



Automated mobility on demand

September 19-21 2016

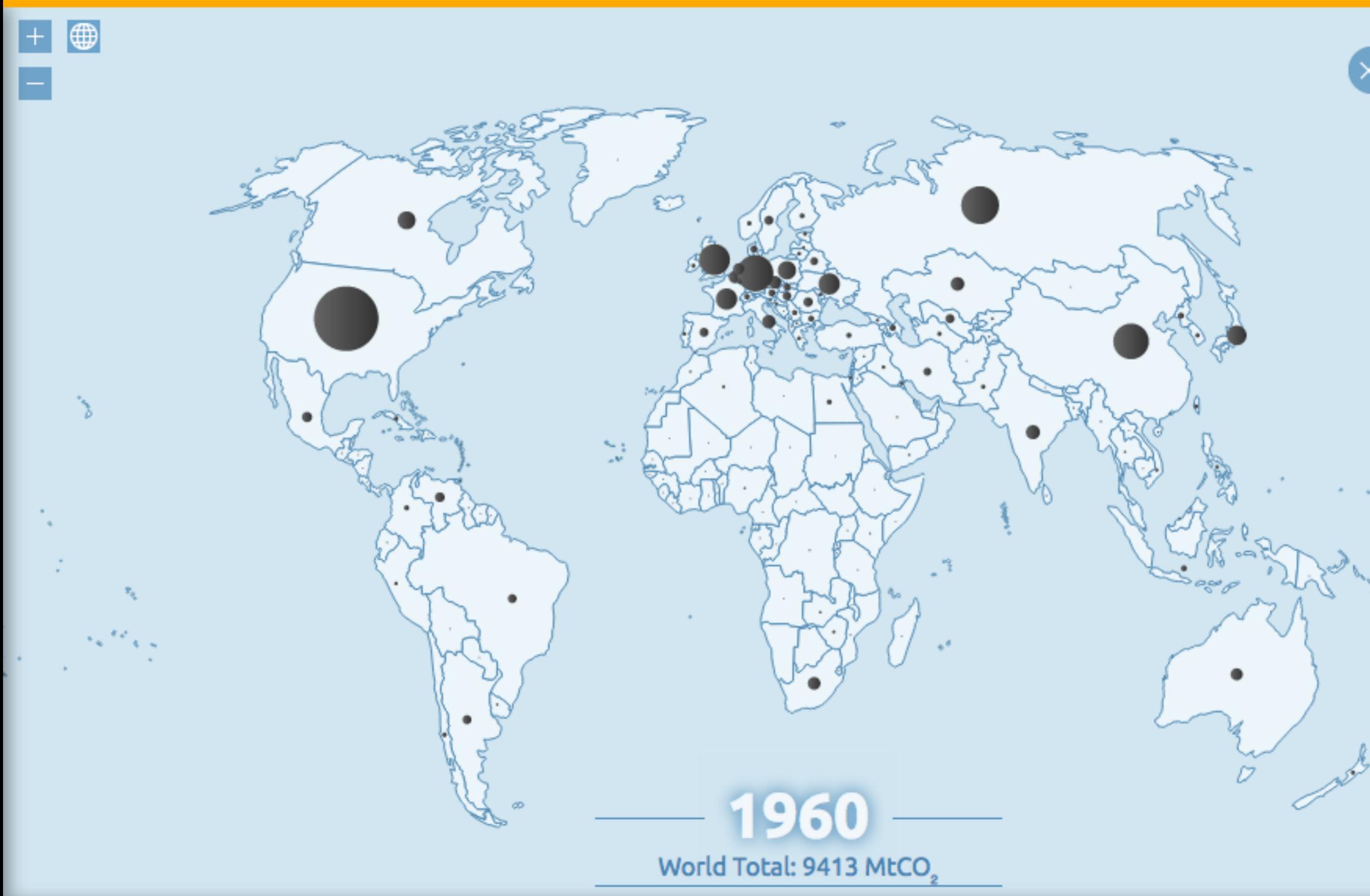
Antwerp, Belgium 

# Mitigating Climate Change with Solar-Powered Transit

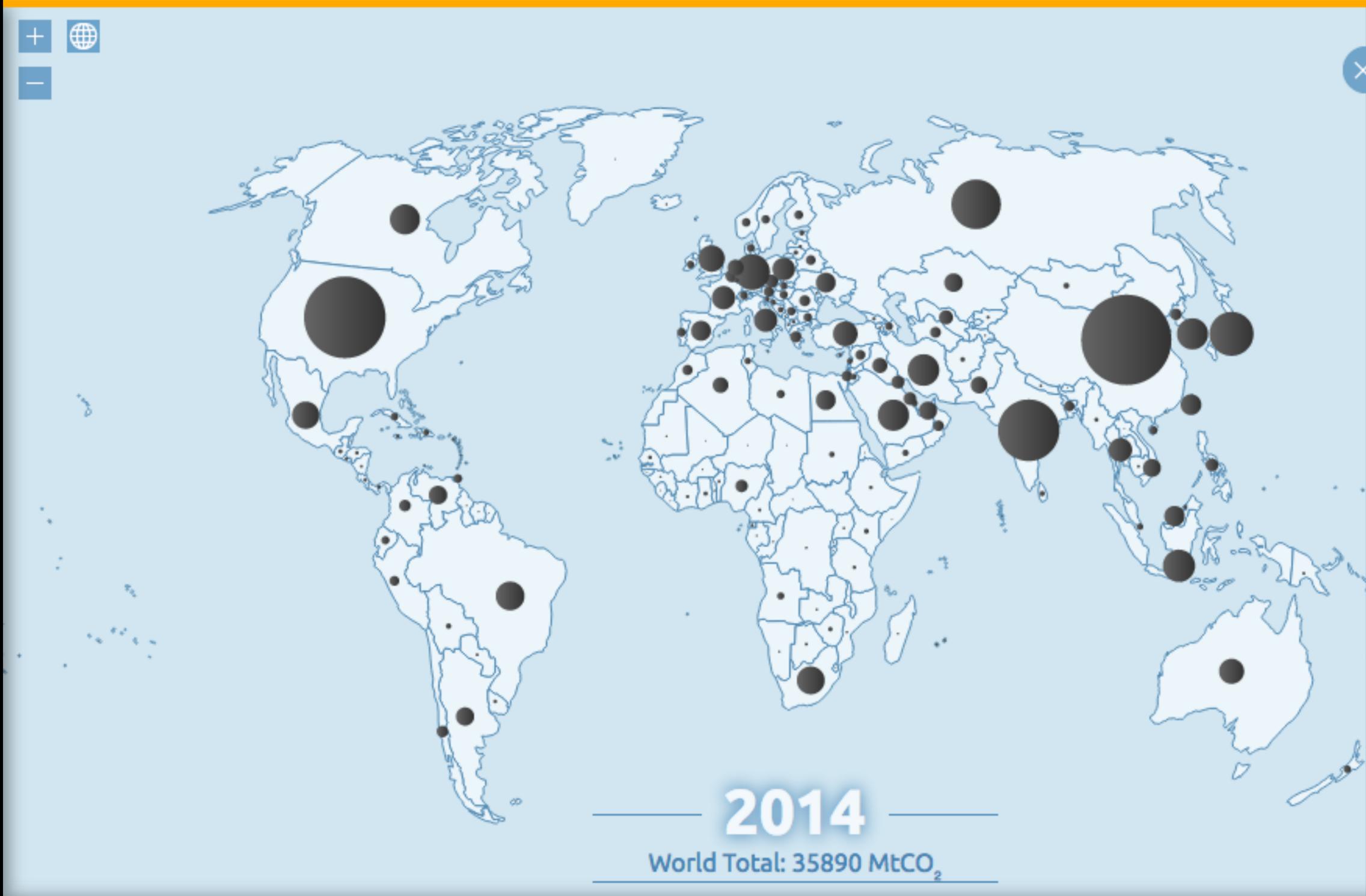


Ron Swenson, INIST

# Carbon emissions continue to increase

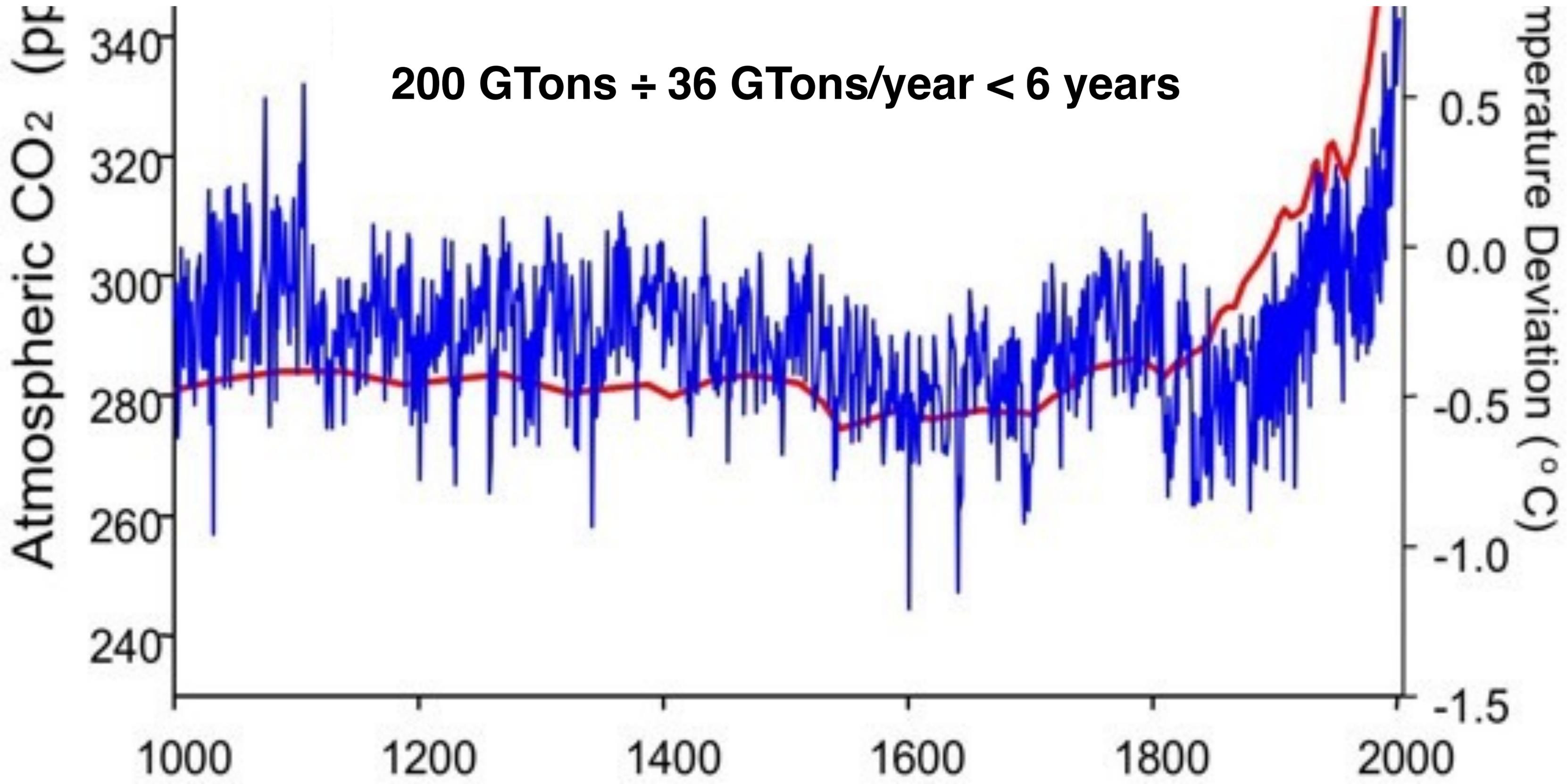


# Carbon emissions continue to increase



**The IPCC claims our carbon budget is 200 billion tons**

# The IPCC claims our carbon budget is 200 billion tons

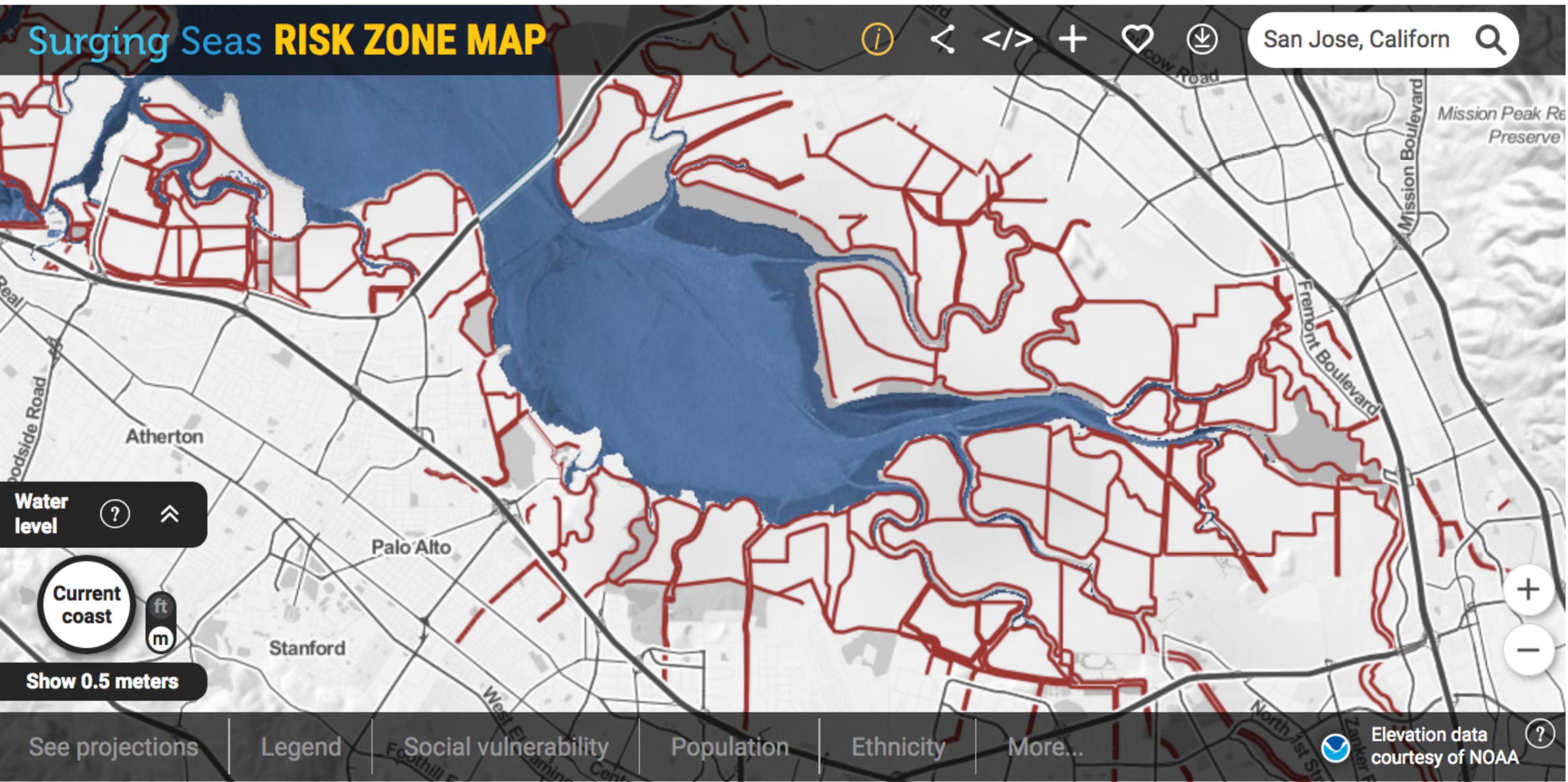


**Mother Nature doesn't care about our round numbers**

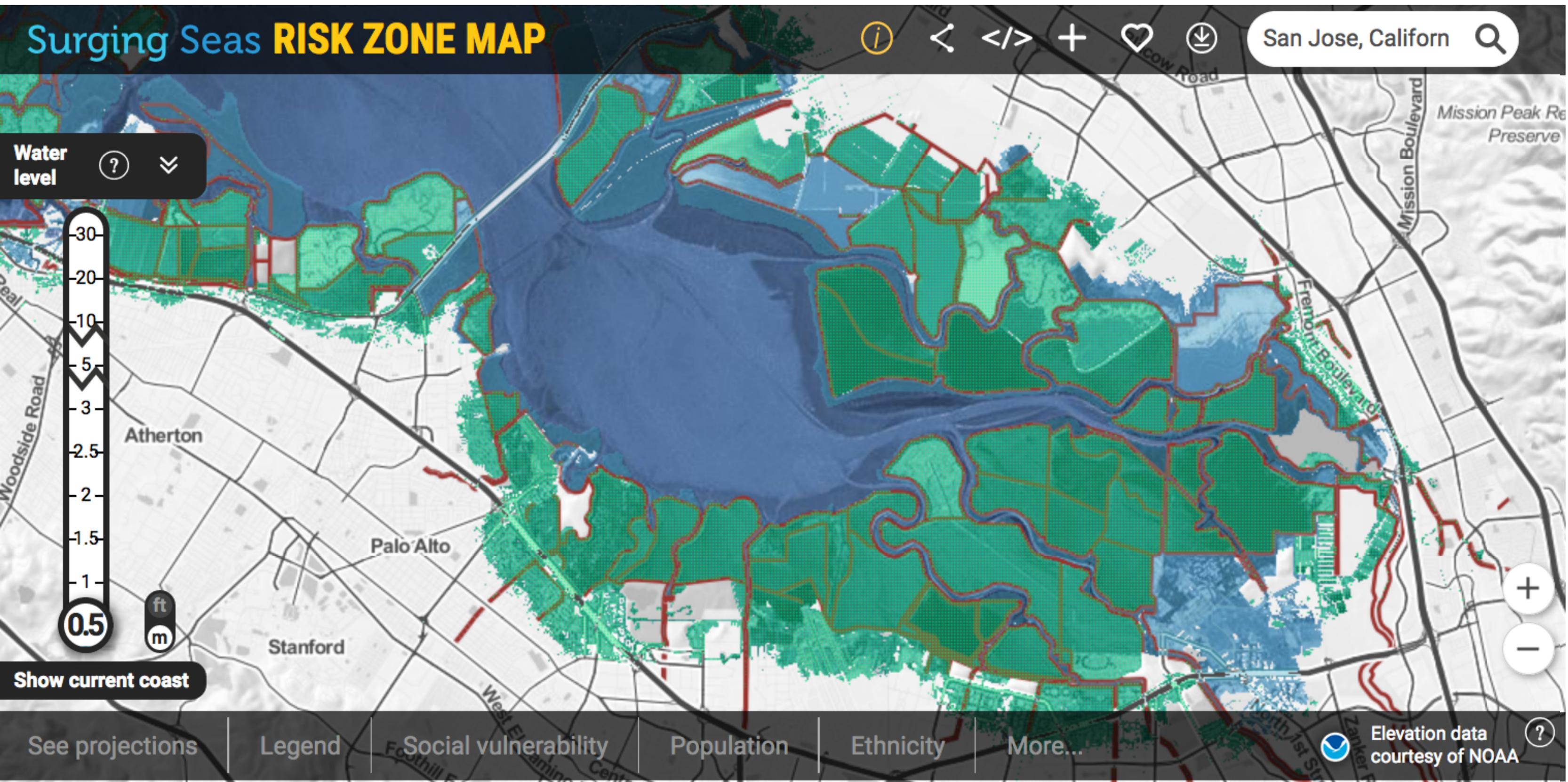
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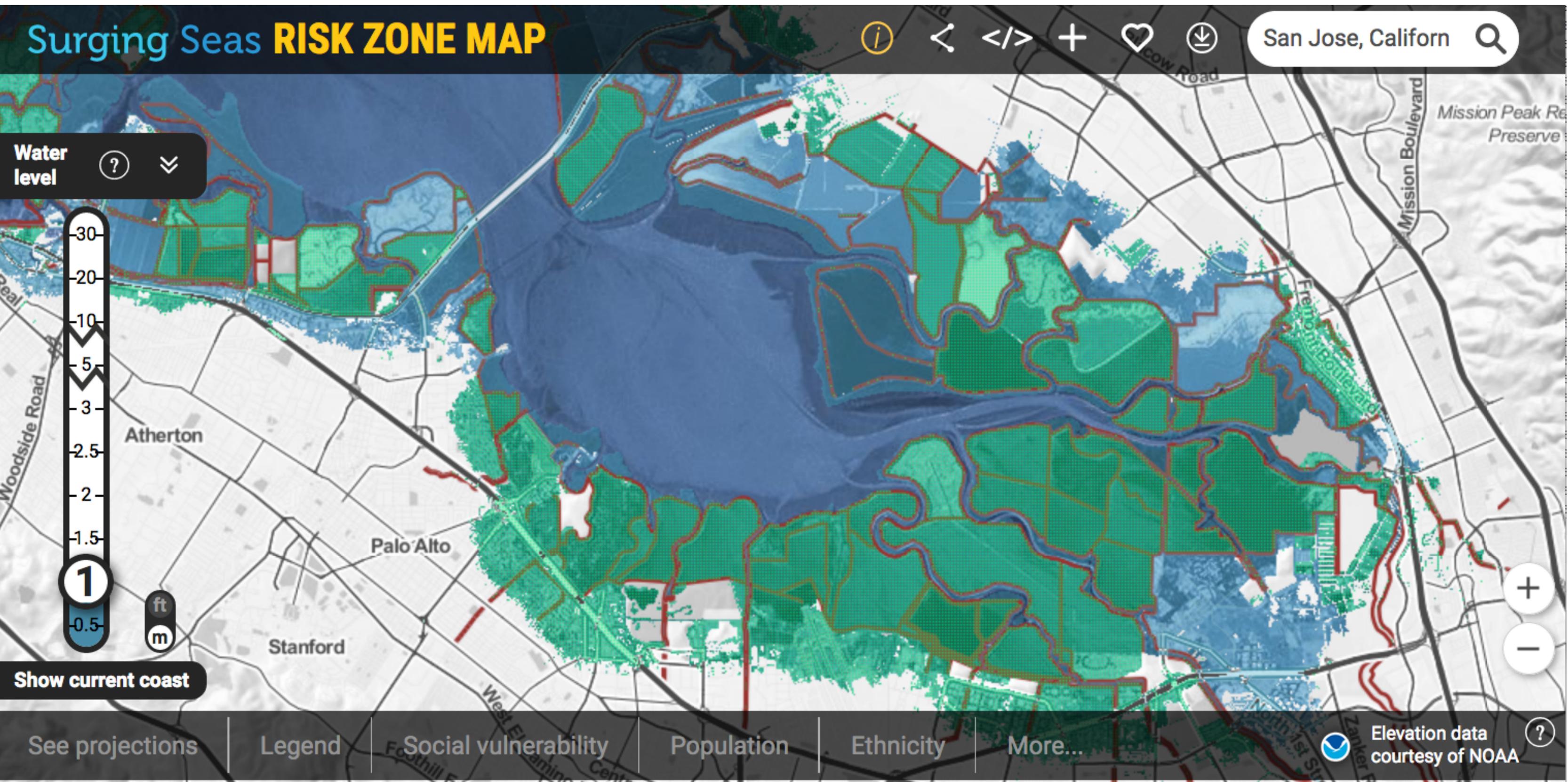
# Climate change will change Silicon Valley



