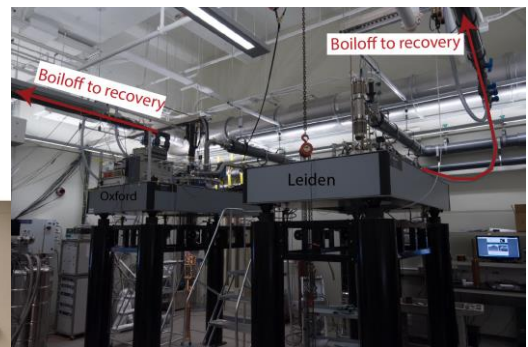
- No inventory, only ~ 150 to 250 L equiv.
- Lab staff do the work (soft money: students, postdocs, . . .)
- Uncertain availability and cost for make-up helium ~ 300L/year
- Considerable energy consumption (~5kW - 7kW)
- Requires efficient helium handling



41

Helium liquefaction

Small-scale Univ. Alberta



Helium conservation: efficiency and recycle



- Helium recovery and liquefaction
- Efficient helium transfers
"Don't waste a drop" or even a "puff" of helium
- Dewars hooked up to recovery



43

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



44

Which of these is of the HIGHEST priority?

- Refrain from buying helium balloons
- Improve transfer efficiency
- Call your congress members and request a hearing on helium
- All of the above

** If your answer differs greatly from the choices above tell us in the chat!*

Answer to Question 3

The highest priority is: **Call your congress people**

Helium for balloons is too small to be a concern.

While it is always wise to improve efficiency, a higher priority is to press Congress to take action, beginning with holding a hearing on ensuring helium supplies for research.

This requires congressional action.

45

In preparation ... for the next supply shock

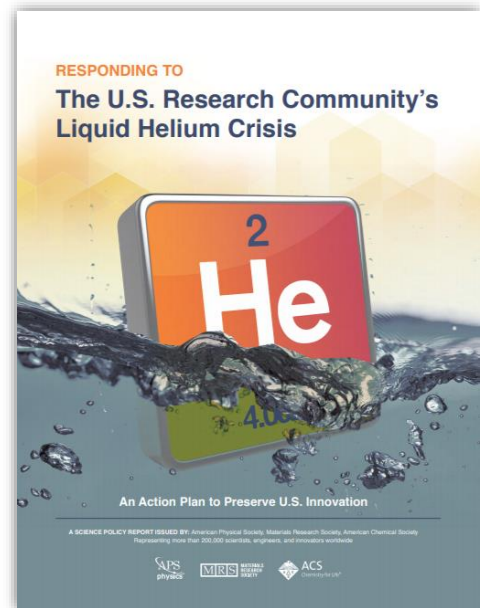
- Recognize there are different “types” of users – ones with a fixed periodic critical need
- Triage helium orders
- Early-warning system for researchers (i.e., AMMRL or other professional society)
- Keep officials informed (to build awareness)
- Call your Members of Congress



46

Want more info?

- American Chemical Society
<https://www.acs.org/content/acs/en/policy.html>
- American Physical Society
<https://www.aps.org/policy/issues/energy/helium/>
- Materials Research Society
<https://www.mrs.org/advocacy-issues>



<https://www.aps.org/policy/reports/popa-reports/helium-crisis.cfm>

47

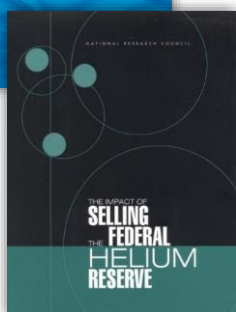
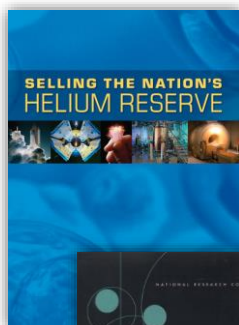
Want more info?

- Bureau of Land Management:

<https://www.blm.gov/programs/energy-and-minerals/helium>

48

Want more info?



National Academies

- 2010: (report)
<https://www.nap.edu/catalog/12844/selling-the-nations-helium-reserve>
- 2013: (testimony)
 "Up in the Air: The BLM's Disappearing Helium Program"
http://www.nationalacademies.org/OCGA/113Session1/testimonies/OCGA_145533
- 2000: (report)
<https://www.nap.edu/catalog/9860/the-impact-of-selling-the-federal-helium-reserve>

49

ACS / APS / MRS action

Our professional societies are considering some of the following in their interactions with Members of Congress. Potential points to raise with MOC's:

