

UK Photonics



£13.5bn

industry value to
the UK economy



69,000

people employed
across the sector



£5.3bn

total GVA

£76,400

GVA per employee
(vs UK manufacturing
average of £67,000)

8.4%

Like for like growth
over 2 years
(4.1% CAGR)



July 2019

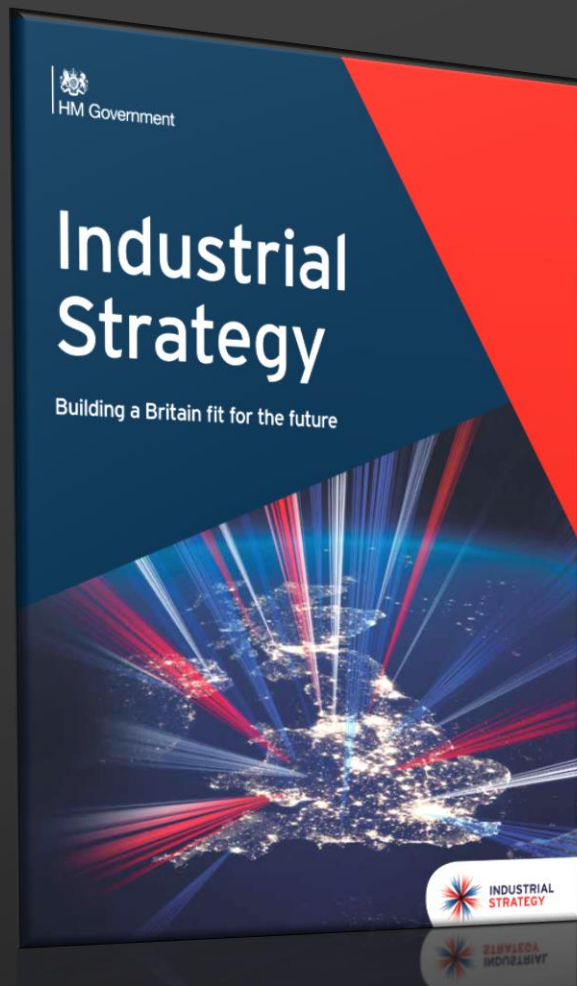
PHOTONICS
LEADERSHIP GROUP

Global Challenges for Photonics

Dr John Lincoln

Chief Executive

- ❖ Global challenges
- ❖ Current impact
- ❖ Future challenges for photonics



4 Grand Challenges

➤ From 2018 UK industry Strategy



AI and Data Economy



Ageing Society



Clean Growth



Future of Mobility

- **Unpick, globalise and update**

AI and Data

➤ Data Access, Security, Accuracy, Interpretation

○ What is the challenge in AI?

- A huge opportunity

○ Challenges in Data

- Data access
 - Time, volume, speed, delay
- Security
- Accuracy
 - *Machine learning reproduces errors in teaching data*
- Interpretation



Aging Society

- Greater Productivity
- Efficient Healthcare

- **Universal challenge in many countries**

- Shifting demographics
 - Retired > working
- Double Economic challenge
 - More costs, less tax income
- Efficiency and productivity
 - In health and social care
 - In entire economy