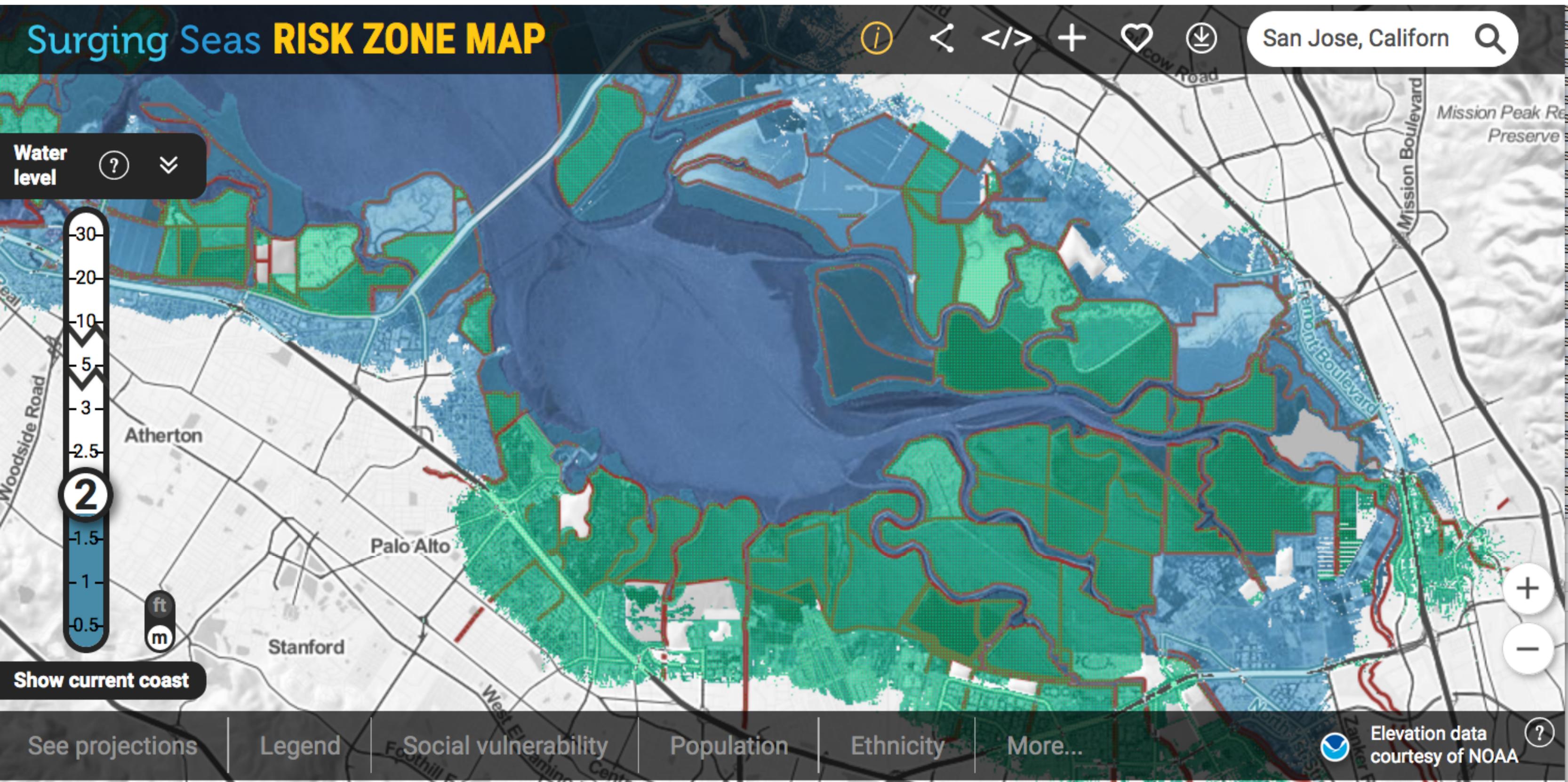
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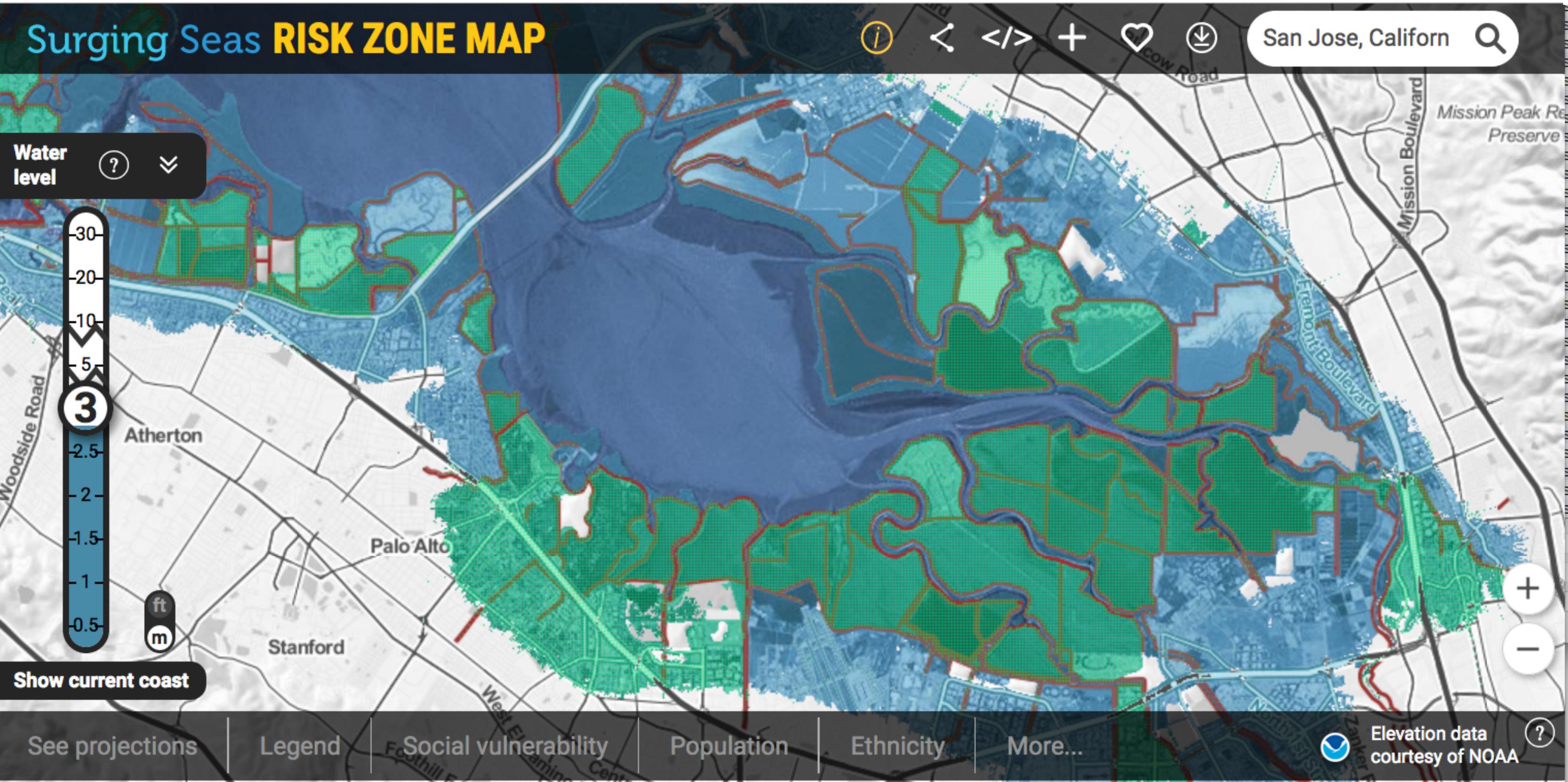
# Climate change will change Silicon Valley



# Climate change will change Silicon Valley



# Climate change will change Silicon Valley



**If Silicon Valley were perfect, with *zero* emissions,  
what good would it do?**

$$\frac{3,000,000}{7,400,000,000} = 0.04\%$$

**If Silicon Valley were perfect, with zero emissions, what good would it do?**

$$\frac{3,000,000}{7,400,000,000} = 0.04\%$$

**If you Techies are serious about survival, your only option is to export zero emission solutions**

# Climate change will change Antwerp

## Surging Seas **RISK ZONE MAP**

*i* < </> + ♥ ⬇️ Antwerp, Belgium 🔍



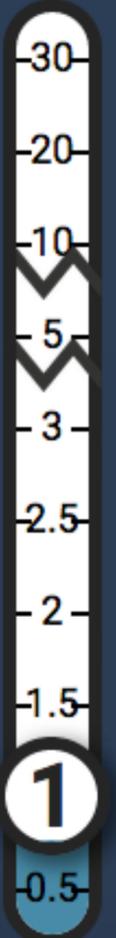
**⚠️ This map may understate risk** ?

# Climate change will change Antwerp

## Surging Seas RISK ZONE MAP

Antwerp, Belgium

Water level



Show current coast

See projections



This map may understate risk

# Climate change will change Antwerp

## Surging Seas **RISK ZONE MAP**

Antwerp, Belgium

Water level



ft  
m

Show current coast

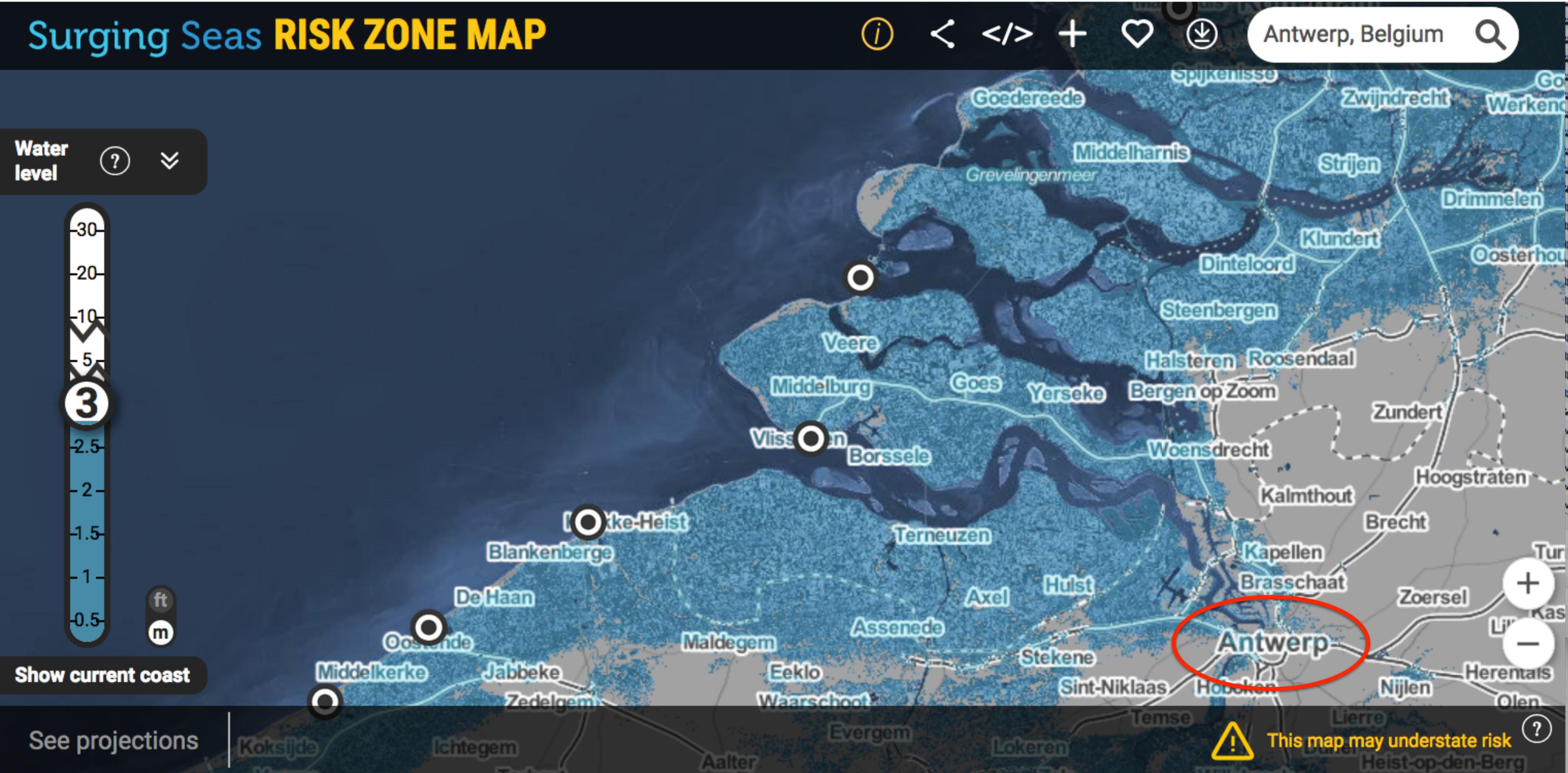
See projections



This map may understate risk

# Climate change will change Antwerp

## Surging Seas RISK ZONE MAP



**If Belgium were perfect, with *zero* emissions, what good would it do?**

$$\frac{11,190,846}{7,400,000,000} = 0.1\%$$

**If Belgium were perfect, with *zero* emissions, what good would it do?**

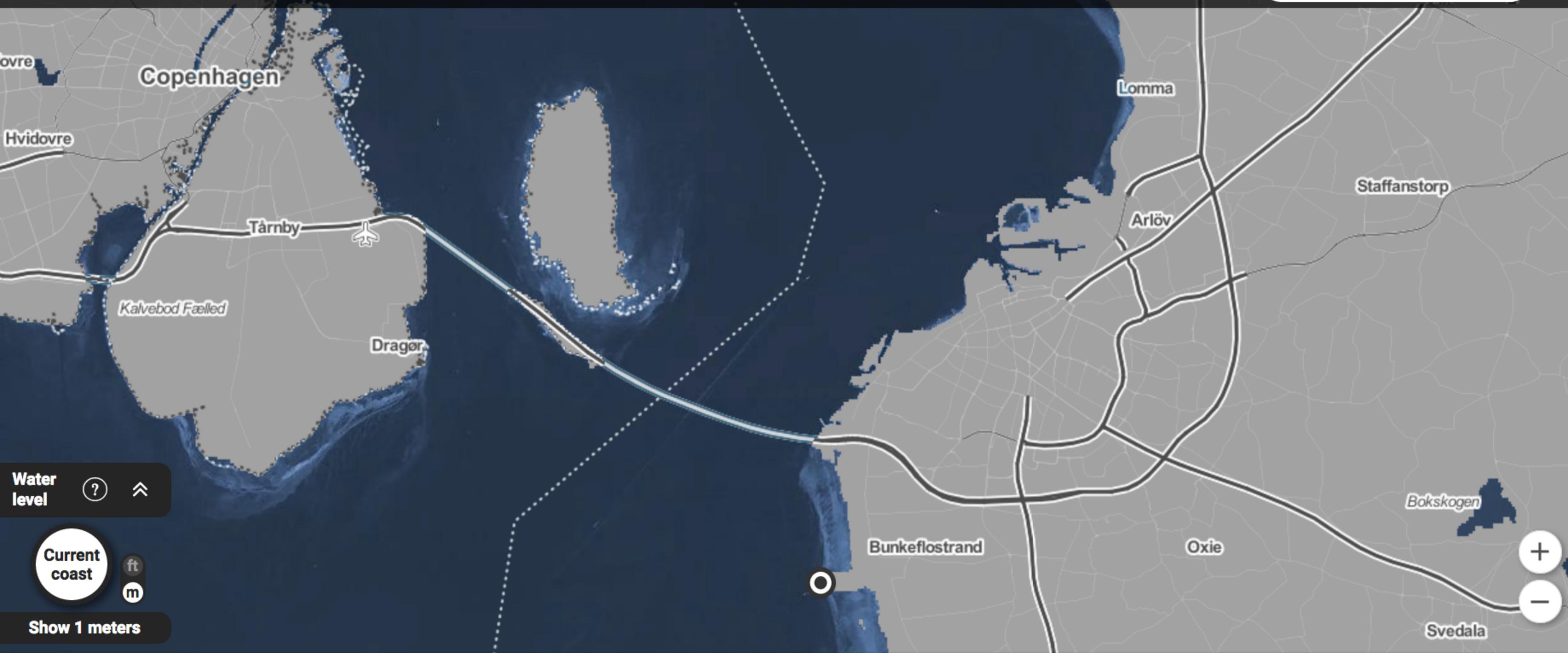
$$\frac{11,190,846}{7,400,000,000} = 0.1\%$$

**If you Belgians are serious about survival, your only option is to export zero emission solutions**

# Climate change will change Sweden

## Surging Seas RISK ZONE MAP

       Malmö, Sweden 



Water level  

Current coast  

Show 1 meters

See projections

 This map may understate risk 

# Climate change will change Sweden

## Surging Seas RISK ZONE MAP



# Climate change will change Sweden

## Surging Seas RISK ZONE MAP

Malmö, Sweden

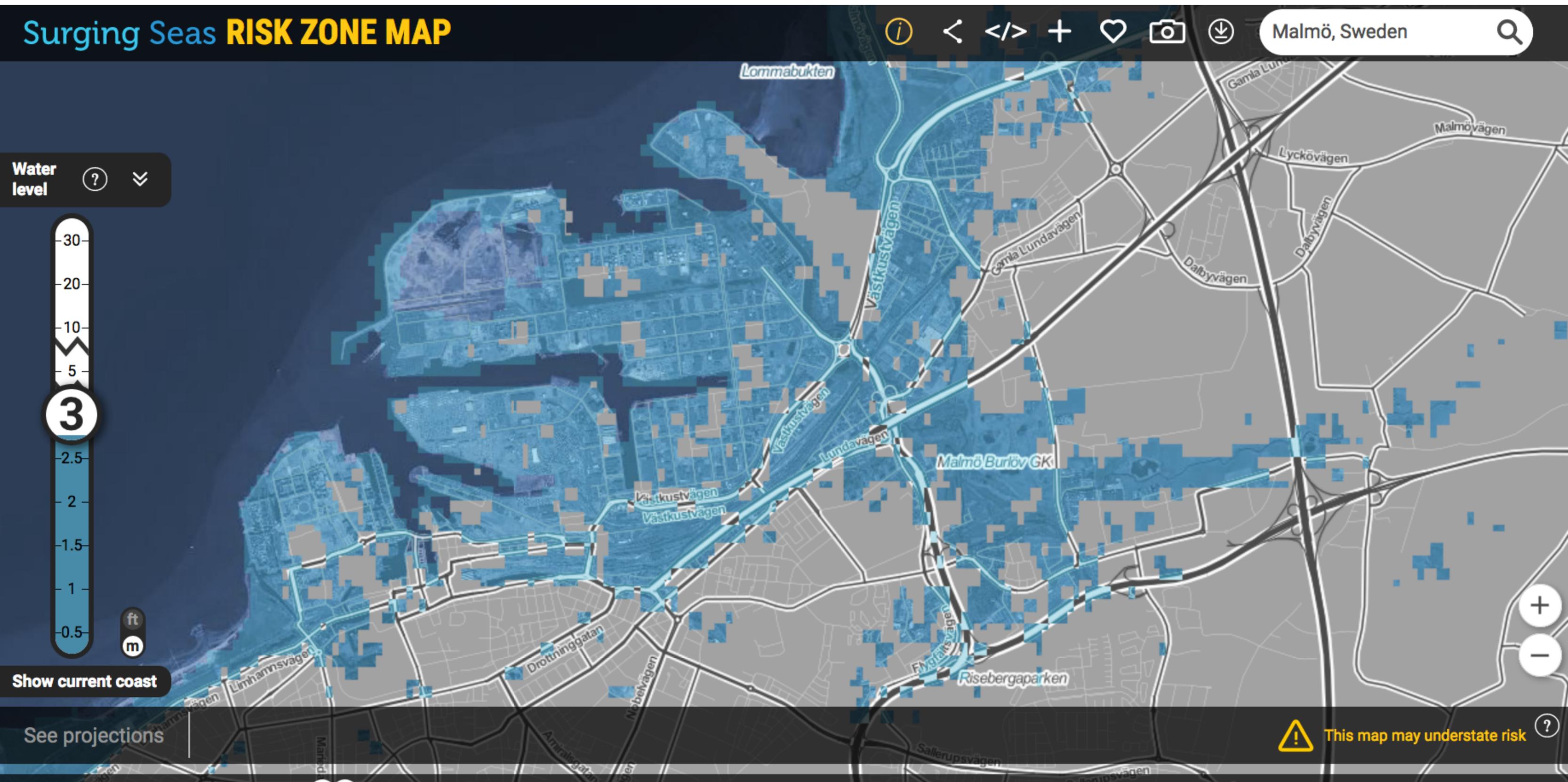


See projections

This map may understate risk

# Climate change will change Sweden

## Surging Seas RISK ZONE MAP



 This map may understate risk 

**If Sweden were perfect, with *zero* emissions, what good would it do?**

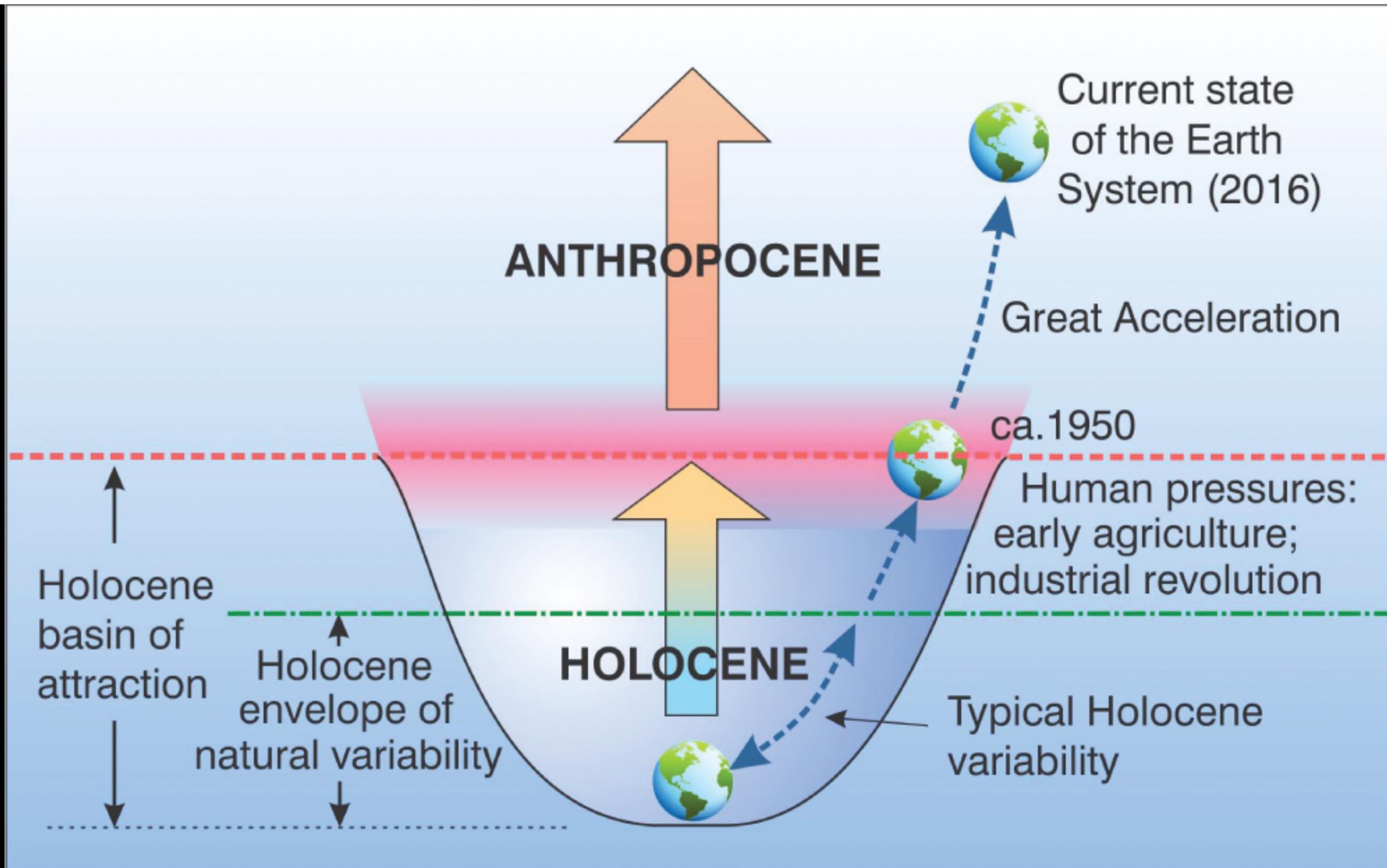
$$\frac{9,875,378}{7,400,000,000} = 0.1\%$$