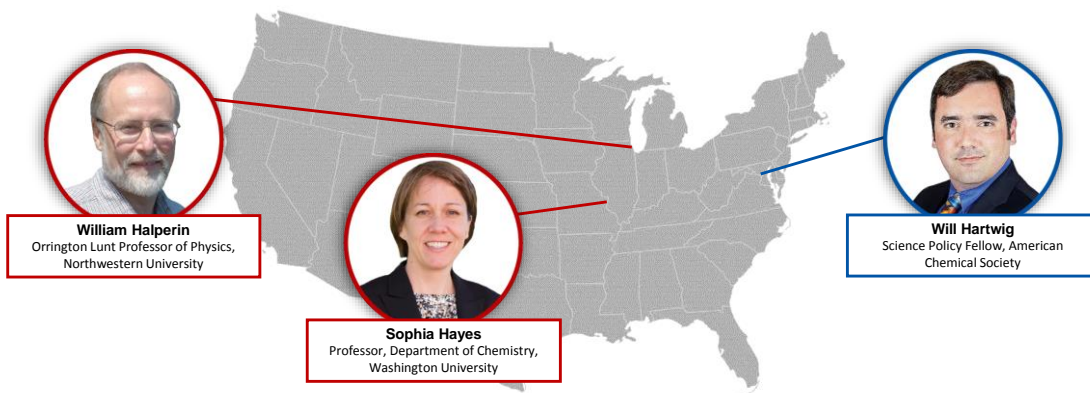
1. The Administration listed helium in its critical minerals list last year, but has yet to take action.
2. Short-term: researchers that are in dire situations need some assistance.
3. Privatization (sale) of the Helium Reserve should be contingent upon a continuation of the in-kind program--providing access to helium for federal users.
4. Long-term: Congress needs to assist federally-funded research with helium recycling and development of helium-free technologies. Congress could use monies from helium royalty contracts for this purpose.



50



Helium: An Irreplaceable Resource and Why We Must Conserve It



Slides available now! Recordings are an exclusive ACS member benefit.

www.acs.org/acswebinars

This ACS Webinar is co-produced with ACS External Affairs & Communications, American Physical Society, and Materials Research Society

51

Upcoming ACS Webinar

www.acs.org/acswebinars



ACS
Chemistry for Life®

JCIM JOURNAL OF CHEMICAL INFORMATION AND MODELING

aaps

ACS Technical Division
Medicinal Chemistry (MED)

EFFECTIVE EXPLORATION
OF CHEMICAL SPACE IN

HIT-FINDING

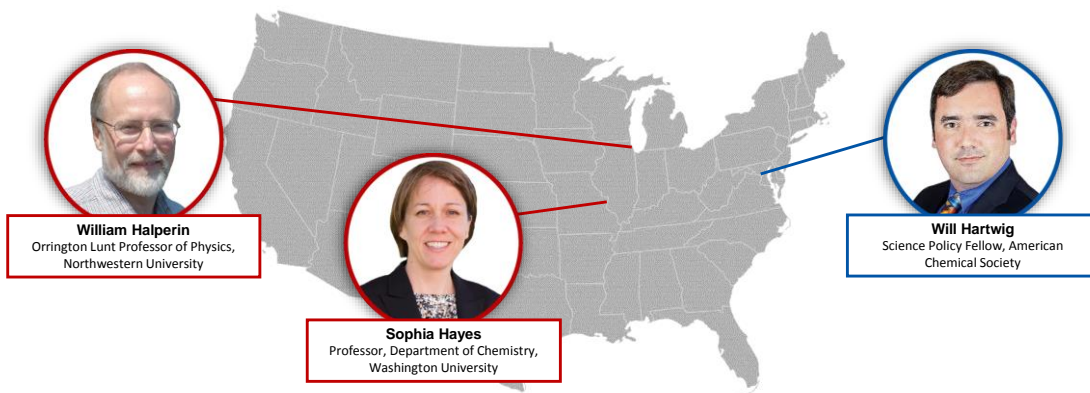
▶ FREE | Thursday, April 18 at 2pm ET

ACS Webinars
CLICK • WATCH • LEARN • DISCUSS

<https://www.acs.org/content/acs/en/acs-webinars/drug-discovery/hit-finding.html>

52

Helium: An Irreplaceable Resource and Why We Must Conserve It



Slides available now! Recordings are an exclusive ACS member benefit.

www.acs.org/acswebinars

This ACS Webinar is co-produced with ACS External Affairs & Communications, American Physical Society, and Materials Research Society


53

How has ACS Webinars benefited you?


"ACS Webinars is always providing interesting real world chemistry. I use examples learned from webinars when explaining chemistry to non-chemists."

Fan of the Week

Michael D. Berger, Ph.D.
Lead Patent Agent, ConocoPhillips Company
ACS member for 6 years strong!



<http://bit.ly/ChocChemVideo>



Be a featured fan on an upcoming webinar! Write to us @ acswebinars@acs.org

54



Benefits of ACS Membership



Chemical & Engineering News (C&EN)

The preeminent weekly digital and print news source.



NEW! ACS SciFinder

ACS Members receive 25 complimentary SciFinder® research activities per year.



NEW! ACS Career Navigator

Your source for leadership development, professional education, career services, and much more.

<http://bit.ly/ACSmembership>

55



ACS Webinars® does not endorse any products or services. The views expressed in this presentation are those of the presenter and do not necessarily reflect the views or policies of the American Chemical Society.



Mike Russell Erik

Contact ACS Webinars® at acswebinars@acs.org

56

Upcoming ACS Webinar
www.acs.org/acswebinars



JCIM JOURNAL OF CHEMICAL INFORMATION AND MODELING

aaps

ACS Chemistry for Life[®]

ACS Technical Division
Medicinal Chemistry (MED)

**EFFECTIVE EXPLORATION
OF CHEMICAL SPACE IN
HIT-FINDING**

FREE | Thursday, April 18 at 2pm ET

ACS Webinars
DISC • WEBEX • EARN • DODDS

<https://www.acs.org/content/acs/en/acs-webinars/drug-discovery/hit-finding.html>

57