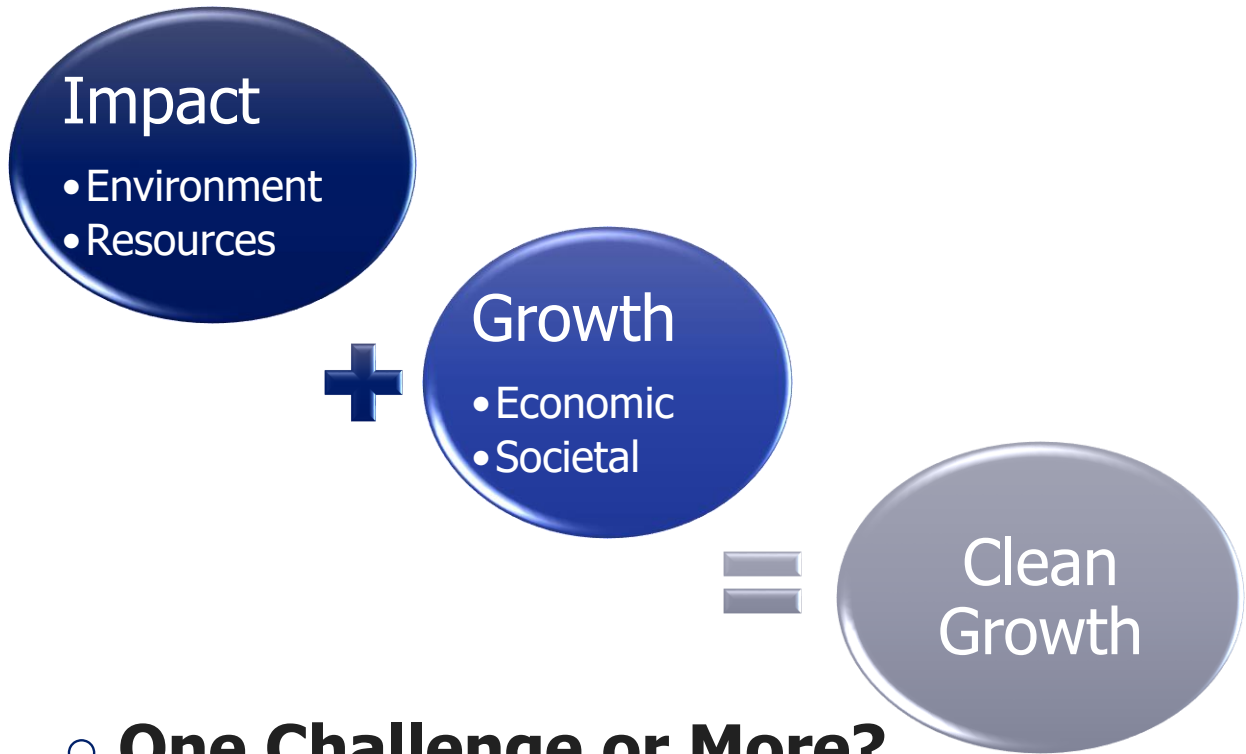
Future Mobility

- Transport efficiency, availability and impact

- **The challenge of future mobility**
 - *Ubiquitous with autonomy – why?*
- Efficiency at the core
 - In Time / Productivity
 - In Resources
 - In Availability
 - Without risk



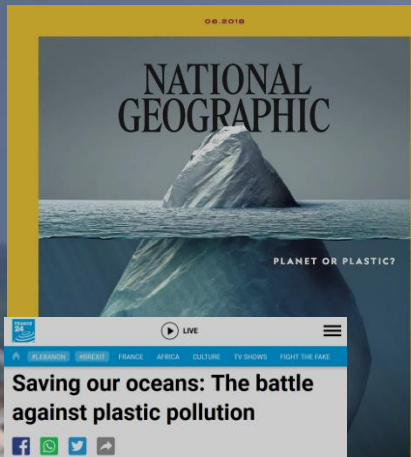
Clean Growth



○ One Challenge or More?

- What's making the news?

2019 Environmental Headlines: Where is the demand for Growth?



Saving our oceans: The battle against plastic pollution

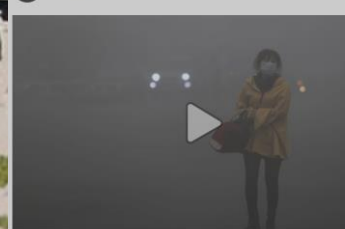
Issued on: 11/06/2019 - 11:33



It's estimated that 8 to 12 million tonnes of plastic are ending up in our oceans every single year. Around half of that plastic is used just once.

Fine dust and toxic smog are suffocating these Asian countries

By Helen Regan, CNN
Updated 08:47 GMT (16:47 HKT) January 15, 2019



How deadly is air pollution? 01:08

(CNN) — Parts of Asia are choking under a thick layer of smog, leading at least one country to experiment in extreme forms of weather modification in an attempt to clear the toxic brown skies.