**If Sweden were perfect, with zero emissions, what good would it do?**

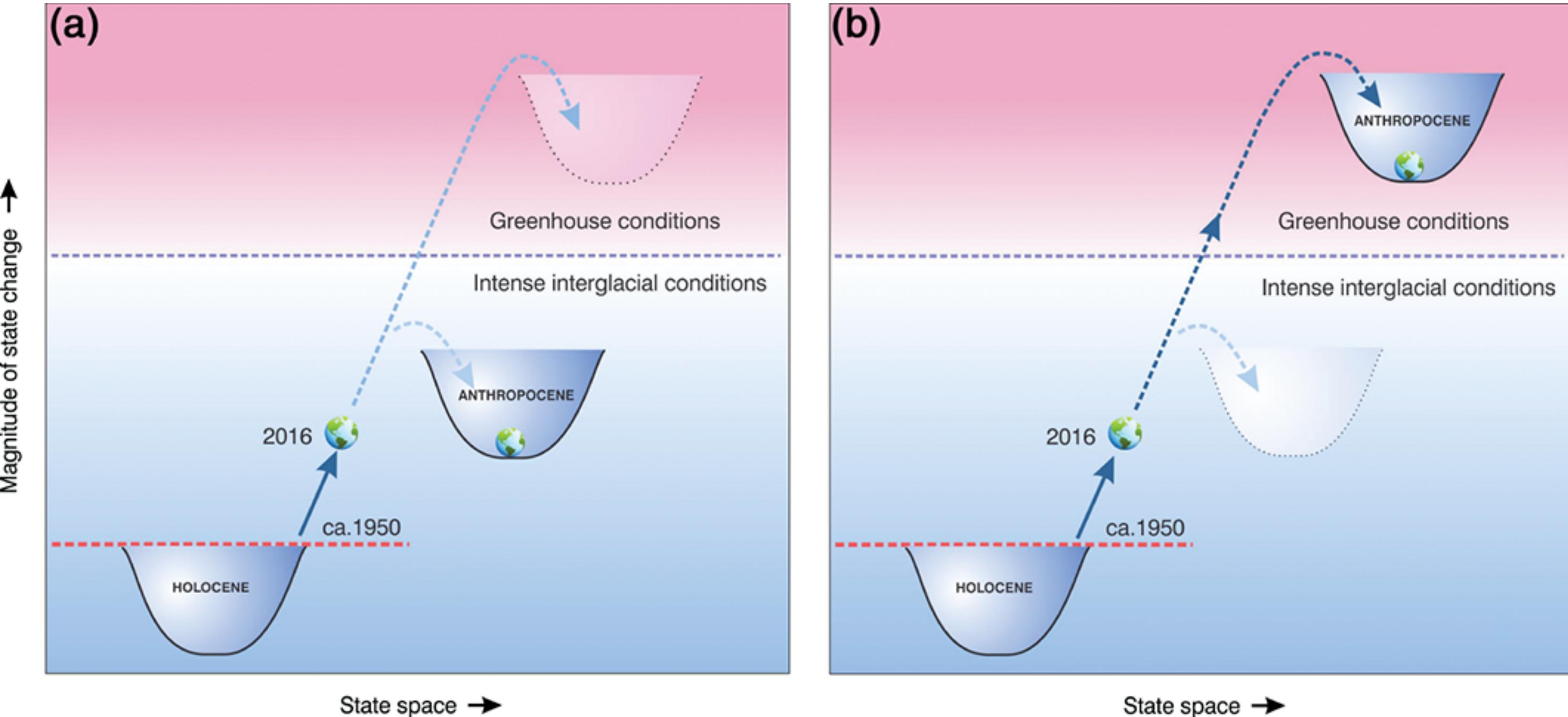
$$\frac{9,875,378}{7,400,000,000} = 0.1\%$$

**If you Swedes are serious about survival, your only option is to export zero emission solutions**

# Sustainability requires a significant and rapid shift in the nature and magnitude of human perturbations



# The climate will stabilize — with intense interglacial conditions or toward unknown greenhouse conditions



# From COP 21 came an urgent call for renewables

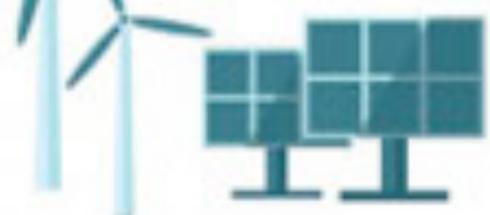
# COP21

## CLIMATE CHANGE CONFERENCE

ACTION FOR PEOPLE  
AND PLANET



**THE CLIMATE IS CHANGING**



**BETTER WARNING  
SYSTEMS**



**ECOSYSTEMS:**  
SUSTAINABLY-MANAGED COASTS  
PRESERVING HEALTHY FORESTS



# World leaders appear to be ready for the solar future

G20 2016  
CHINA

## 从巴黎到杭州 应对气候变化在行动

FROM PARIS TO HANGZHOU, CLIMATE RESPONSE IN ACTION

气候变化《巴黎协定》批准文书交存仪式

DEPOSIT OF INSTRUMENTS OF JOINT INTENTIONS TO RATIFY THE PARIS AGREEMENT

中国·杭州 2016年9月 HANGZHOU CHINA SEPTEMBER 2016



# World leaders appear to be ready for the solar future

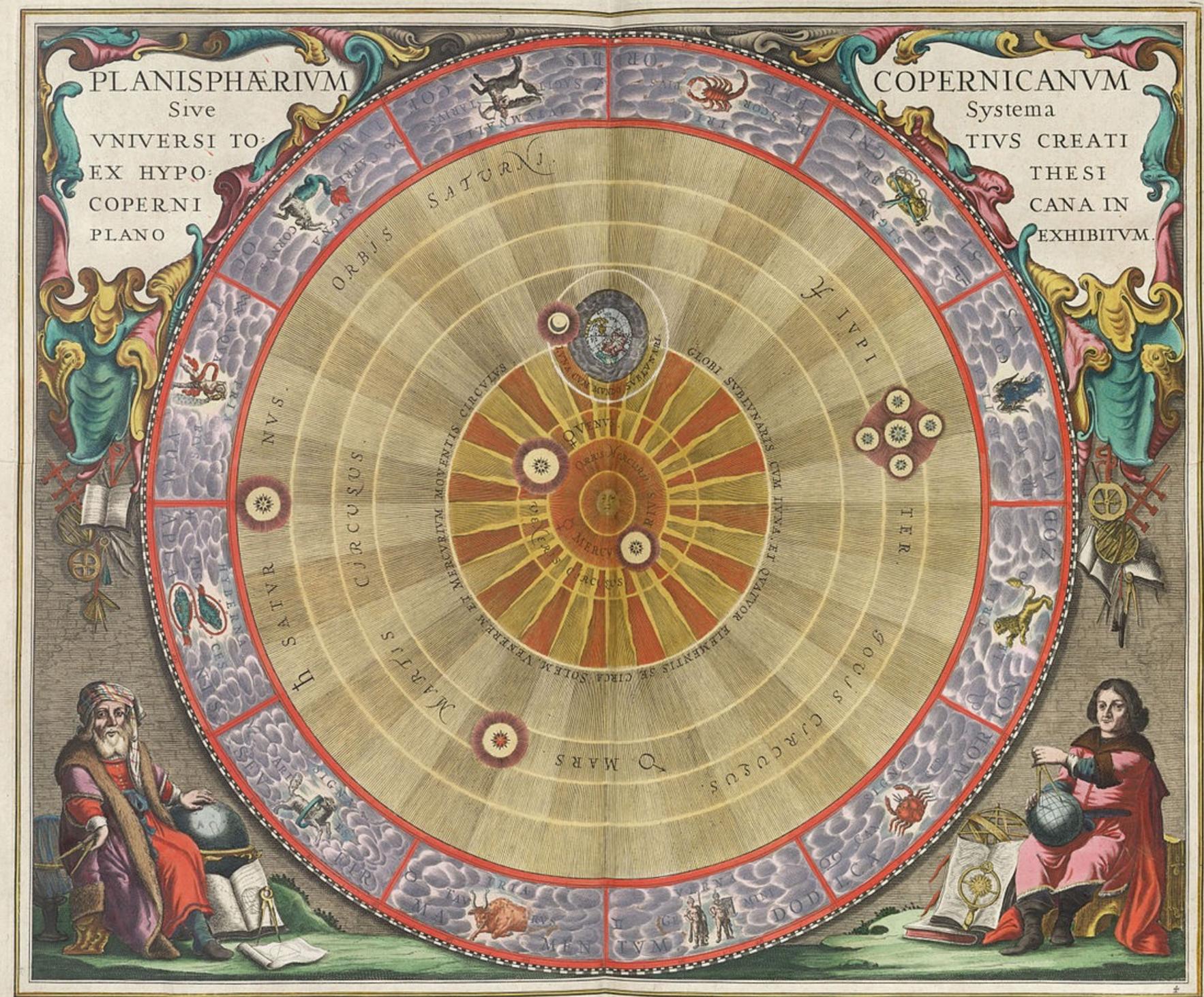
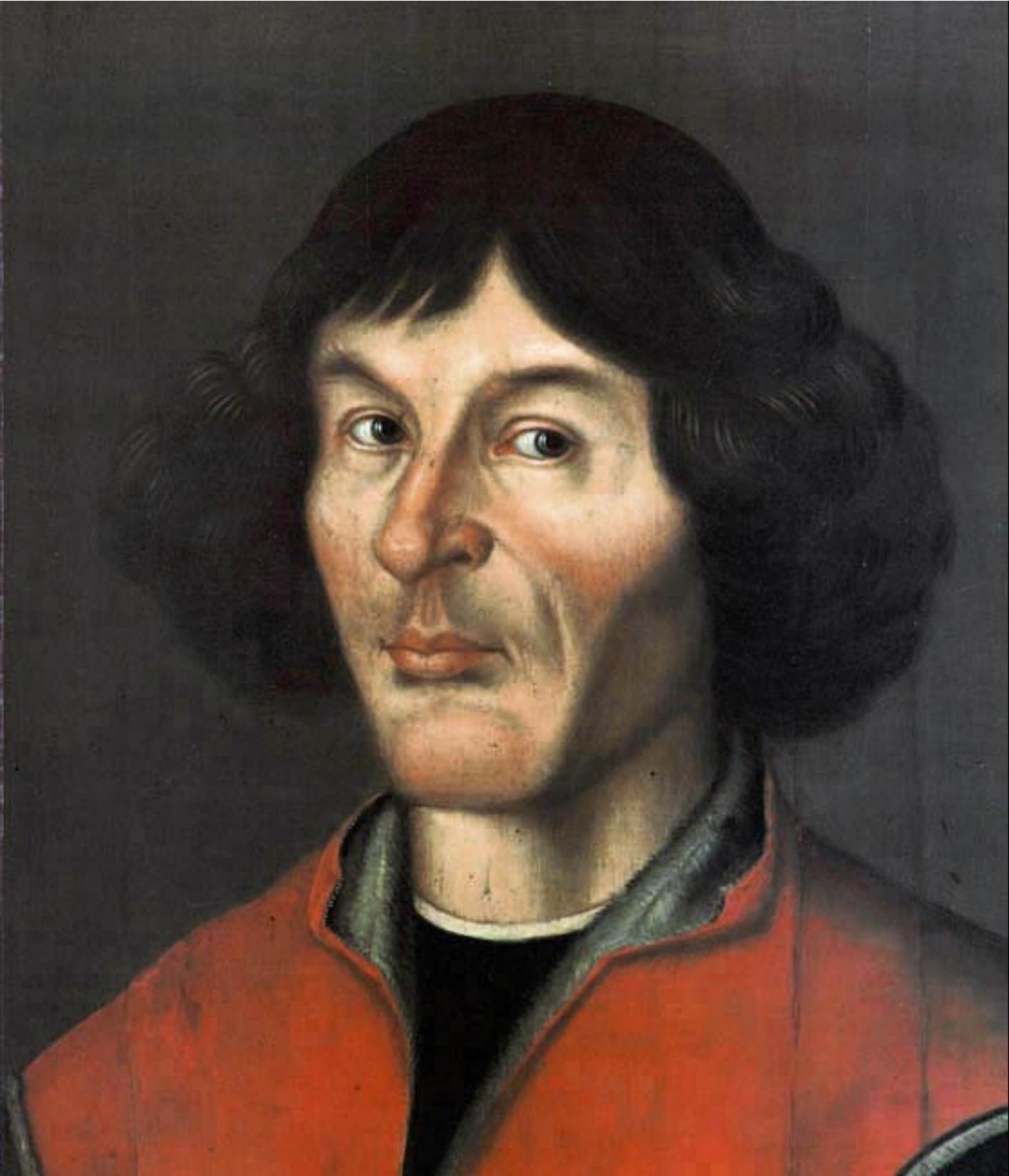


**Yes, but...**

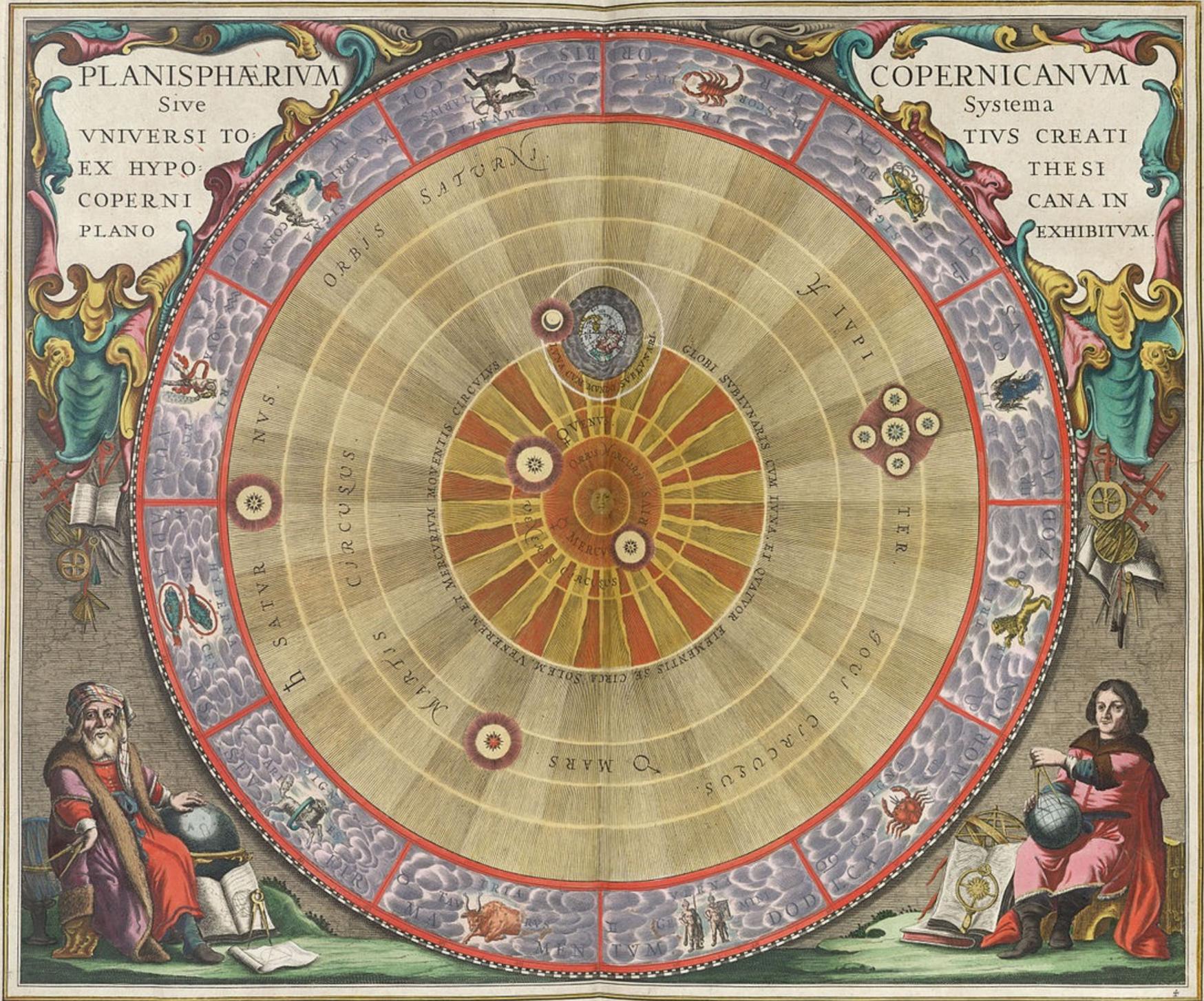
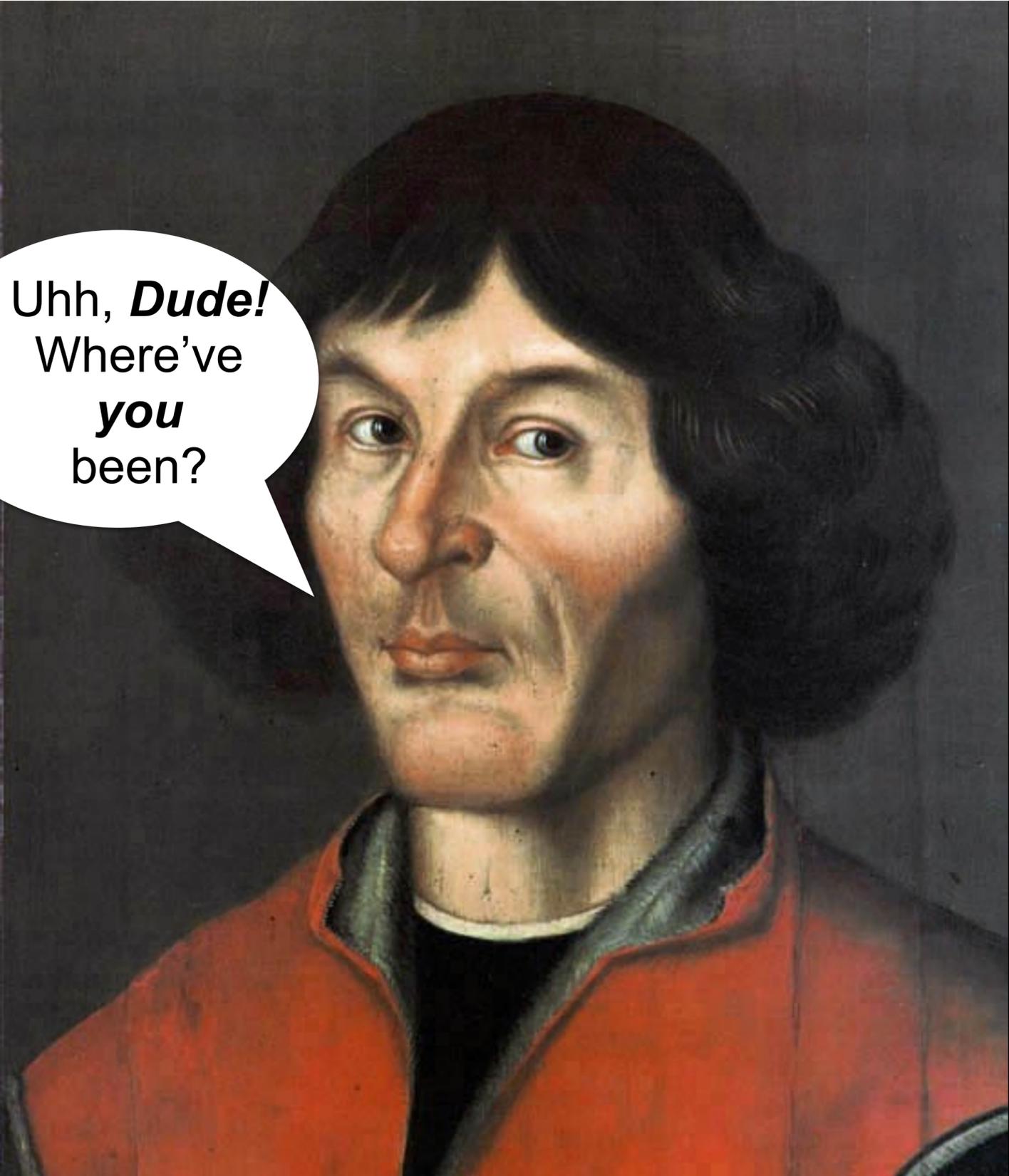
**“Also, these are intermittent sources”**



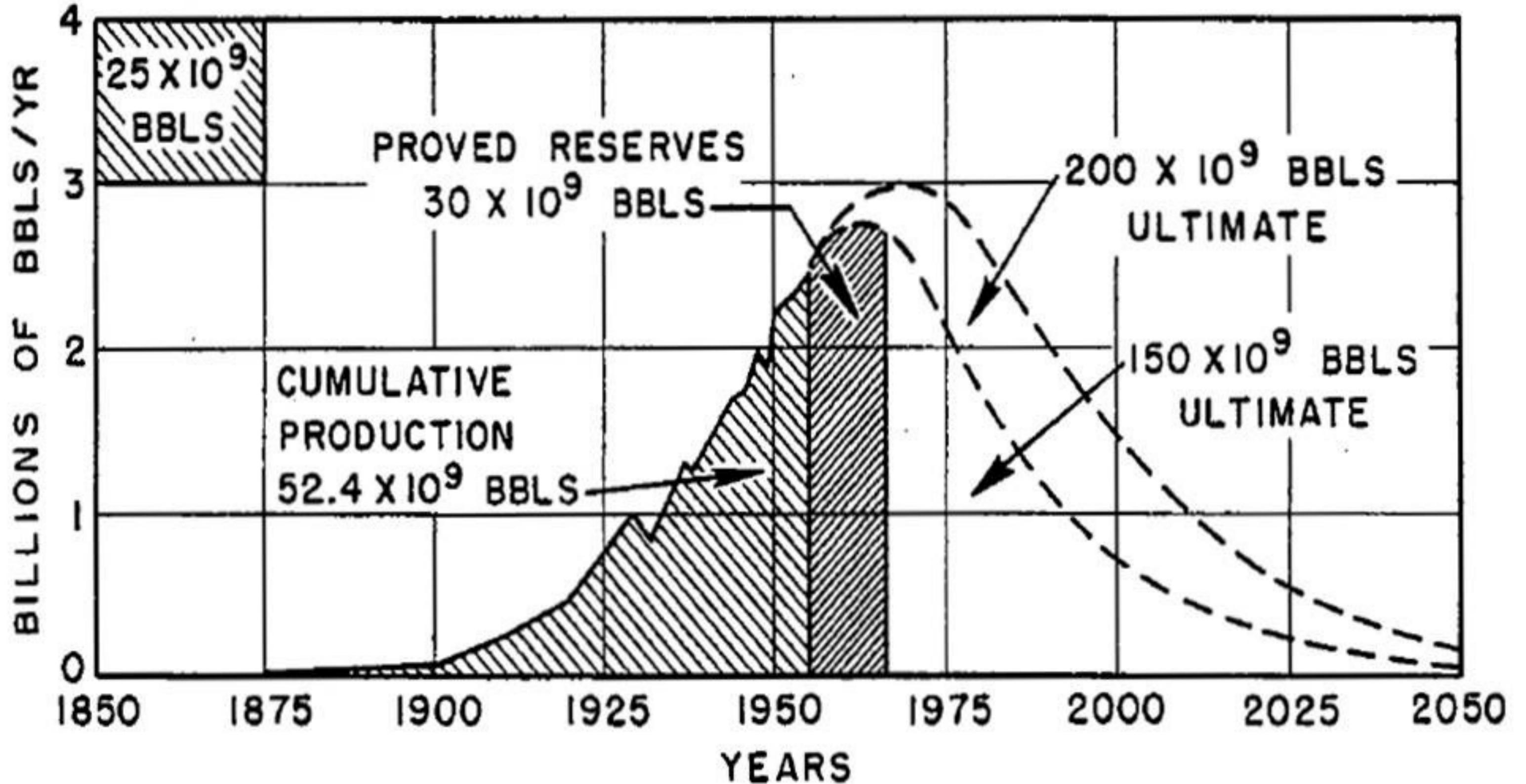
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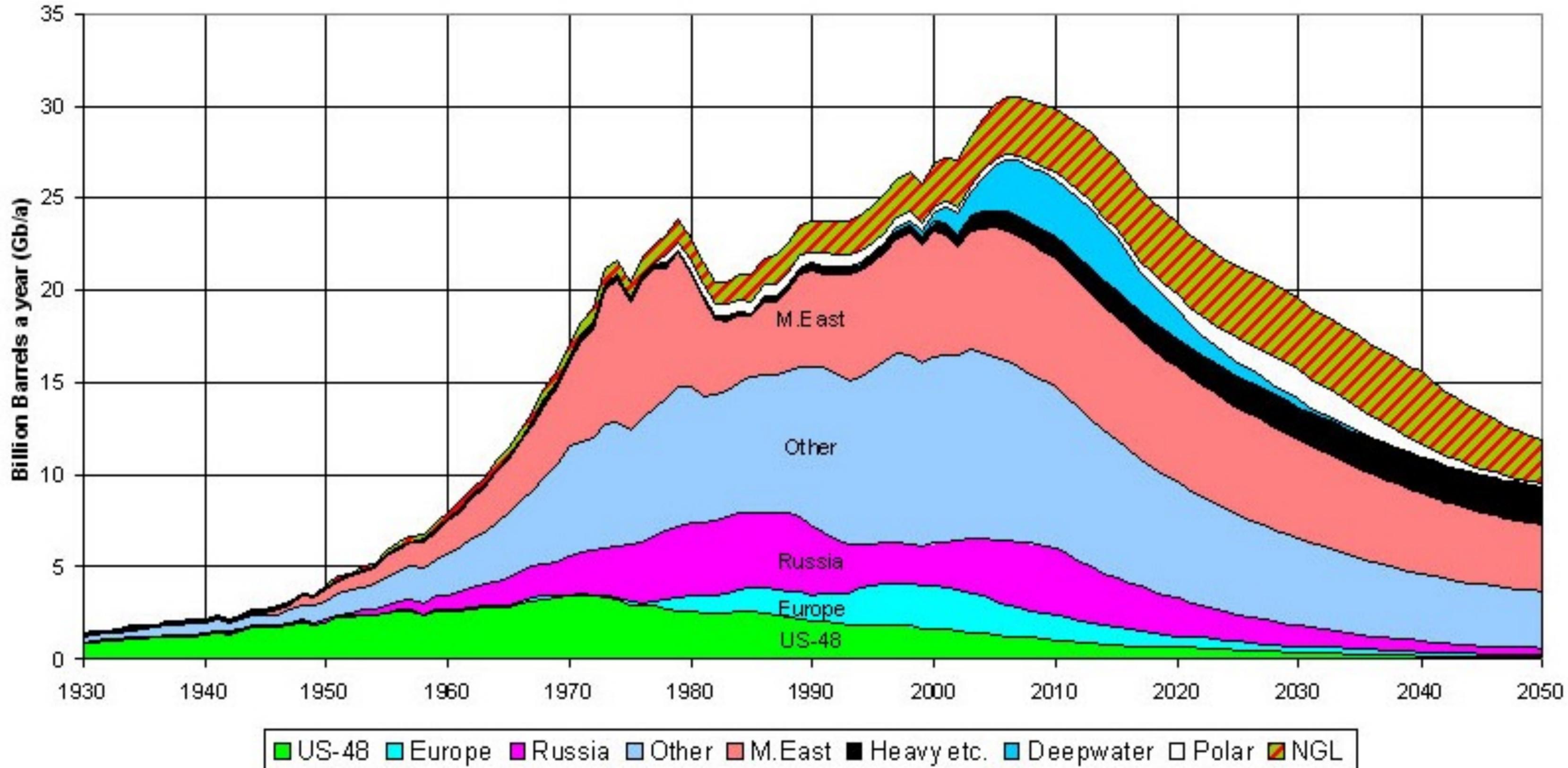
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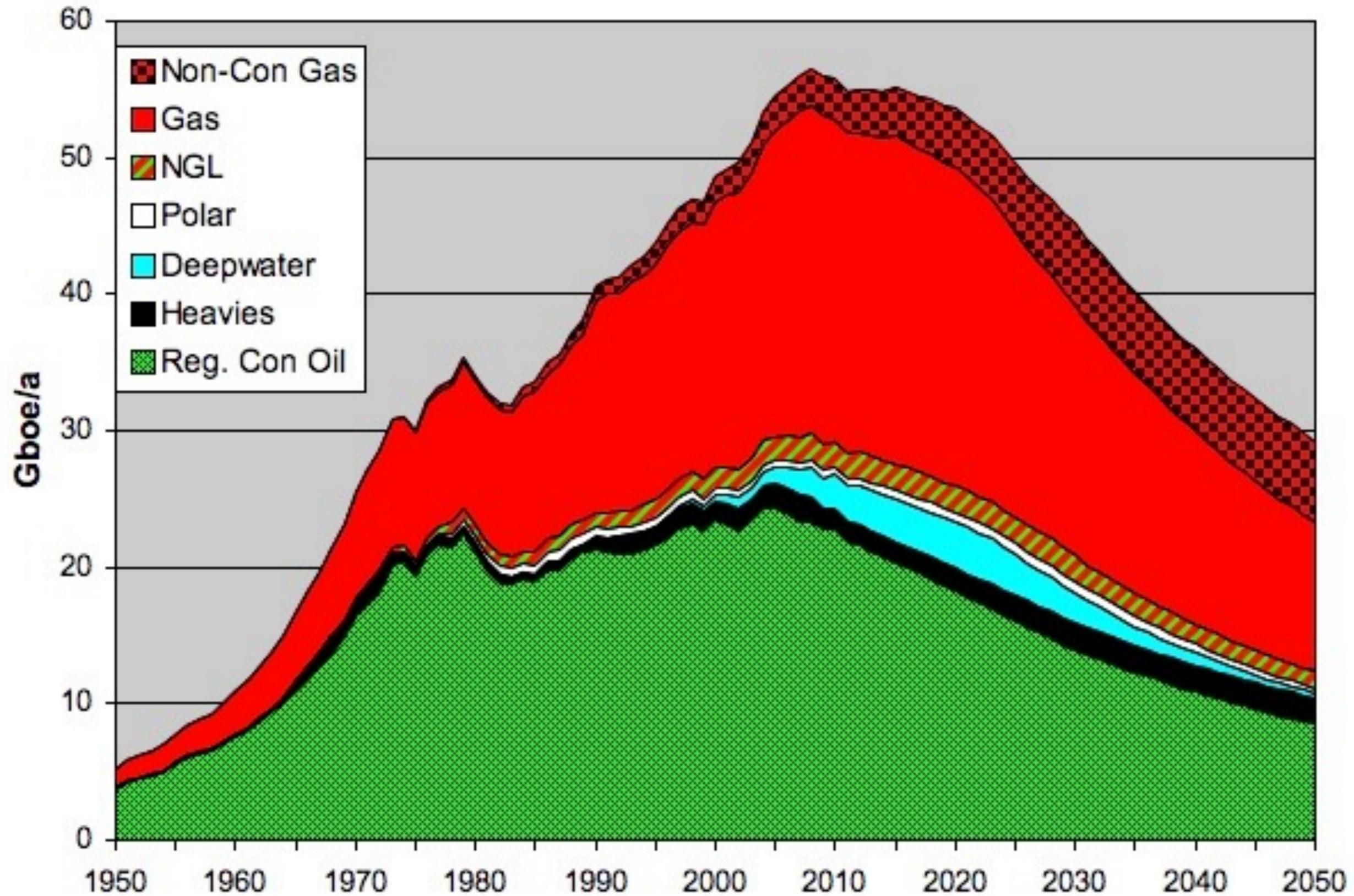
**Au contraire, Bill, it's *fossil fuels* that are "agotable"**



# Au contraire, Bill, it's *fossil fuels* that are "agotable"

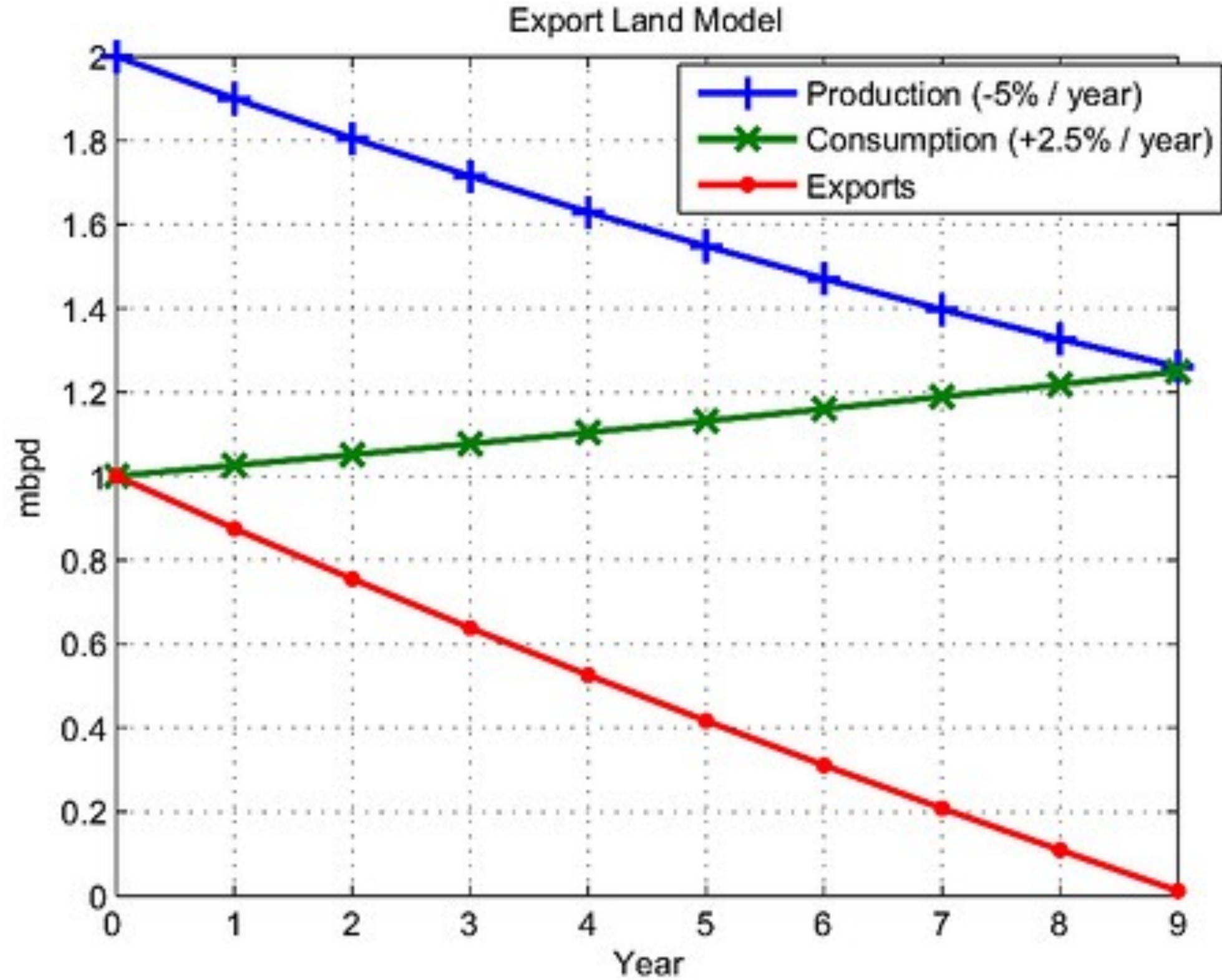


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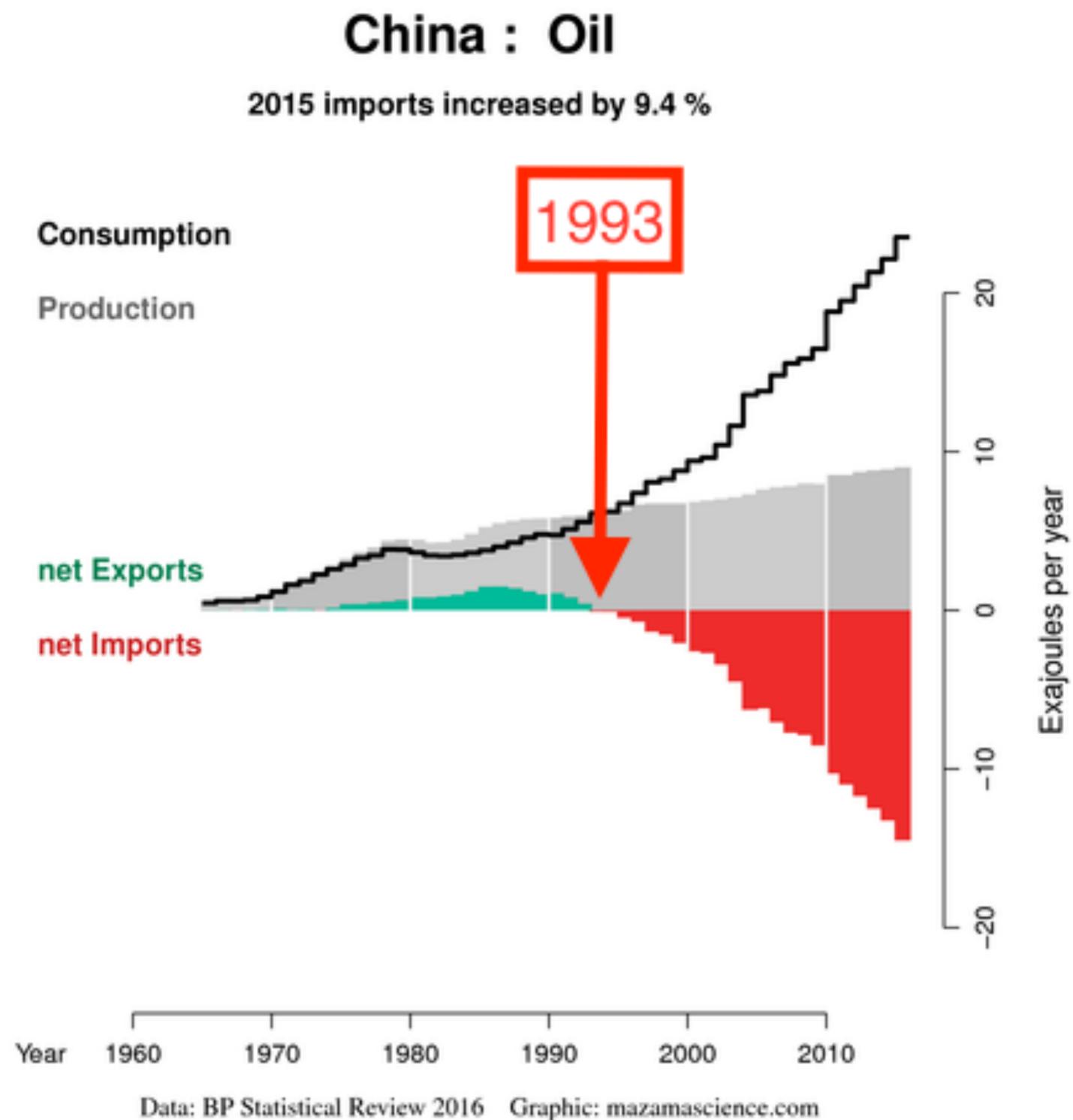


**X2M**

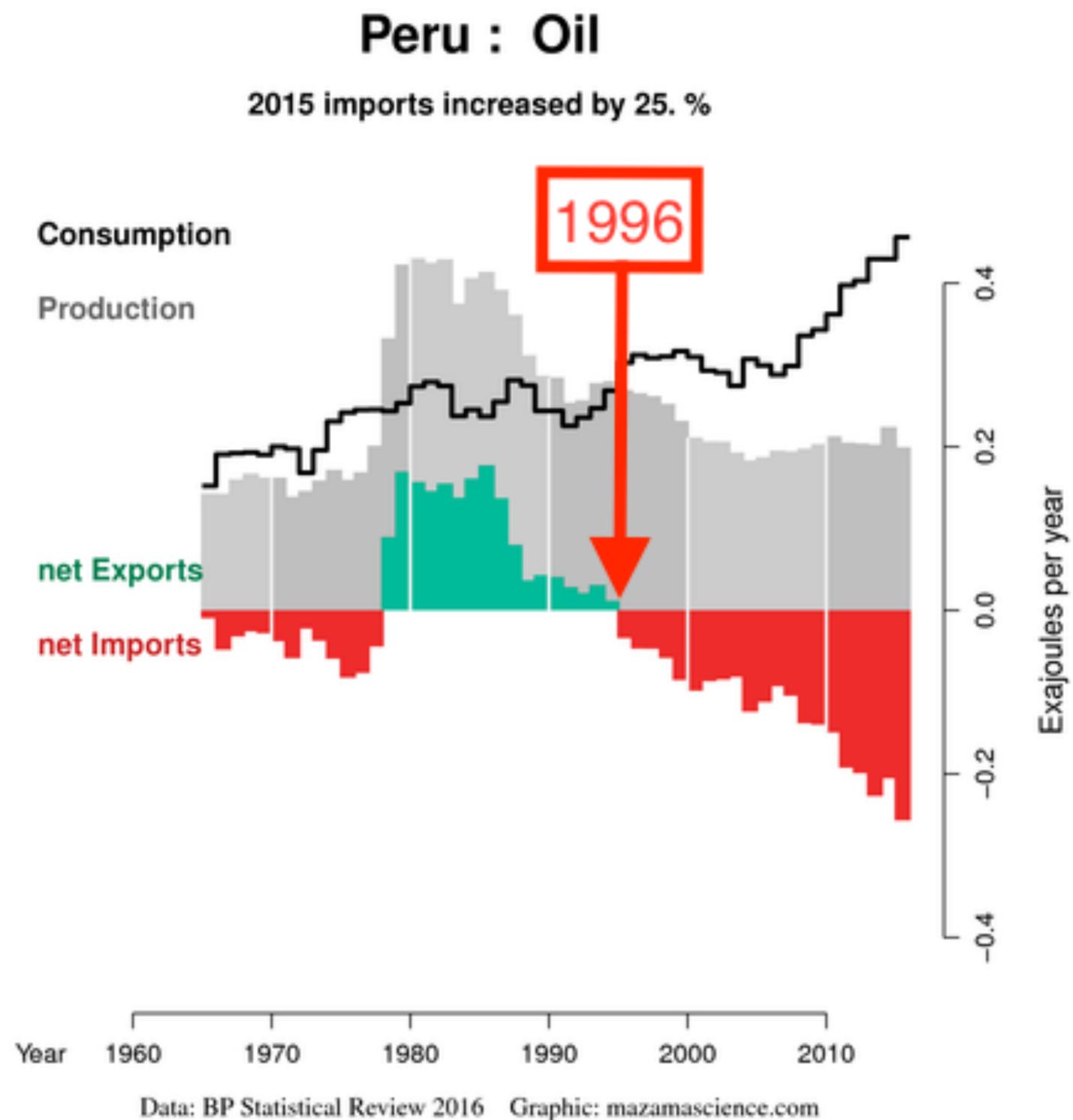
# It gets more interesting for oil exporting countries



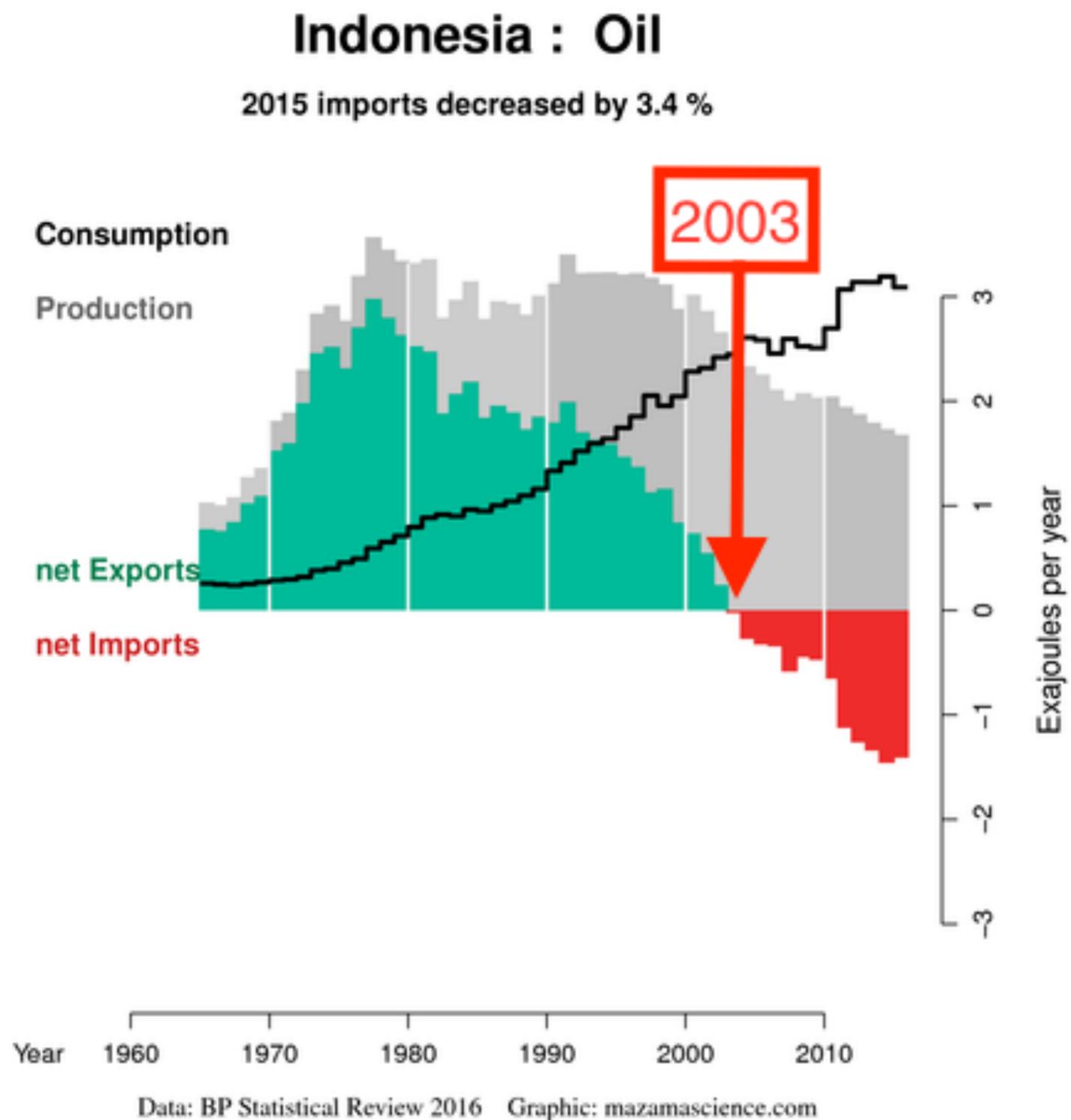
# The X2M Club has many distinguished members