Thailand, South Korea, China, India and Hong Kong are all facing unhealthy and even hazardous levels of pollution as weather patterns, coal heating and emissions contribute to the annual

Meghan, 15, tries on a diamond ring. Another exclusive picture of a princess in the making

SEE PAGE 3

Daily Mail

As a report reveals beaches are getting cleaner, supermarket chains back our bottle de

LET'S TURN THE TIDE ON PLASTIC



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Part of complete coverage on **On China**

Airports, schools remain closed as smog blankets Chinese city of Harbin

By Paul Armstrong, CNN
Updated 11:35 AM EDT, Tue October 22, 2013



The Guardian Opinions



Hundreds of people demanded action a

THE Sun
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What is Extinction Rebellion and what are XR's demands?

Extinction Rebellion London: BBC Broadcasting House 'locked down' by protesters



Extinction Rebellion comes to South Africa

By GroundUp
Updated 11:35 AM EDT, Tue October 22, 2013

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What is Extinction Rebellion and does it want?

UK climate change protests



Extinction Rebellion rally in Sydney, October 7. DEAN SEWELL



Environmental campaign group Extinction Rebellion has launched a protest which it plans to continue for two weeks.

The Telegraph

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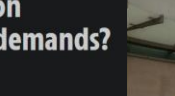
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Extinction Rebellion London: BBC Broadcasting House 'locked down' by protesters

What is Extinction Rebellion and what are XR's demands?



Extinction Rebellion comes to South Africa



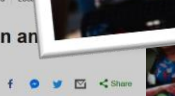
Extinction Rebellion rally in Sydney, October 7. DEAN SEWELL



Environmental campaign group Extinction Rebellion has launched a protest which it plans to continue for two weeks.



Extinction Rebellion rally in Sydney, October 7. DEAN SEWELL



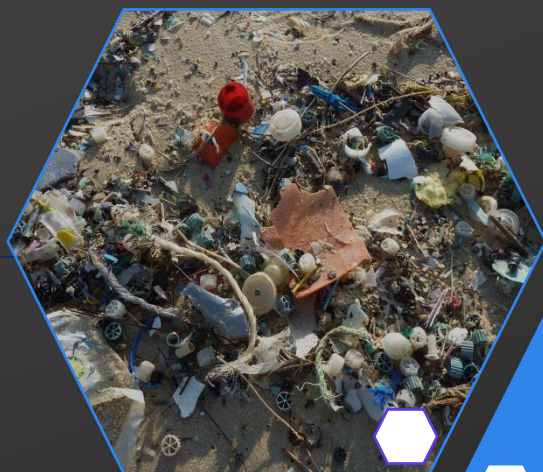
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Present

**Physical
Pollution**

- Air, sea, land
- Waste, recycle

Direct

**Climate
change**

- Sustainability
- Impact
- Warming

Indirect



Future

Clean Growth ➤ **Sustainability**

- Physical pollution
- Climate impact



Economic Patriotism

- De-globalisation, sovereignty politics of extremes
- Uncertainty

Another set of Headlines

- Another challenge



- Globalisation in reverse
 - Focus on local & national first
 - Focus on extremes not medians
 - Lack of compromise to median voter
- Uncertainty is the new certainty

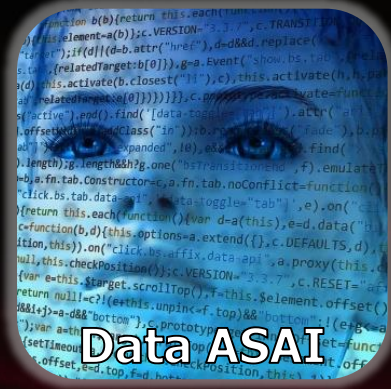


Defence & Security

➤ Agile, Affordable, On-Demand

- Minimum viable (affordable) volume
 - COTS?
- Adaptable to the unpredictable
 - Inservice modification/upgrade
- Rapid development
 - Research, develop, deploy in <decade
- UK supply chain
 - Sovereign capability