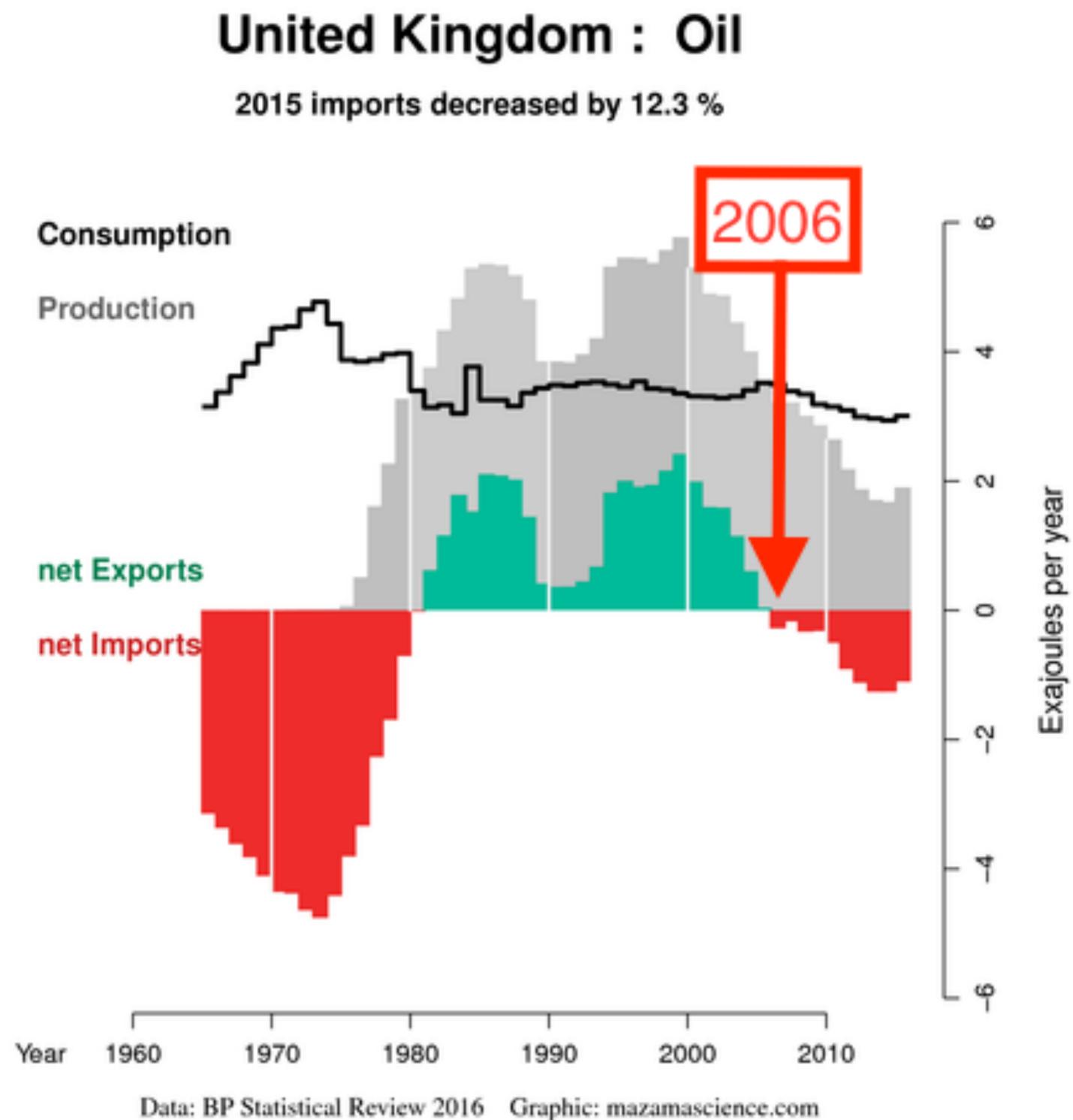
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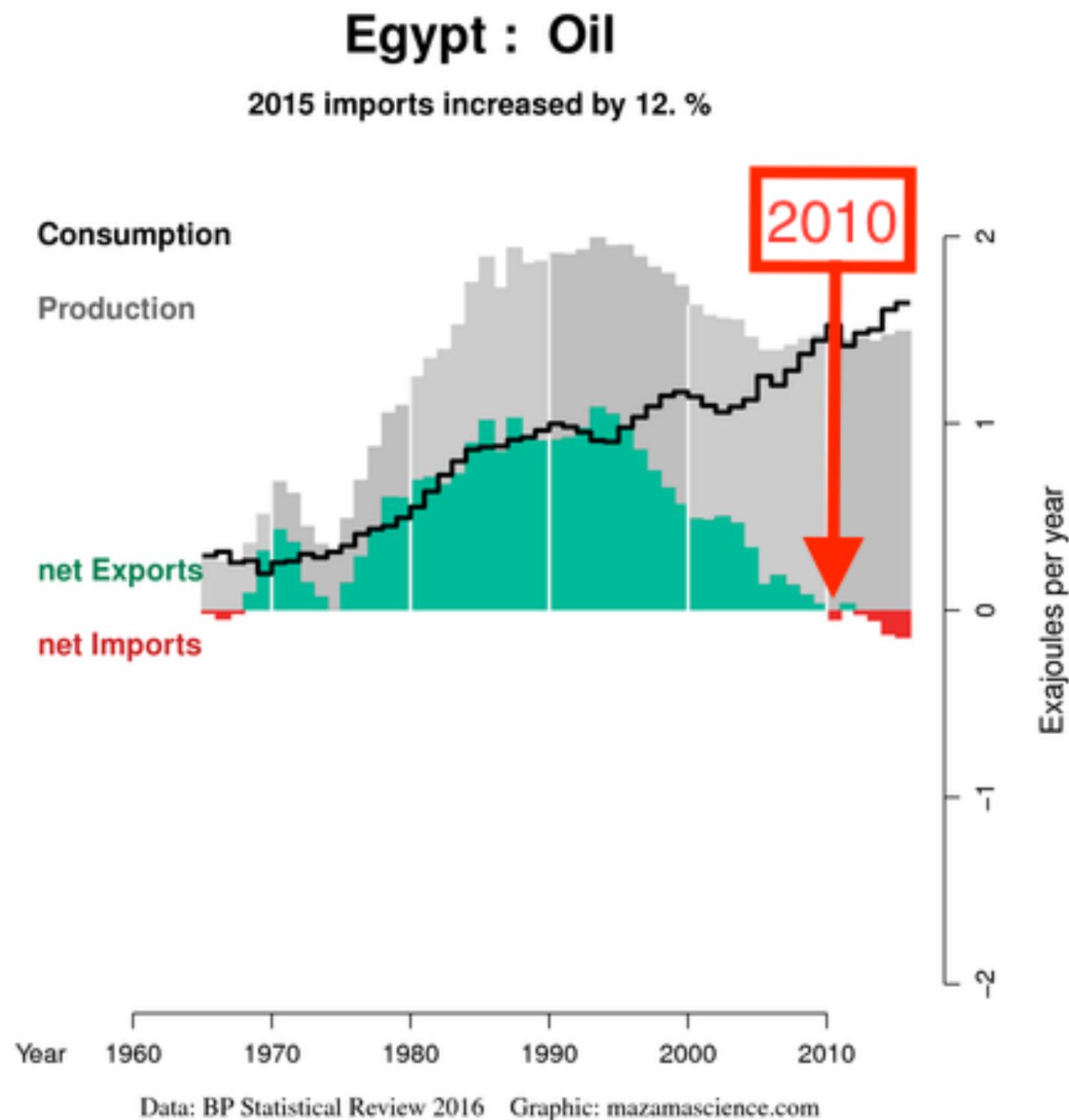
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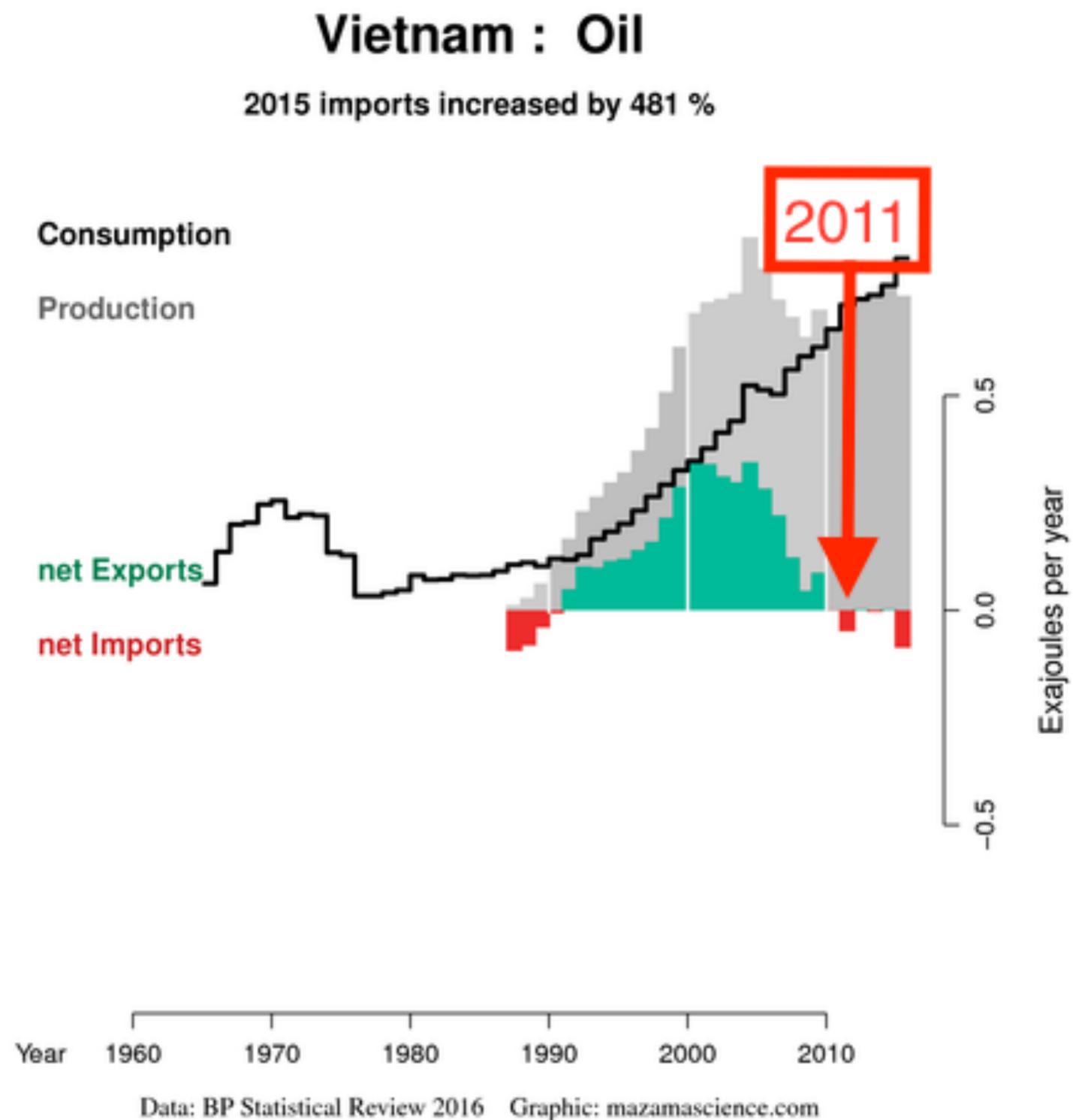
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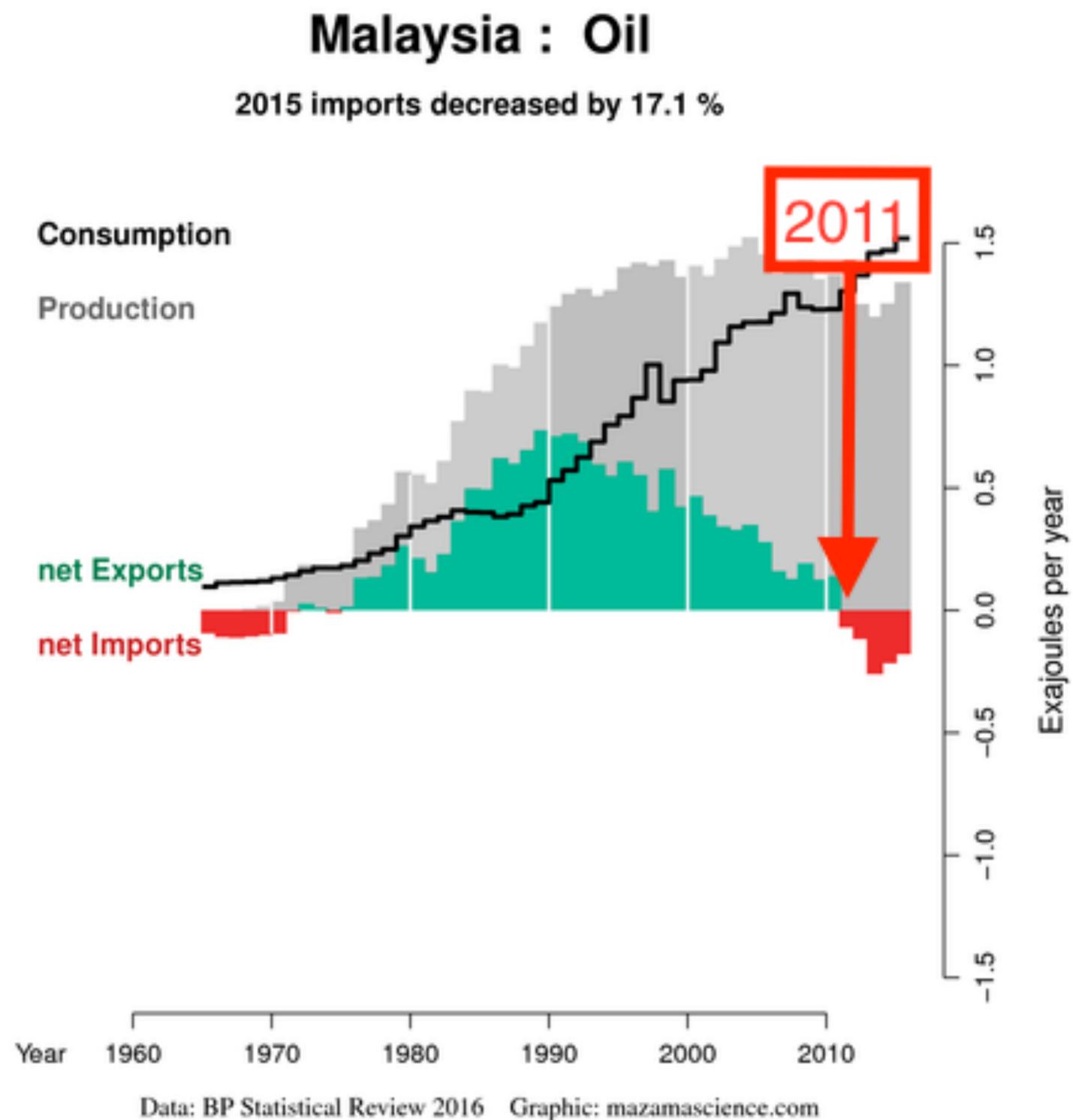
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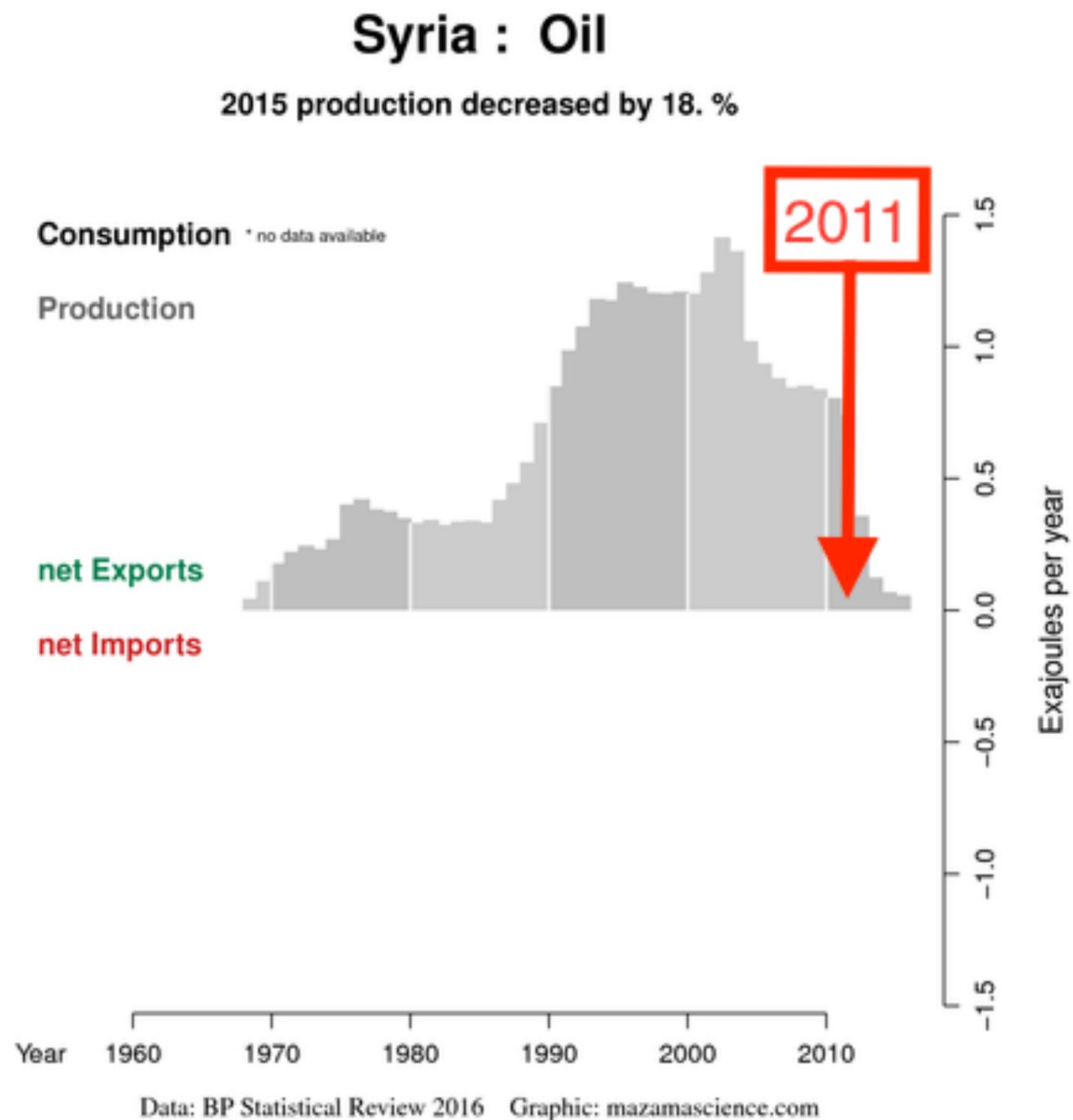
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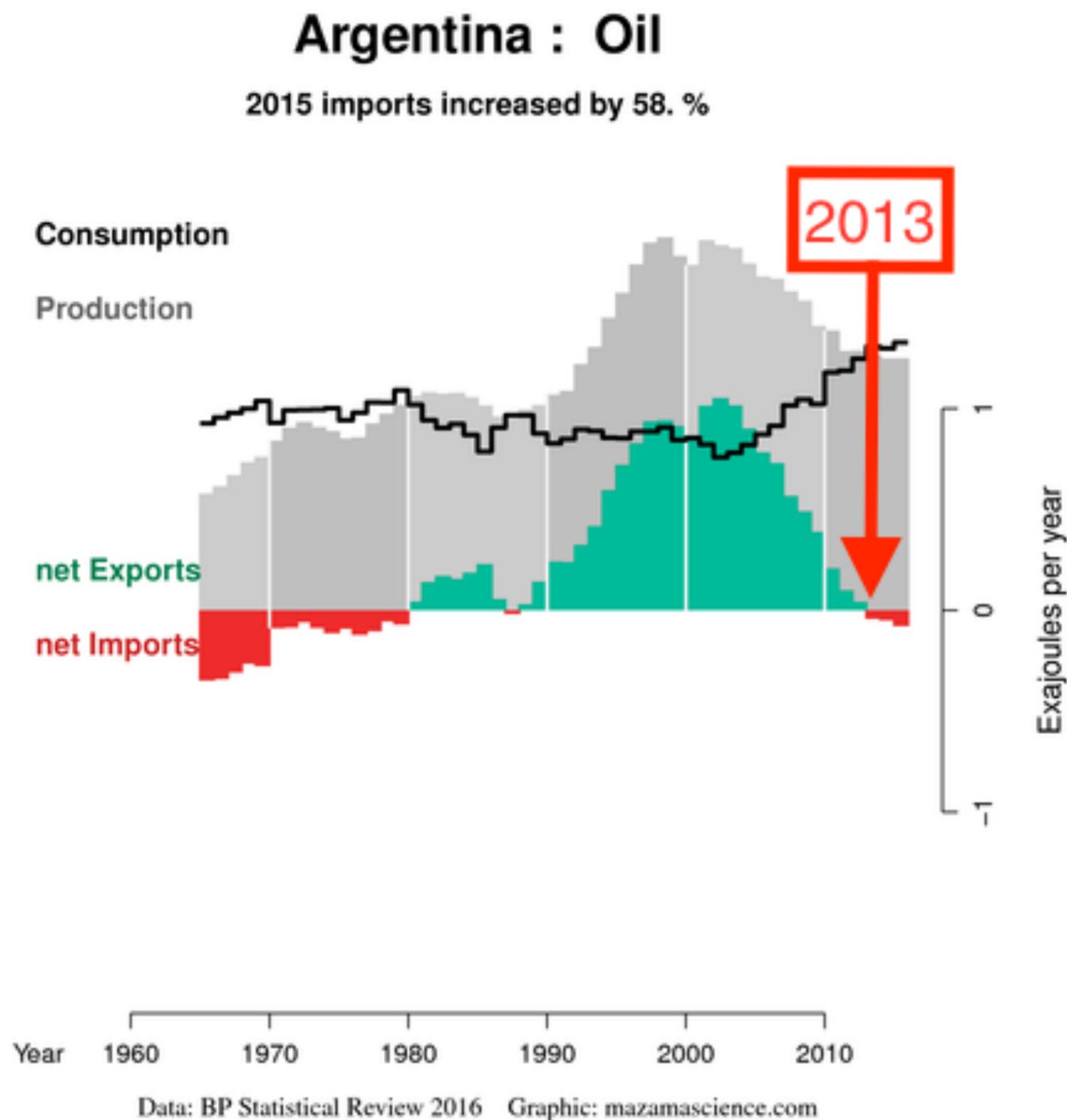
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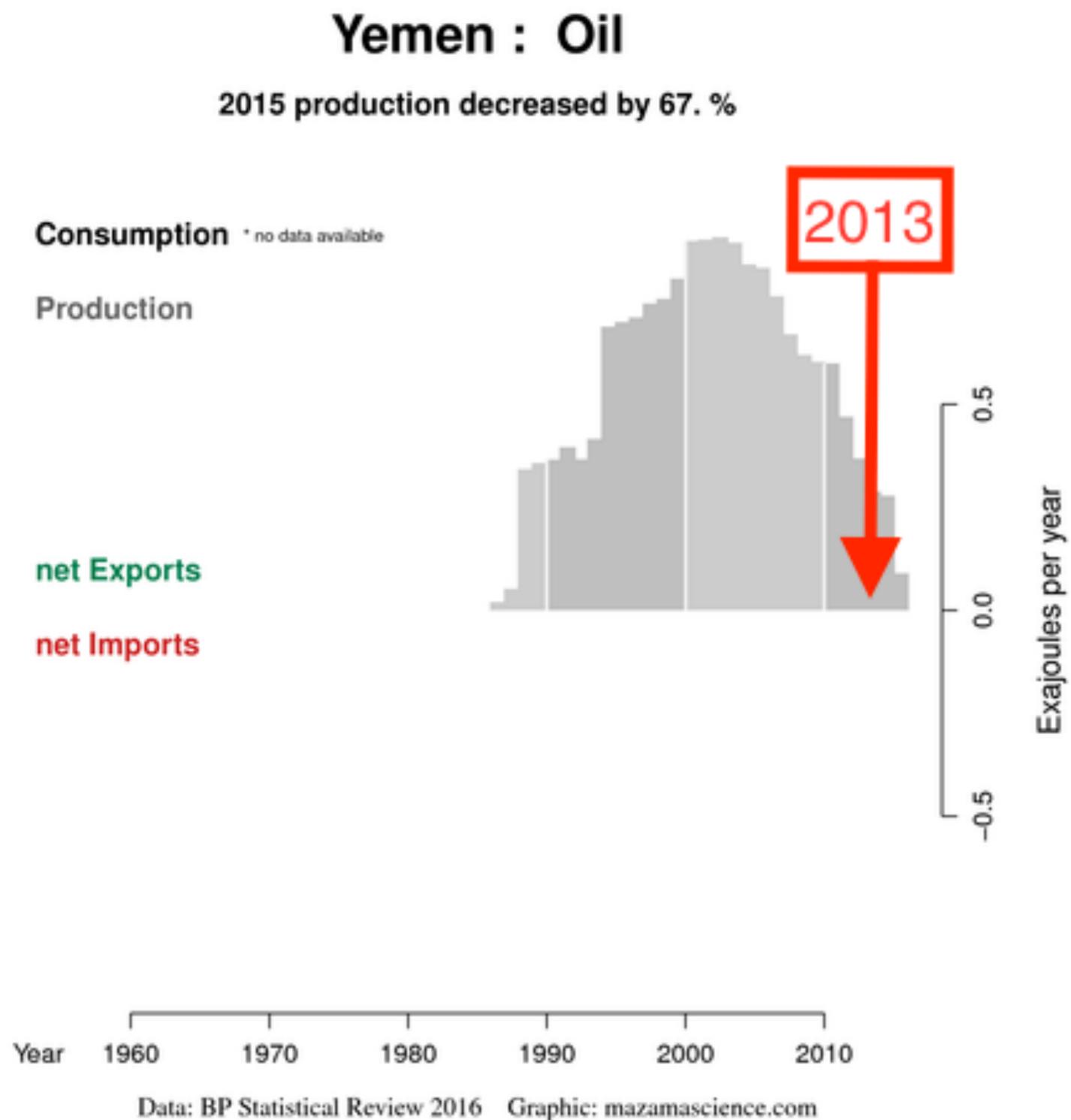
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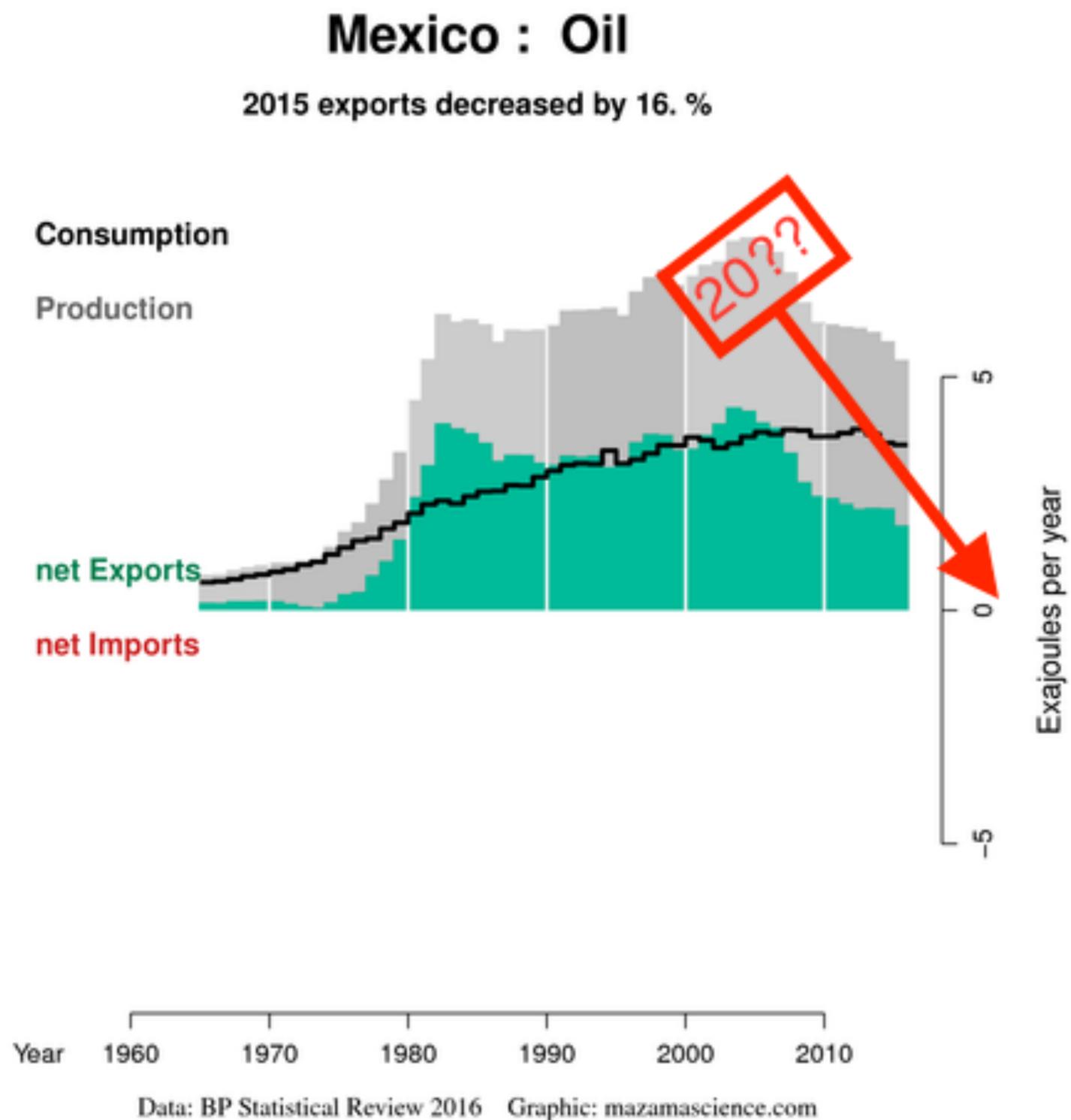
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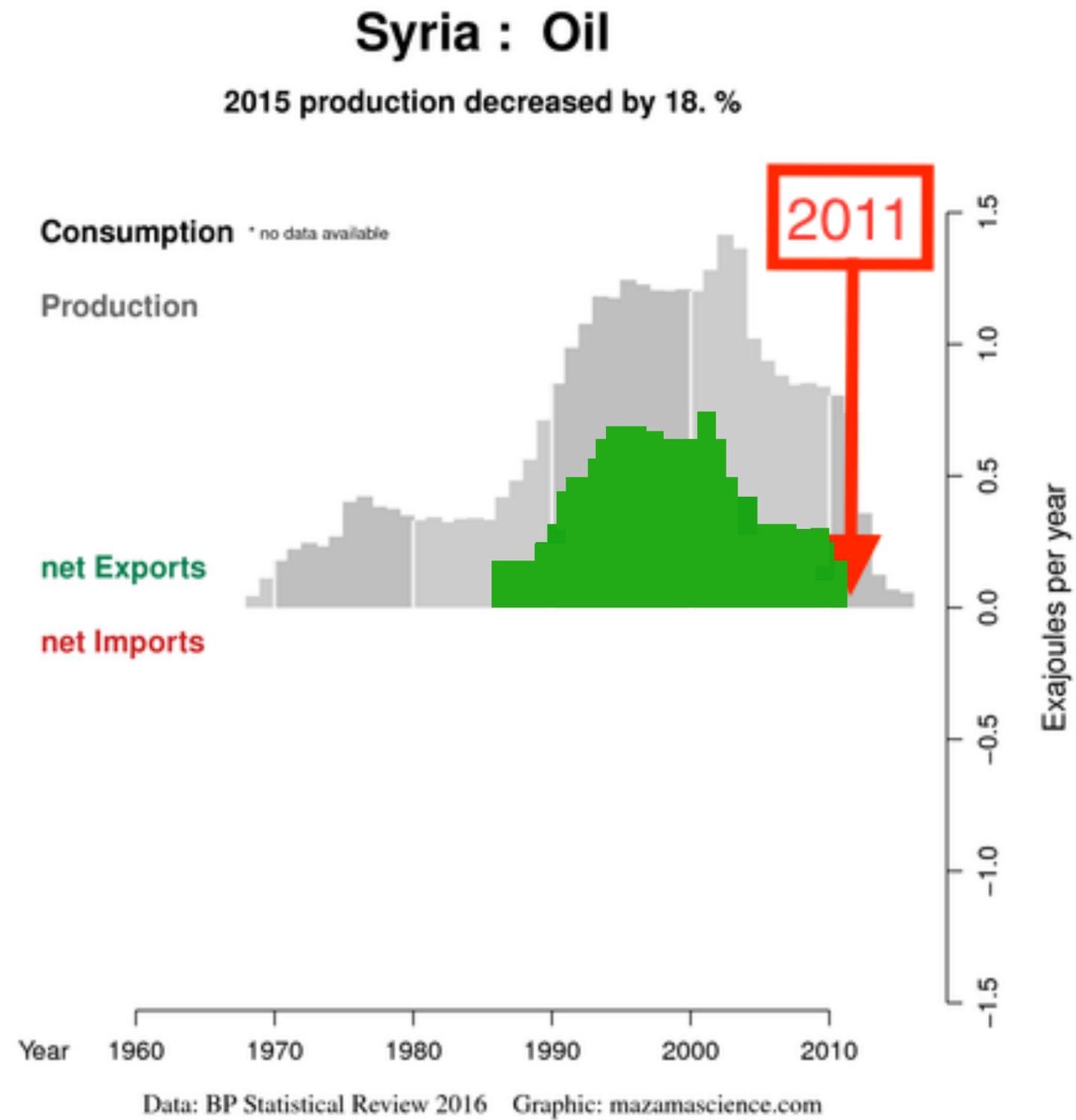
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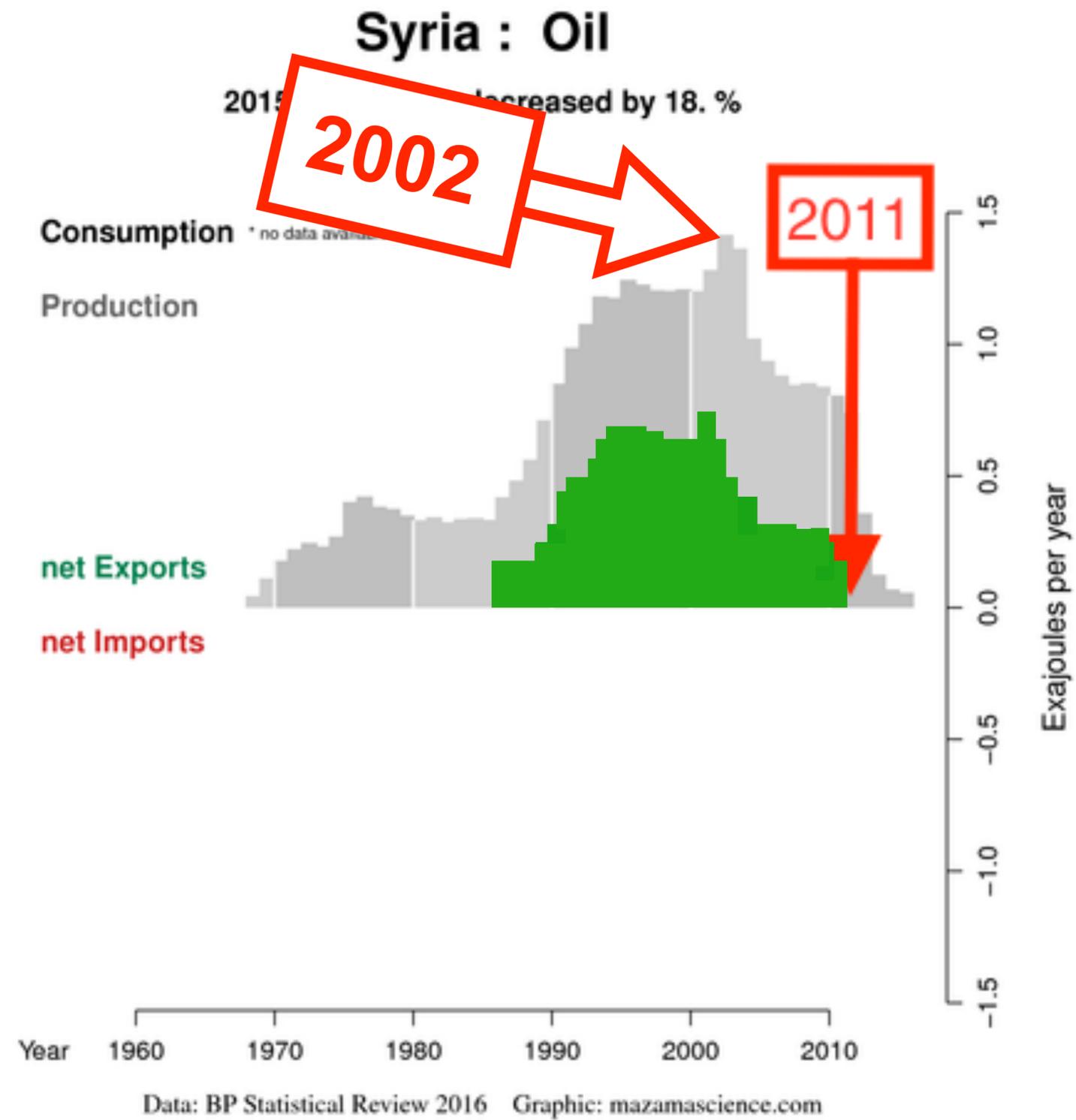
**One country after another is using up its seed corn**



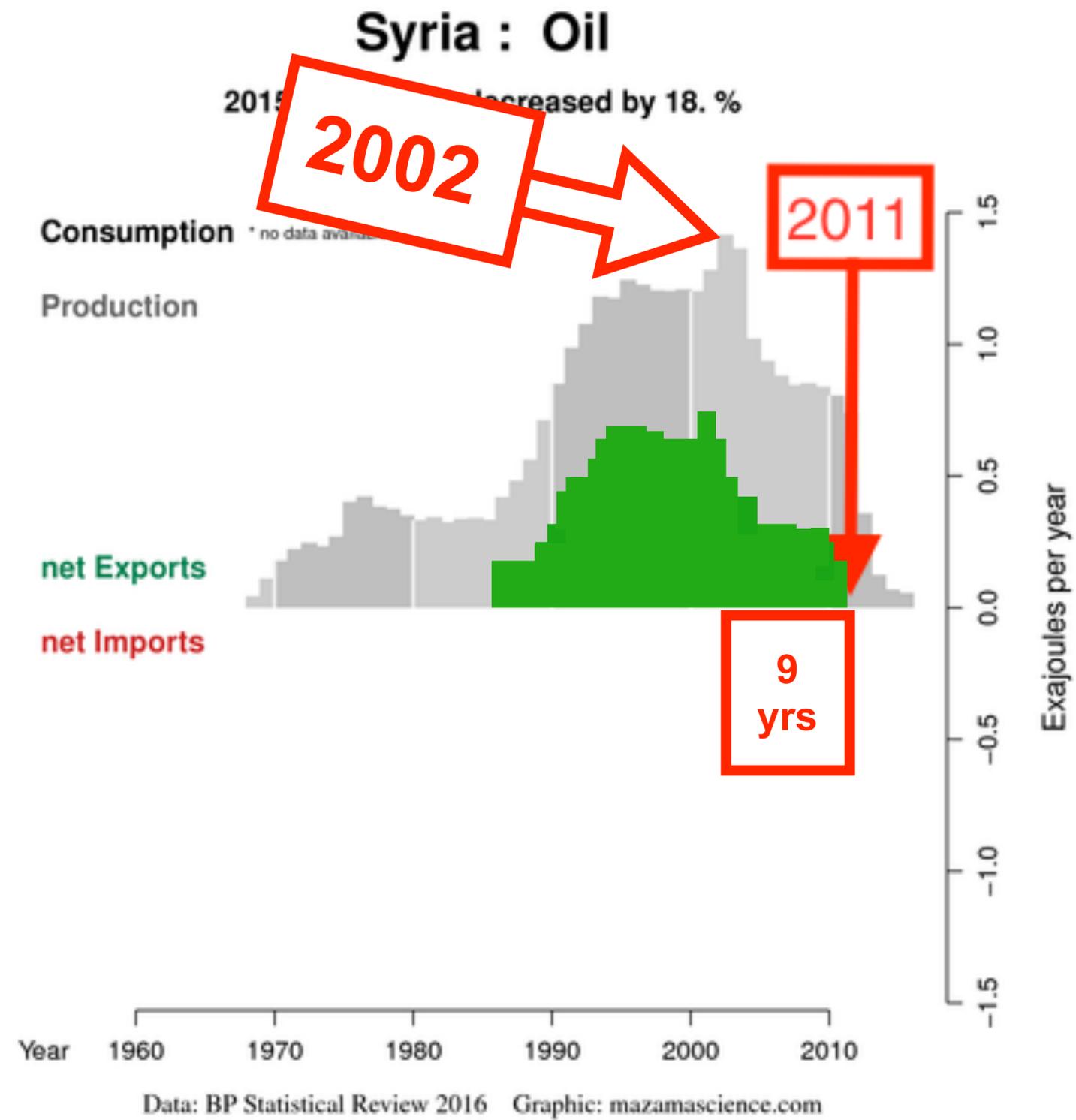
# Back up a minute and reconsider this X2M country



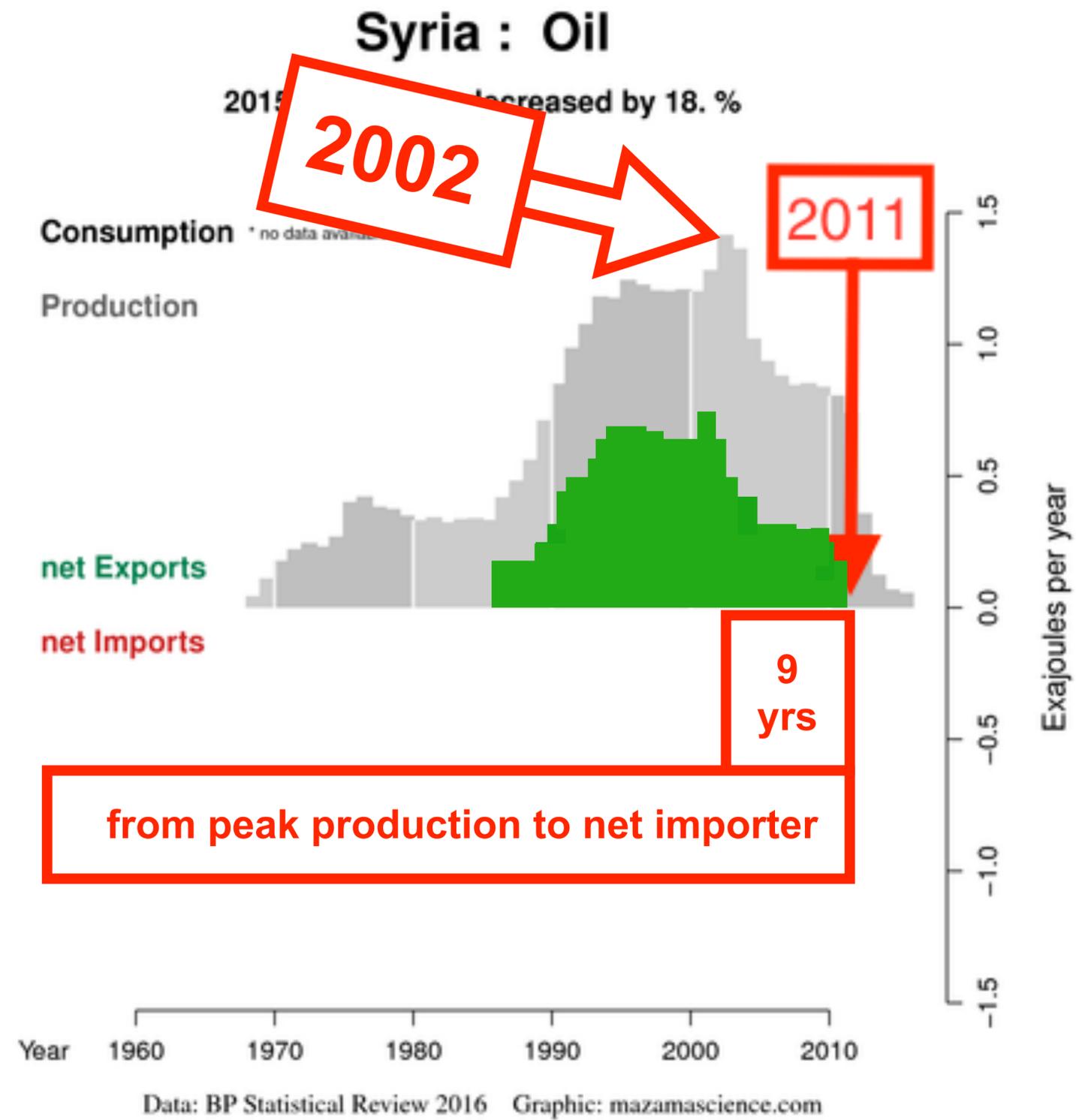
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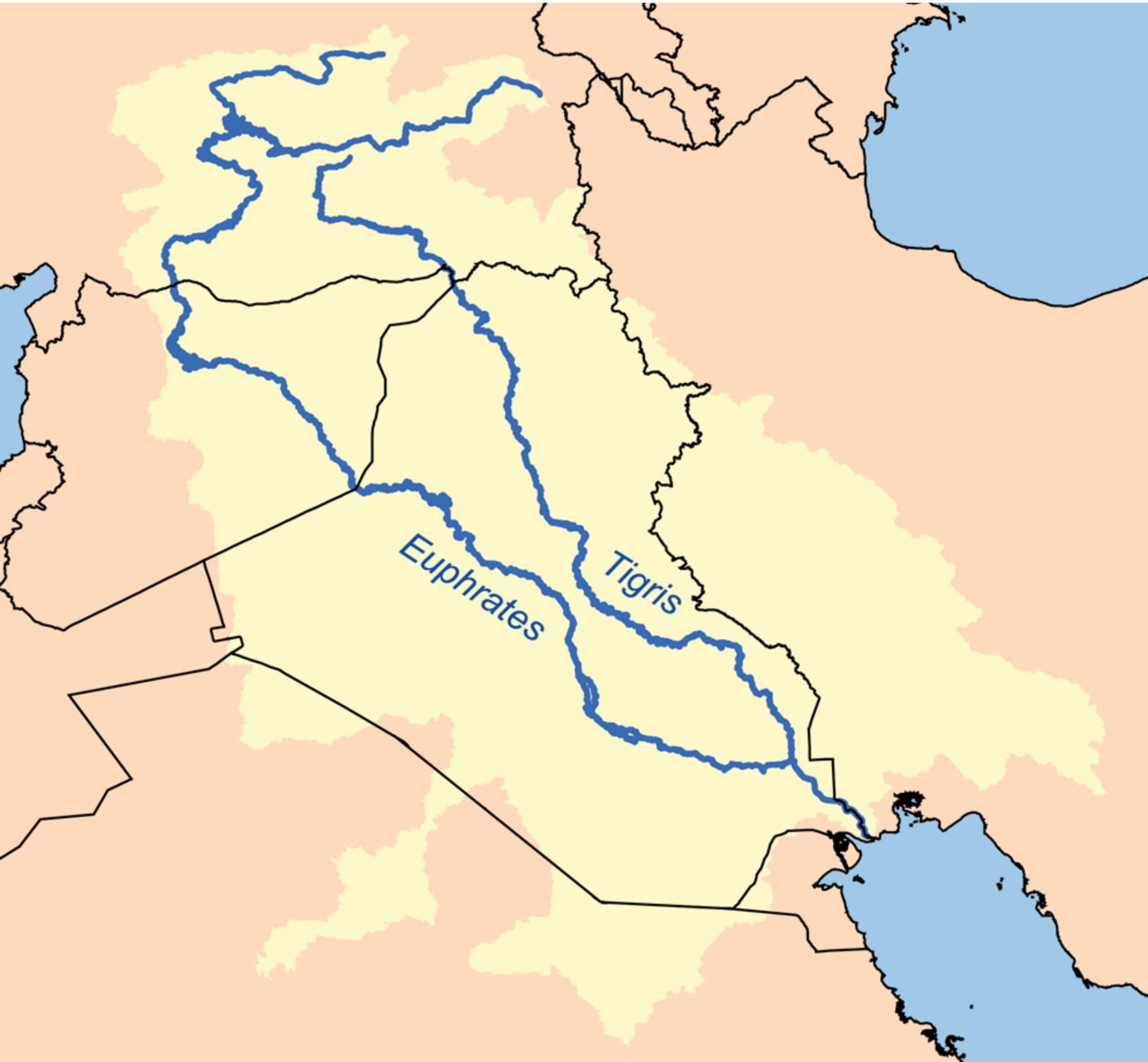
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# Back up a minute and reconsider this X2M country



# The Tigris-Euphrates basin crosses several borders



# ... and Syrian farms are impacted by dams upstream

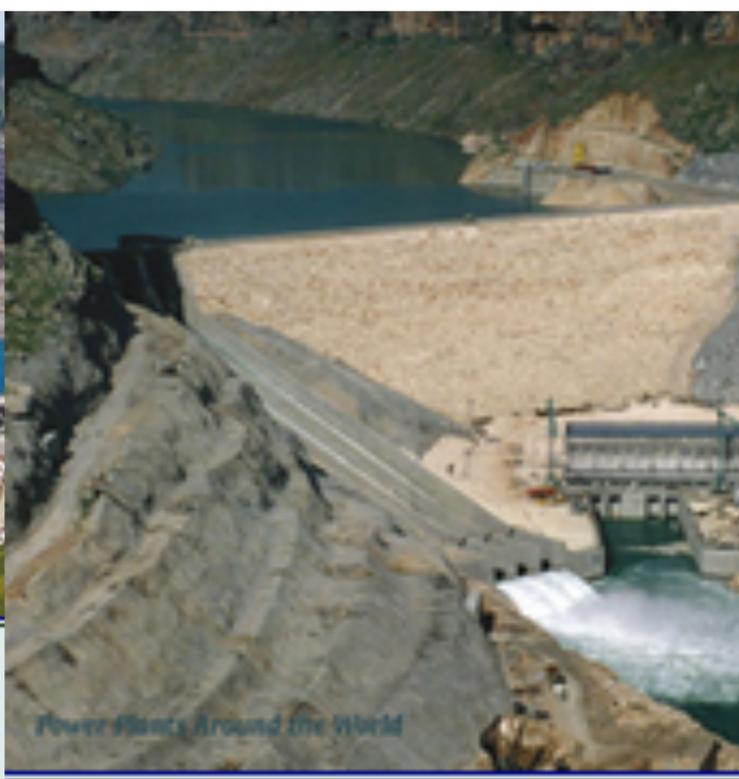




# ... and Syrian farms are impacted by dams upstream



# ... and Syrian farms are impacted by dams upstream



**Ataturk**

Location: Sanliurfa  
 Operator: EUAS  
 Configuration: 8 X 300 MW Francis  
 Operation: 1992-1993  
 T/G supplier: SZEW, ABB  
 EPC: Dolsar, ATA Insaat

Quick facts: Ataturk Dam is the largest in a series of 22 dams and 19 hydroelectric plants built on the Euphrates and Tigris rivers as part of the massive irrigation and hydroelectricity scheme. The dam is one of the world's largest earth-and-rock dams measuring 184m high and 1,820m long.