21st Century Global Challenges



Data ASAI

Access, Security,
Accuracy, Interpretation



**Health cost,
demographics**

Productivity in care &
economy



**Physical
Pollution**

Air, land, sea,
waste & recycling



Transport

Efficiency, Availability
Impact



**Climate
change**

Sustainability, resource
use



**Economic
patriotism**

De-globalisation,
sovereign, uncertainty



**Defence &
Security**

Agile, affordable,
available

**+ inspired
innovation**

...what do these mean for photonics

- Real time diagnosis
- Treatment- photo-dynamic therapy/ drug activation
- Non-invasive monitoring O₂ & glucose to lifestyle
- Precision surgery

Challenges for Photonics

- Fit to healthcare pathways
- Enable automation / reduce health professional touch time
- Individualisation vs minimum viable product vs cost
- Complex system integration - photonics only fraction of cost



Photonics for Health and Care

Devilish practical detail
Photonics is only the start

- **3d sensing**
 - Driver assist and autonomous
 - Distance, location, speed in real-time
- **Laser manufacturing**
 - Lighter, stronger, cheaper chassis

Challenges for Photonics

- **3d sensing**
 - Range vs Safety vs Weather
 - Merging data streams
 - Assistance vs autonomy- what & when
 - Multifunctionality
- **Processing dissimilar materials**
 - Batteries and E-motors

LIDAR Point Cloud image

Light for efficient transport

Autonomy is a wild frontier

Lasers are in manufacturing, but vehicles are changing

- **The internet is built on optical data transmission**
 - Optics being used for ever shorter distances inside datacentre, inside circuit board
 - Nothing moves faster than speed of light

Challenges for Photonics

Latency critical in Digital 2.0

- Remote health, gaming, autonomy, finance

Capacity scaling going cost linear

- Bandwidth limit of optical amplifier & fibre vs consumer asking more b/w for less

Integration

- On-chip, in-chip on-board at volume

Connectivity as essential utility

Optics for real-time data

Biggest photonics application

Future latency and integration without compromise



Energy Generation

- **Photovoltaics**
 - Efficiency
 - Building integration
- **Monitoring**
 - Turbines
 - Combustion
 - Pollution

Pollution

- Optics = fragile & clean
 - How to avoid single use packaging & maintain performance
 - Operating in contaminated environments
 - Minimise consumable use
 - Recycling content

Energy Use & Productivity

- **Lasers for Manufacturing**
 - Cutting, joining, marking, finishing, 3d printing
 - Efficiency electrical to optical to **parts**
- **Data processing** - Energy per bit of data processed
 - Datacentres use % of global energy
- **Lighting**

Priority?

- Recruitment
 - Appeal to next generation
- Be part of solution not problem

Optics for the environment

- **Photonics is globalised**
- **Viable return = global customers**

Challenges for Photonics

- Building and maintaining supply chains
- Uncertainty vs investment horizon in building scale
- Access to capital
- Adaptable versatile solutions
 - Lower min viable volume
 - More Local supply chains



Optics & Photonics in economic patriotism

Adapt and thrive



Beyond the challenge

Inspiration led Innovation

....for the consumer

"A lot of times, people don't know what they want until you show it to them." Steve Jobs

- **2 & 3D sensing**
 - Cameras and VCSELS for
 - Facial recognition & cameras
 - Augmented reality
 - Gesture control
- **Displays**
 - Micro to very macro
- **Lighting**

Challenges for Photonics

- **Technology**
 - Integration, size weight and power
- **Manufacturing challenges**
 - Cost and volume
 - Minimum volumes in millions
 - Time to production
 - Time to ramp



Optics for the consumer

Leverage knowledge from data storage, cameras and food

Consumer AR/VR	Health	Data- comm	Transport
100m units	100m tests	100m units	150m units
\$60bn	\$23bn	\$10bn	\$15bn