Photograph courtesy of Palet Insaat  
 Re-posted 1 Dec 2010

**Dicle**

Location: Diyarbakir  
 Operator: EUAS  
 Configuration: 2 X 55 MW Francis  
 Operation: 1991-2001  
 T/G supplier: Resita, Temelsu  
 EPC: Romenergo, Kiska

Quick facts: The 87m multipurpose dam is located 50km north of Diyarbakir city where the Dicle and Dabni rivers join and become the Tigris. The reservoir has an area of 24 km<sup>2</sup> and is part of the GAP project.

Photograph courtesy of Türkiye Mühendislik  
 Posted 9 Dec 2006

**Karakaya**

Location: Diyarbakir  
 Operator: EUAS  
 Configuration: 6 X 300 MW Francis  
 Operation: 1987-1989  
 T/G supplier: Sulzer Escher Wyss, Temelsu  
 EPC: Electrowatt

Photograph copyright by and courtesy of VA  
 Posted 16 Feb 2002

**Karkamis**

Location: Kahramanmaras  
 Operator: EUAS  
 Configuration: 6 X 32 MW Bulb  
 Operation: 1999-2000  
 T/G supplier: Voith, Elin  
 EPC: Temelsu, Yuksel, Verbundplan

Quick facts: Karkamis is the second of the lower Euphrates schemes within the Southeastern Anatolia Project. The clay-cored dam has a crest elevation of 344m and a crest length of 1,647m.

Photograph courtesy of Yuksel Insaat AS  
 Posted 4 Aug 2004

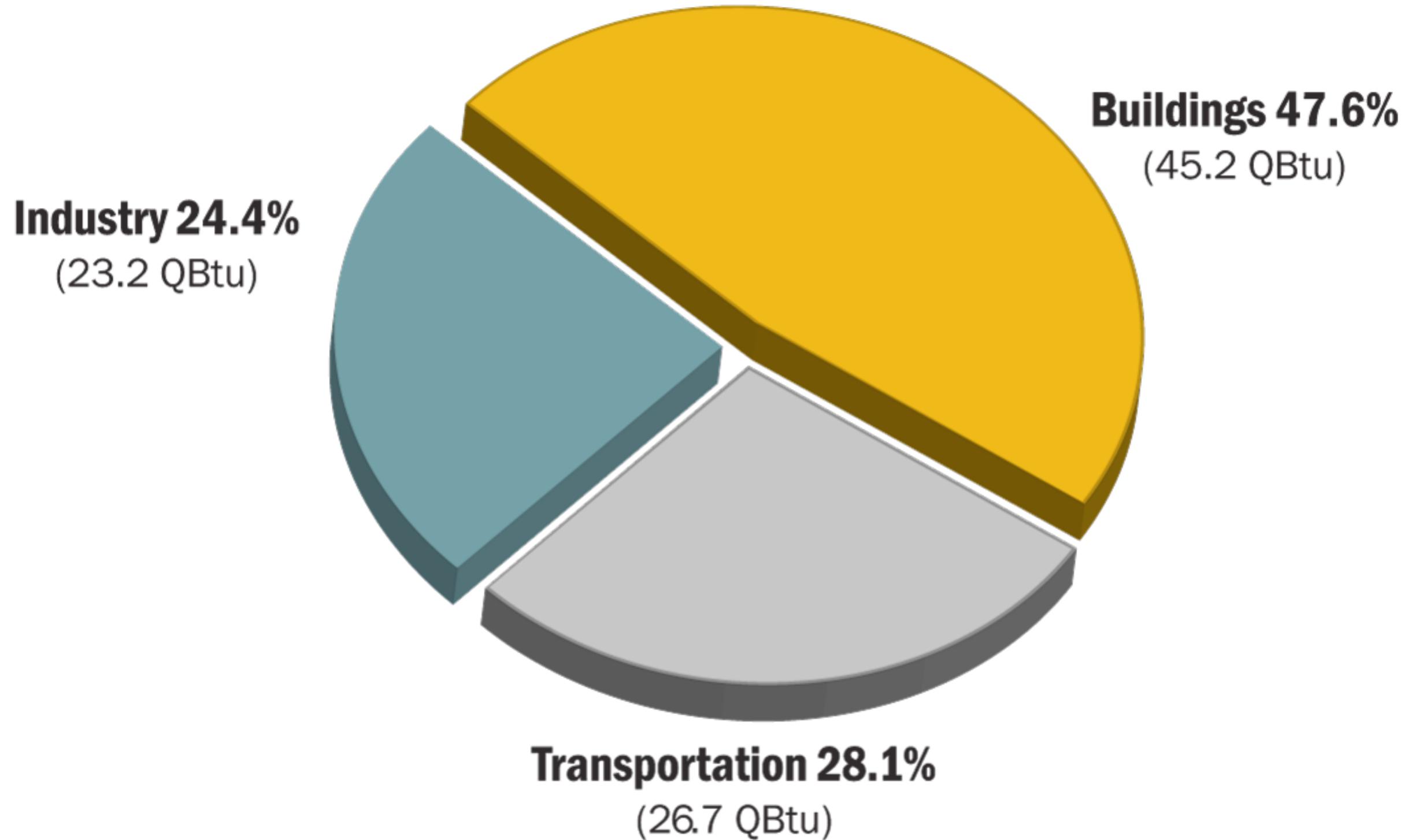
**Those who don't study history are doomed to repeat it**



**Yet those who *do* study history are doomed to stand by helplessly while everyone else repeats it**



# Transport consumes a third of commercial energy



**U.S. Energy Consumption by Sector**

**Our seed corn isn't what it's cracked up to be**



# Our seed corn isn't what it's cracked up to be



## Kellogg's

### Double Standard Breakfast

AMERICA'S

EUROPE'S

GMO CORN

NATURAL CORN

# Our seed corn isn't what it's cracked up to be



We use our cars to travel to these wonderful creations of nature.

**Our seed corn isn't what it's cracked up to be**



**ALBERTA TAR SANDS**

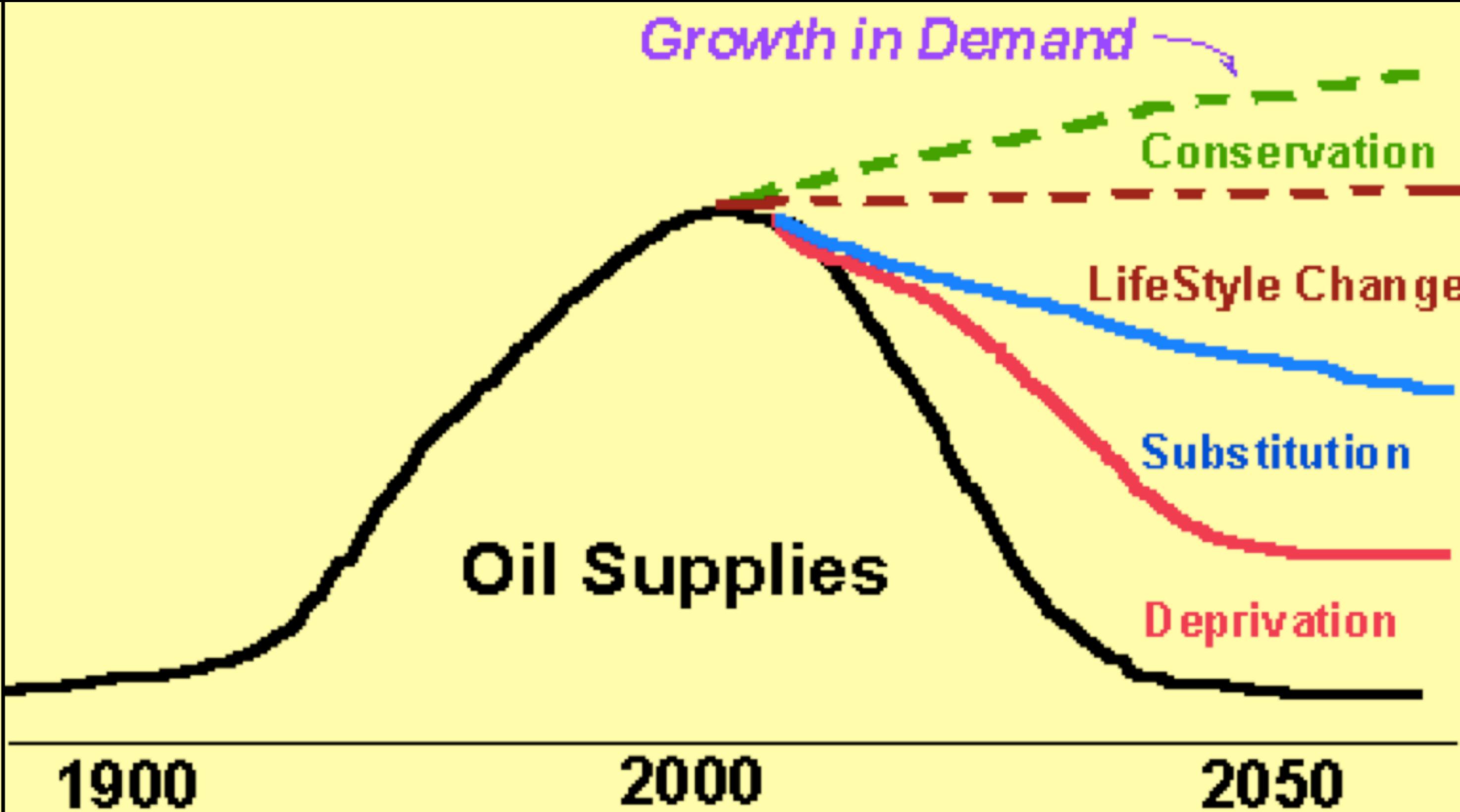
**One option might be the Toyota Cowrolla**



**Or we might consider the all-new Doncar**



# If you're not enthusiastic, consider Swenson's law



**We have two options: *denial* ...**

**We have two options: *denial* ...**



**...or we can employ our technology for mutual well-being**

# ...or we can employ our technology for mutual well-being

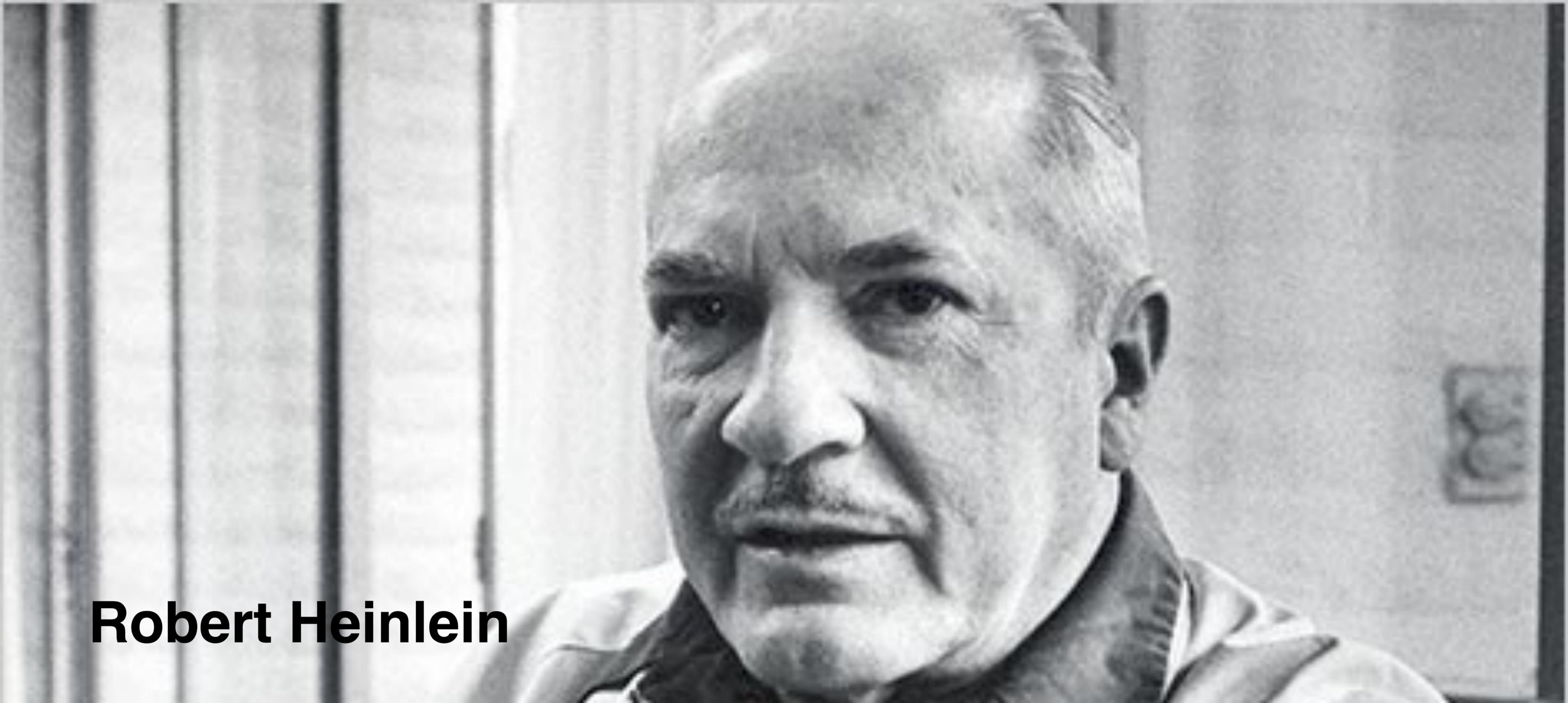


**Yes, but...**

**“Industry is hard to decarbonize”**



**Always listen to experts. They'll tell you what can't be done and why. *Then do it.***



**Robert Heinlein**

# One industry is doing something about it

**SSAB**

PRODUCTS ▾

STEEL SELECTOR

SUPPORT

SERVICES

CONTACT US

COMPANY ▾

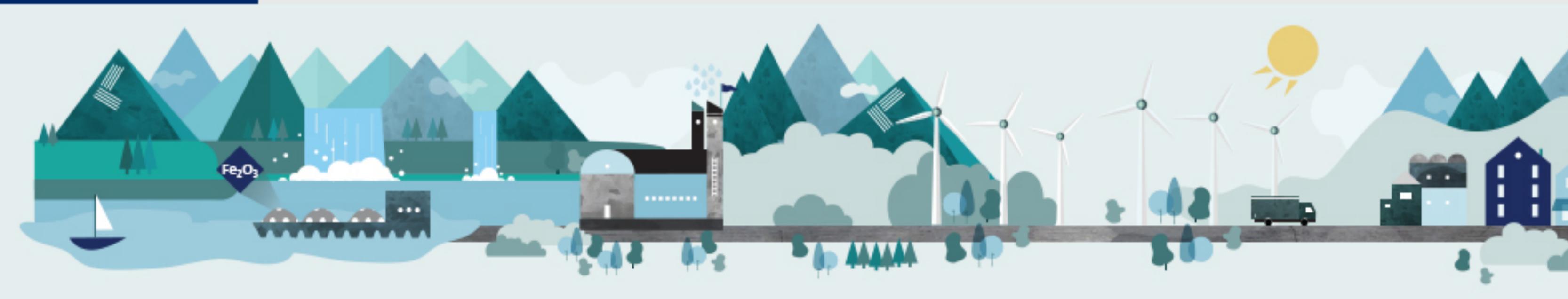
**SUSTAINABILITY**

SSAB AND SUSTAINABILITY

SUSTAINABLE OFFERING

SUSTAINABLE OPERATIONS

RESPONSIBLE PARTNER



## Carbon-dioxide-free steel industry

SSAB, LKAB and Vattenfall are launching an initiative to solve the carbon dioxide problem in the Swedish steel industry. Together, the companies involved will initiate work to develop a steel production process that emits water rather than carbon dioxide.

# One industry is doing something about it



SERVICES

CONTACT US

COMPANY ▾

OFFERING

SUSTAINABLE OPERATIONS

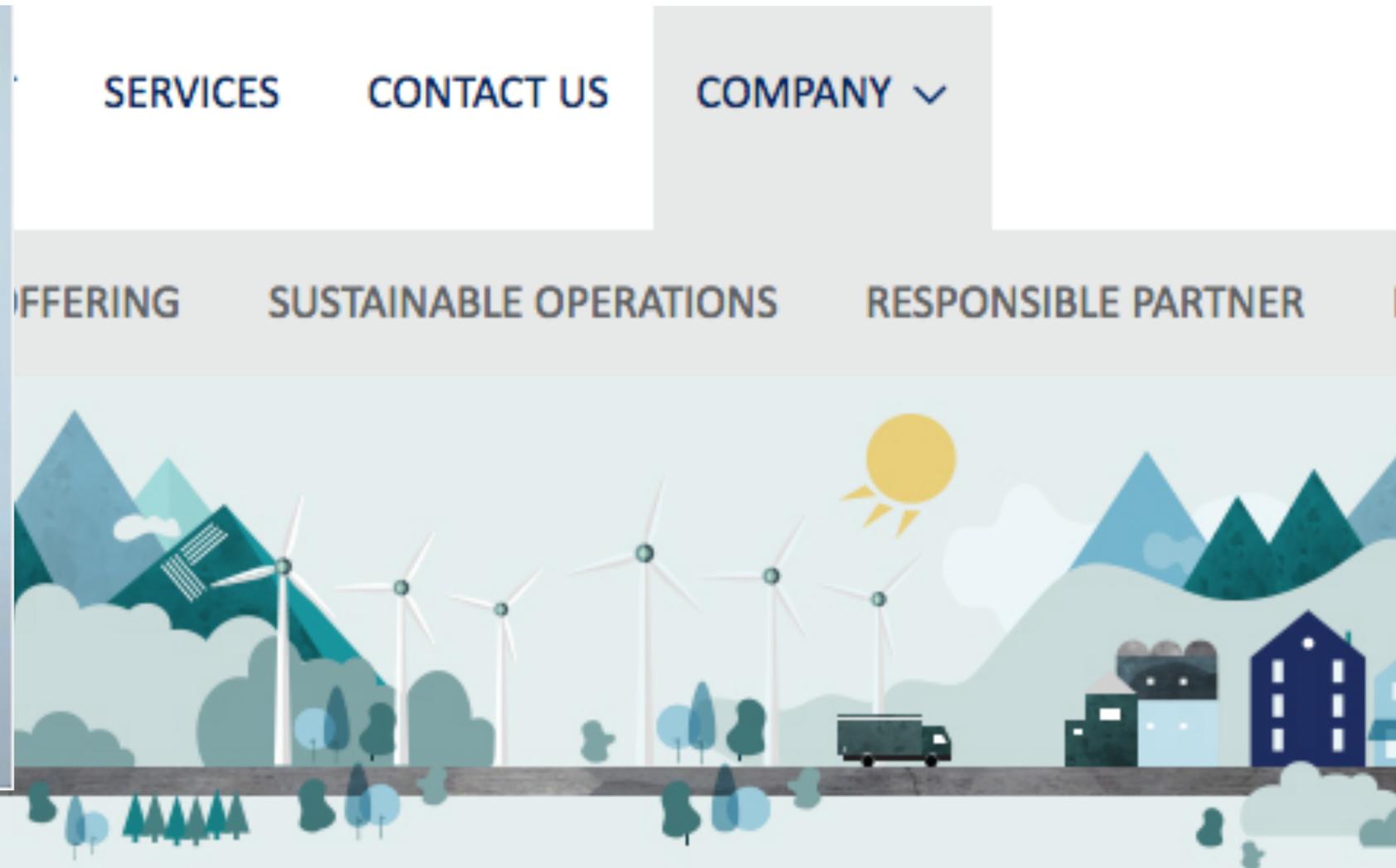
RESPONSIBLE PARTNER



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# One industry is doing something about it



## l industry

ive the carbon dioxide problem in the  
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# One industry is doing something about it



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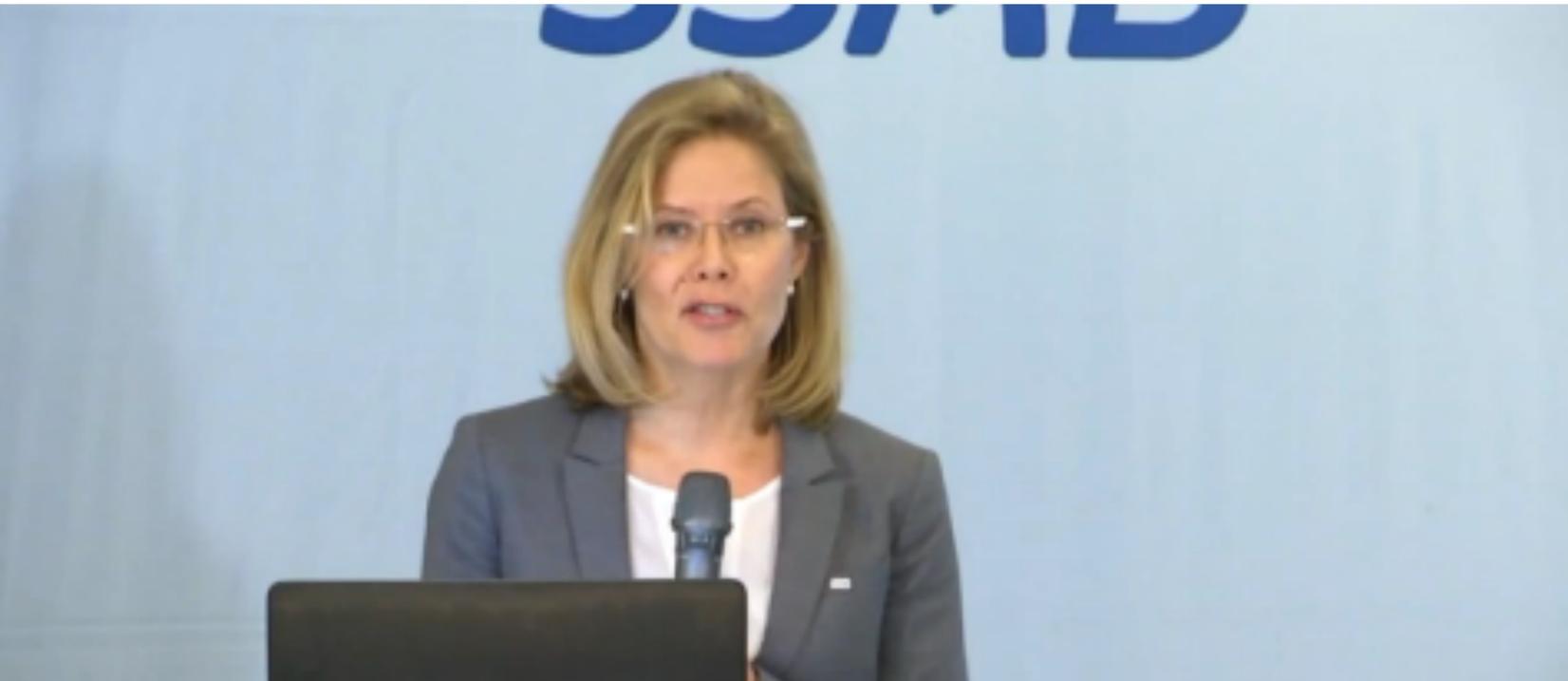
# One industry is doing something about it



## l industry

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ioxide.

# One industry is doing something about it



# One industry is doing something about it



**“Renewables  
not nuclear”**

# Wake up!!!

*We are here*



**Oil**



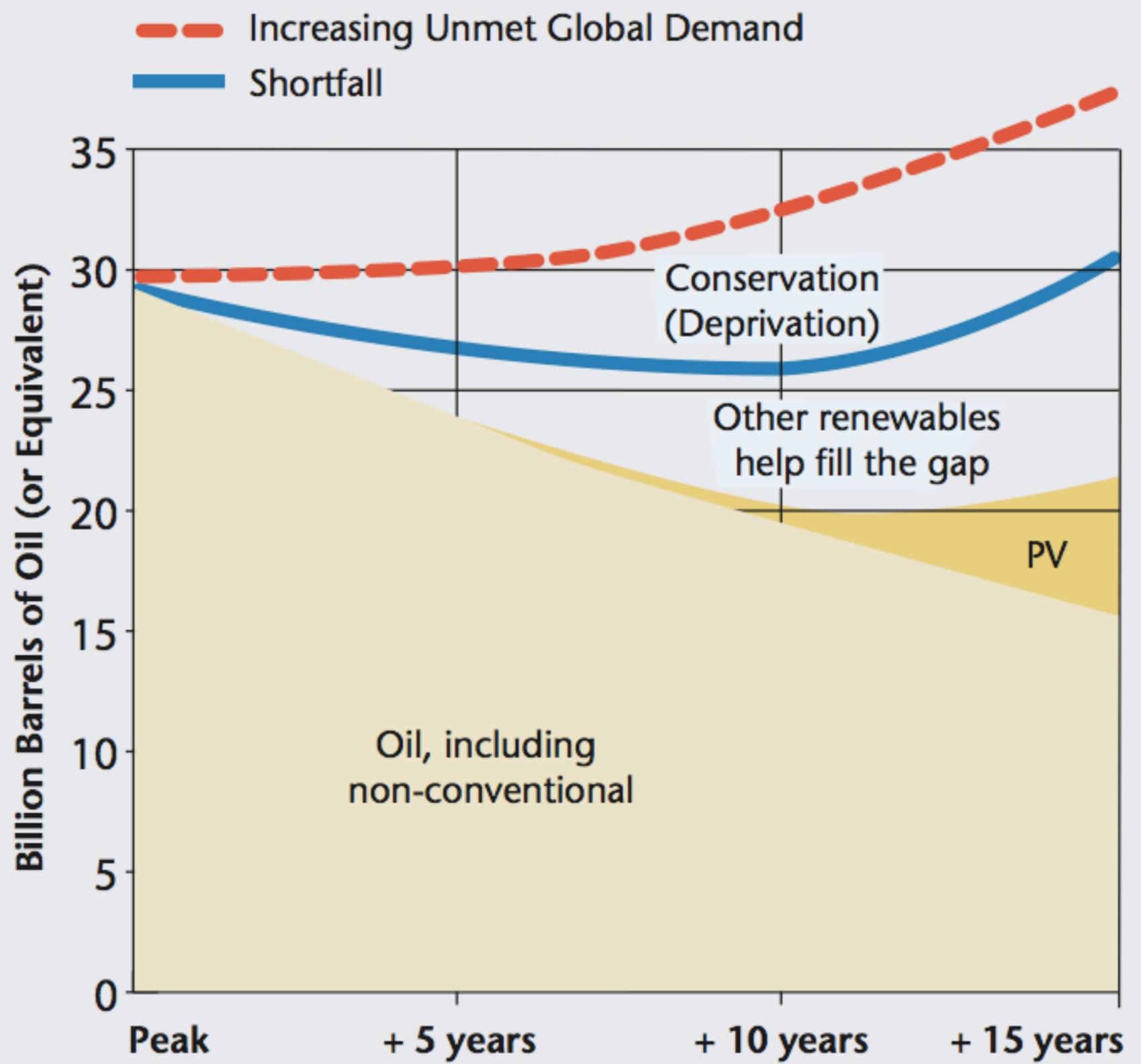
**1900**

**2000**

**2100**

# ...to the power of Solar

# I did some math to confirm that it makes sense



# Now others have taken it further

**50** TECHNOLOGY LEADERS: THE SCIAM 50  
Trends Shaping Tomorrow's Computers, Medicine, Materials and More

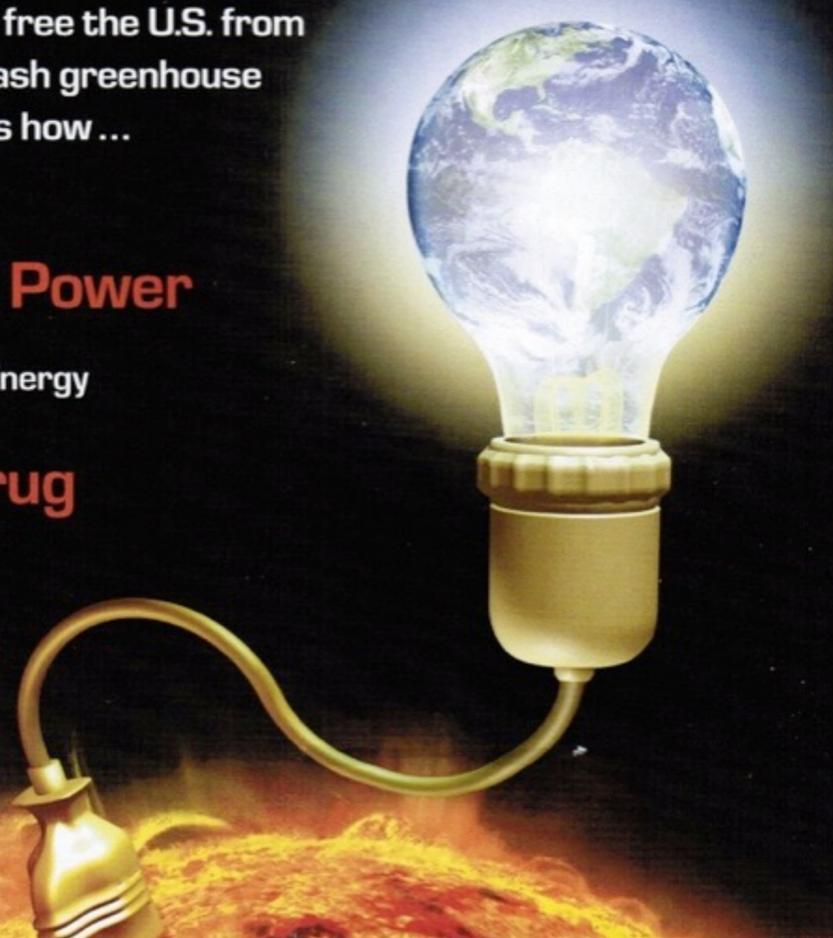
# SCIENTIFIC AMERICAN

New Concerns about **FLUORIDE**  
page 74

January 2008 \$4.99 www.SciAm.com

## A GRAND PLAN FOR SOLAR ENERGY

By 2050 it could free the U.S. from foreign oil and slash greenhouse emissions. Here's how ...



**Nanotech Power**  
Tiny Devices  
Reclaim Wasted Energy

**Cancer Drug Paradox**  
It Kills Tumors by Repairing Them

**Sing Out!**  
The Physics of the Voice



# Battle of the Grids

Report 2011

How Europe can go 100 % renewable and phase out dirty energy

RETHINKING "HOBBITS"  
What They Mean for Human Evolution

THE EVERYTHING TV  
Get Ready for the Wide-Screen Web

# SCIENTIFIC AMERICAN

November 2009 www.ScientificAmerican.com

The Long-Lost Siblings of **OUR SUN**  
page 40



## A Plan for a Sustainable Future

How to get all energy from wind, water and solar power by 2030

**Chronic Pain**  
What Goes Wrong

**Plus:**

- The Future of Cars
- Farms in Skyscrapers



0 74470 38529 5 11 >

\$5.99



Now we're just arguing about how much it will cost

**Bloomberg** ▼

# The \$8 Trillion Fight Over How to Rid America of Fossil Fuel

Economists agree it can be done, but differ on how much it will cost.

# Podcars would be a natural solution to this dilemma if the technology could be taken to scale



## Morgantown 1975

- 73 vehicles
- 15.5' L x 8.75' H x 6.7' W
- 8,760 pounds
- 52 kW motor
- 30 miles per hour
- 5 off-line stations

# Podcars would be a natural solution to this dilemma if the technology could be taken to scale



Masdar 2010



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Heathrow 2011

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Heathrow 2011



Suncheon Bay 2014



Cuernavaca ~2015~

# Podcars would be a natural solution to this dilemma if the technology could be taken to scale



**But podcars have experienced great challenges in overcoming the barriers against innovation**



Suncheon Bay 2014

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- 8,760 pounds
- 52 kW motor
- 30 miles per hour
- 5 off-line stations



Cuernavaca ~2015~

# Finger-pointing isn't going to work



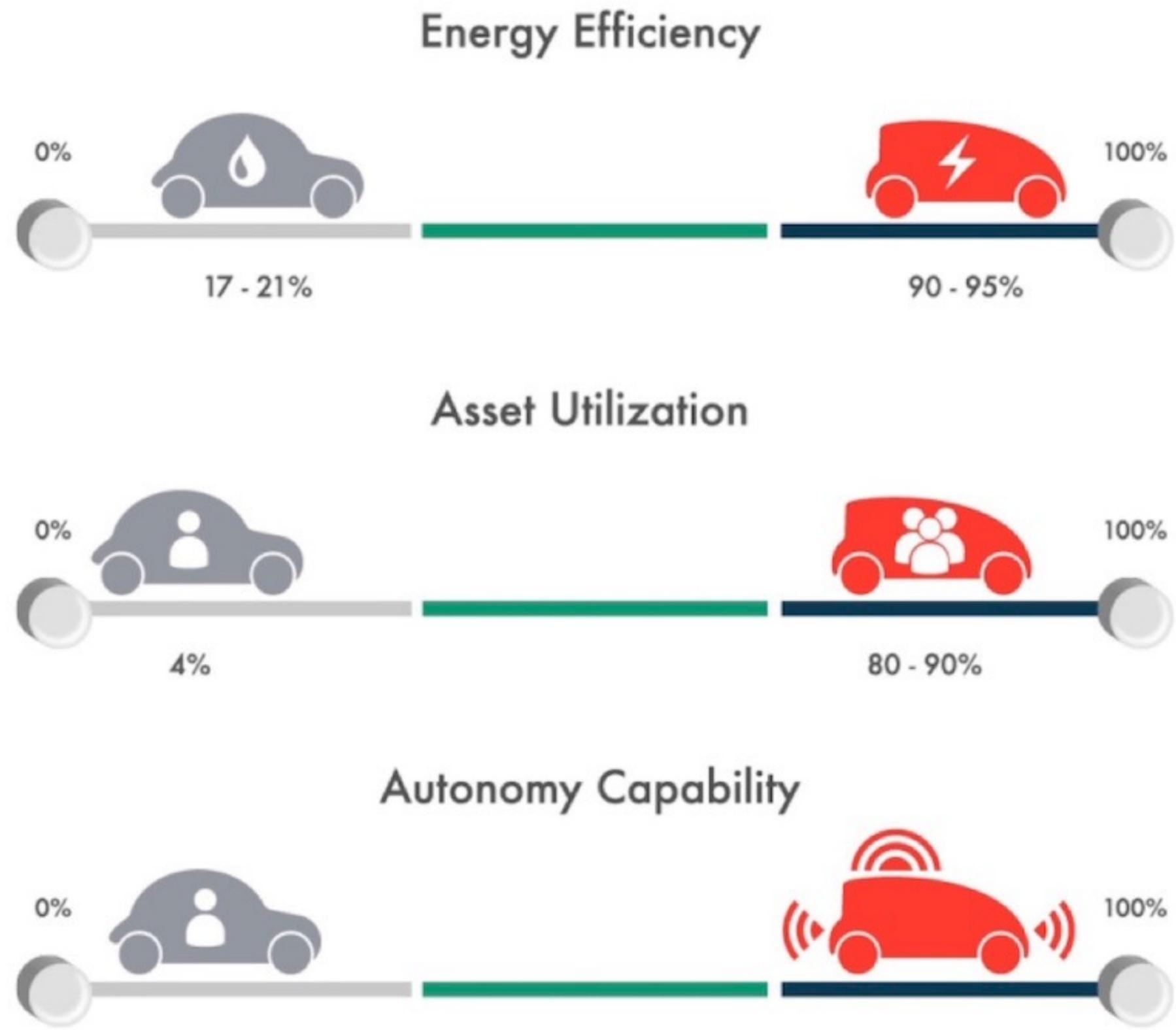
**The best way to predict the future is to invent it**



**Solar energy offers Podcar Cities a powerful tool to mitigate climate change and build a viable future**



# Autonomous vehicles might do the trick



**But what happens when we flip the tables on them?**



**But what happens when we flip the tables on them?**



**But what happens when we flip the tables on them?**



*(oops...)*

**But what happens when we flip the tables on them?**



*ahh, that's better!*

# We make room for people, pets, pedals, and petals!



# **The Solar Skyways Network of Universities**

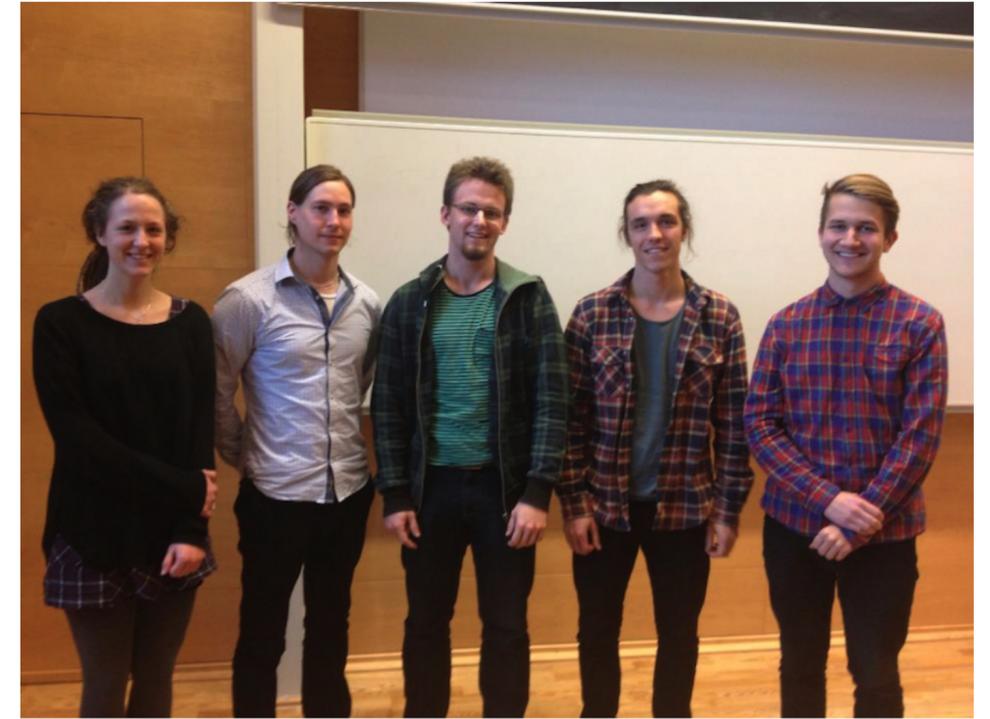
# San José State University has completed 4 years



# Students and interns from Sweden have participated



UPPSALA  
UNIVERSITET



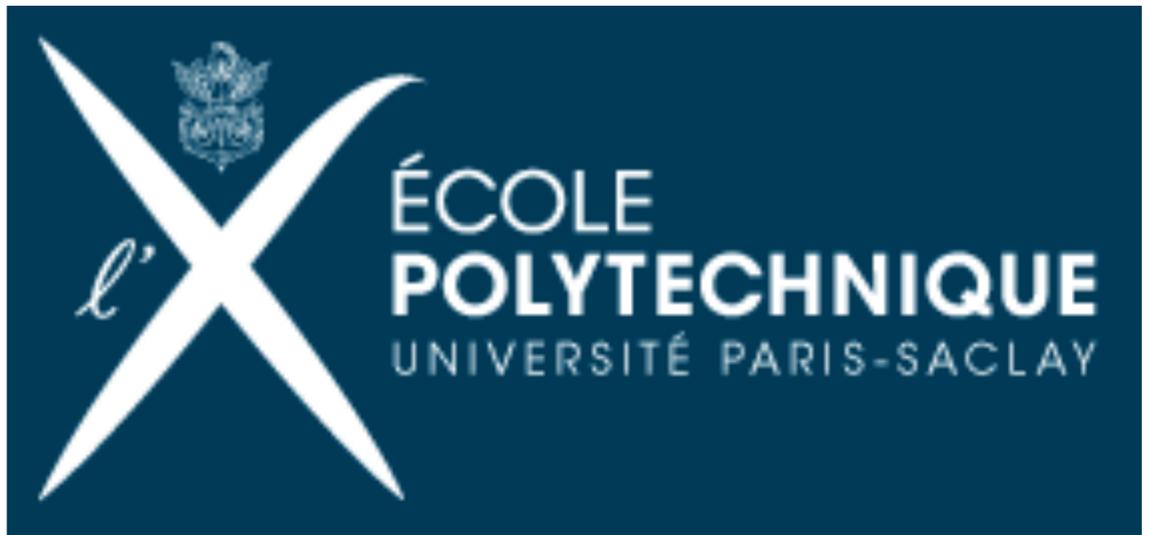
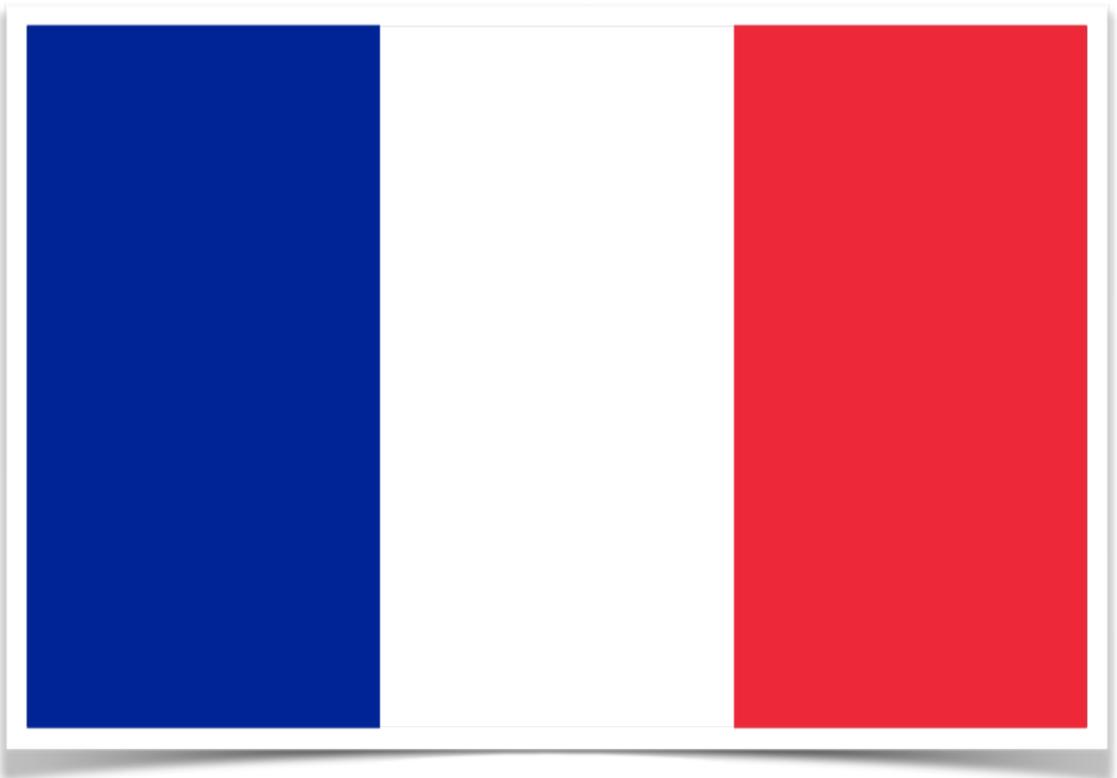
# Summer interns from South Korea have participated



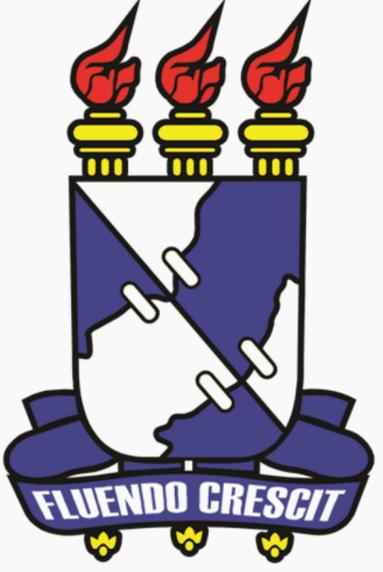
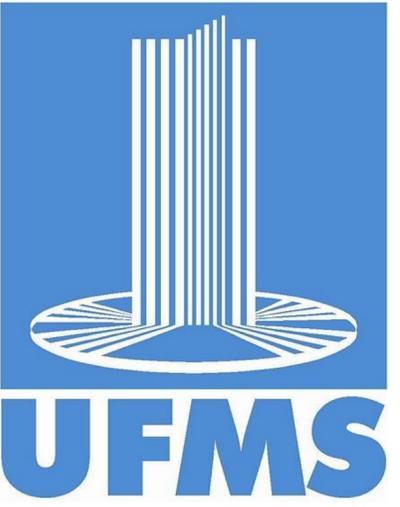
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# Summer interns from France have participated



# Summer interns from Brazil have participated



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**If we want a better world, we are the ones who will do it**



**Questions?**