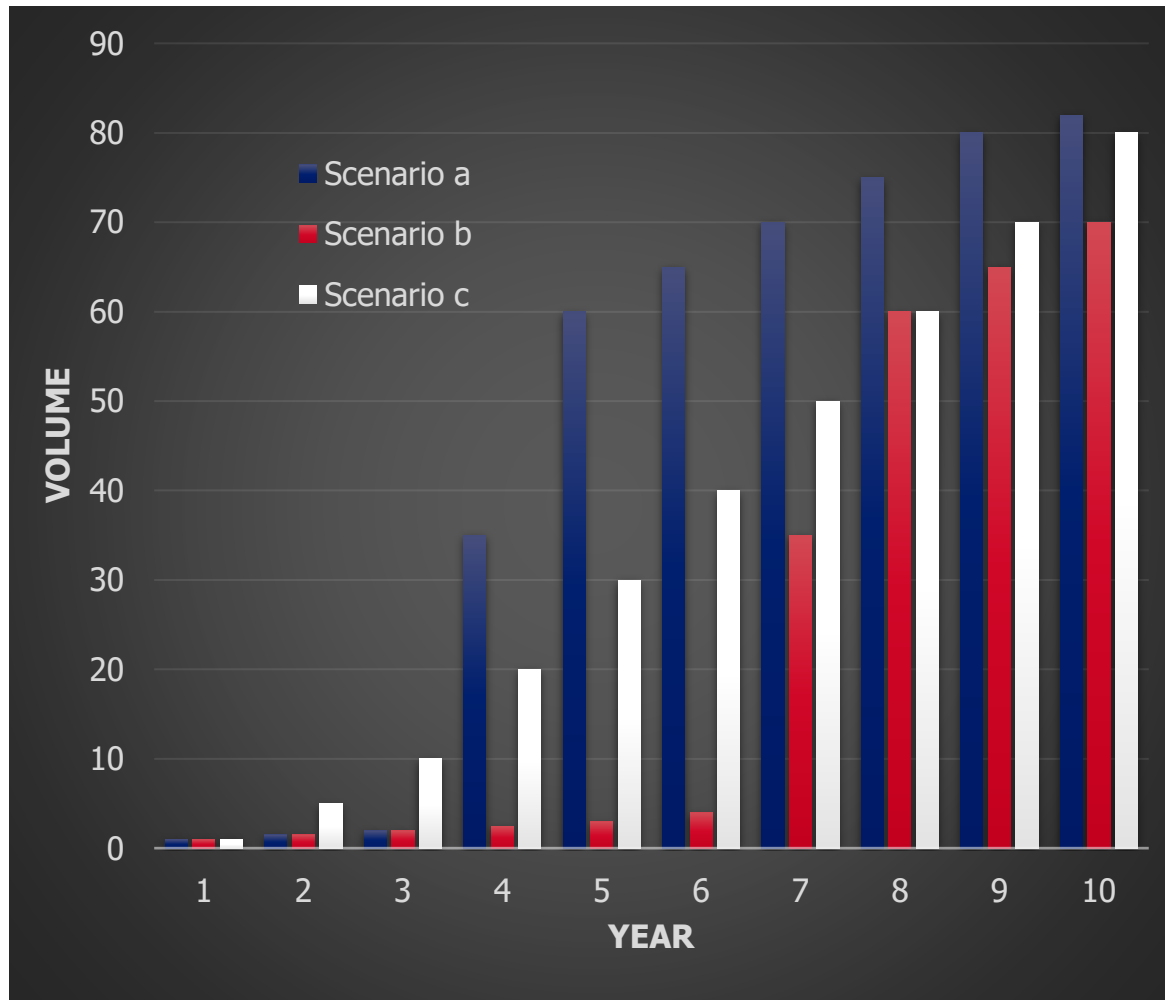
Mega opportunities - the ultimate challenge

How to get from hundreds to millions

- Multiple applications needing 100 million units <10 years
 - ~\$100bn opportunity
- How to scale from zero to hero
 - Without crashing



Solving scale up challenge



- Need solutions scale near instantly from hundreds to millions-
 - No intermediate market
 - “Supply all our needs or none”.
 - Innovations in:-
 - Integration & manufacturing research key
 - Delivering sub-linear cost scaling
- **Scale of opportunity is not in question**
 - Does it matter how many billions?
 - Step is unpredictable
 - **Can interventions smooth demand?**
 - **Where will all the people come from?**

Eight challenges

...how to apply photonics



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economy



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Scale

Ramp, Volume,
Timing