UNIVERSITY OF BIRMINGHAM | THE INSTITUTE FOR GLOBAL INNOVATION

A Cool World

1st International Congress on Clean Cooling

18th - 19th April, University of Birmingham

UNIVERSITY OF BIRMINGHAM | BIRMINGHAM ENERGY INSTITUTE

Welcome and Objectives

Professor Martin Freer, Director, Birmingham Energy Institute

Adam Chase, E4tech, chair for the day

THE NEED AND CHALLENGES OF COOLING
"BRINGING COOLING IN FROM THE COLD"

Sir David King, former Special Representative for Climate Change

Pawanexh Kohli, National Centre for Cold-chain Development, India

Cooling Needs: the Climate Change Context

SIR DAVID KING

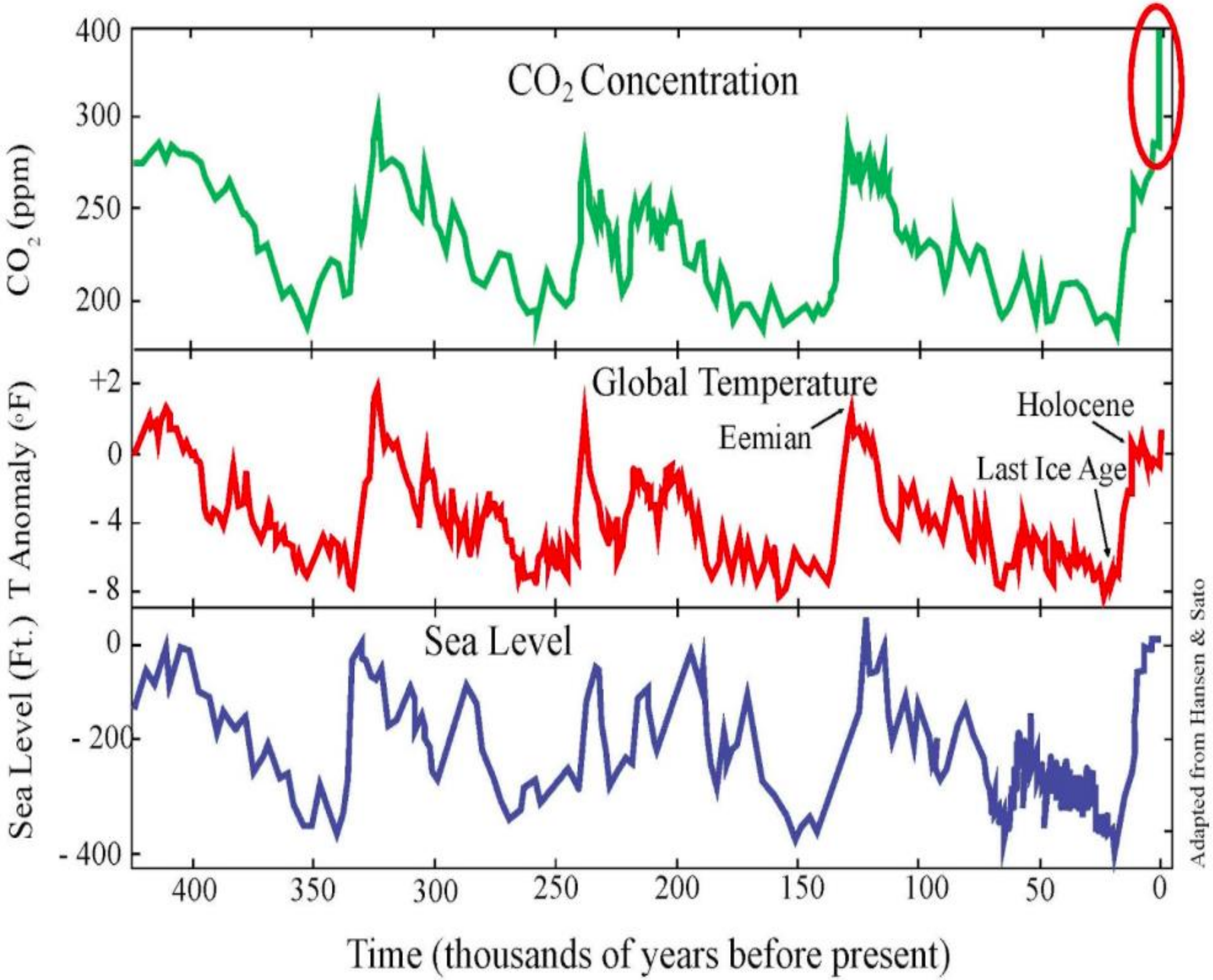
- Partner, SYSTEMIQ Limited
- Former UK Govt CSA and Climate Envoy

- 1st International Congress on Clean Cooling

University of Birmingham

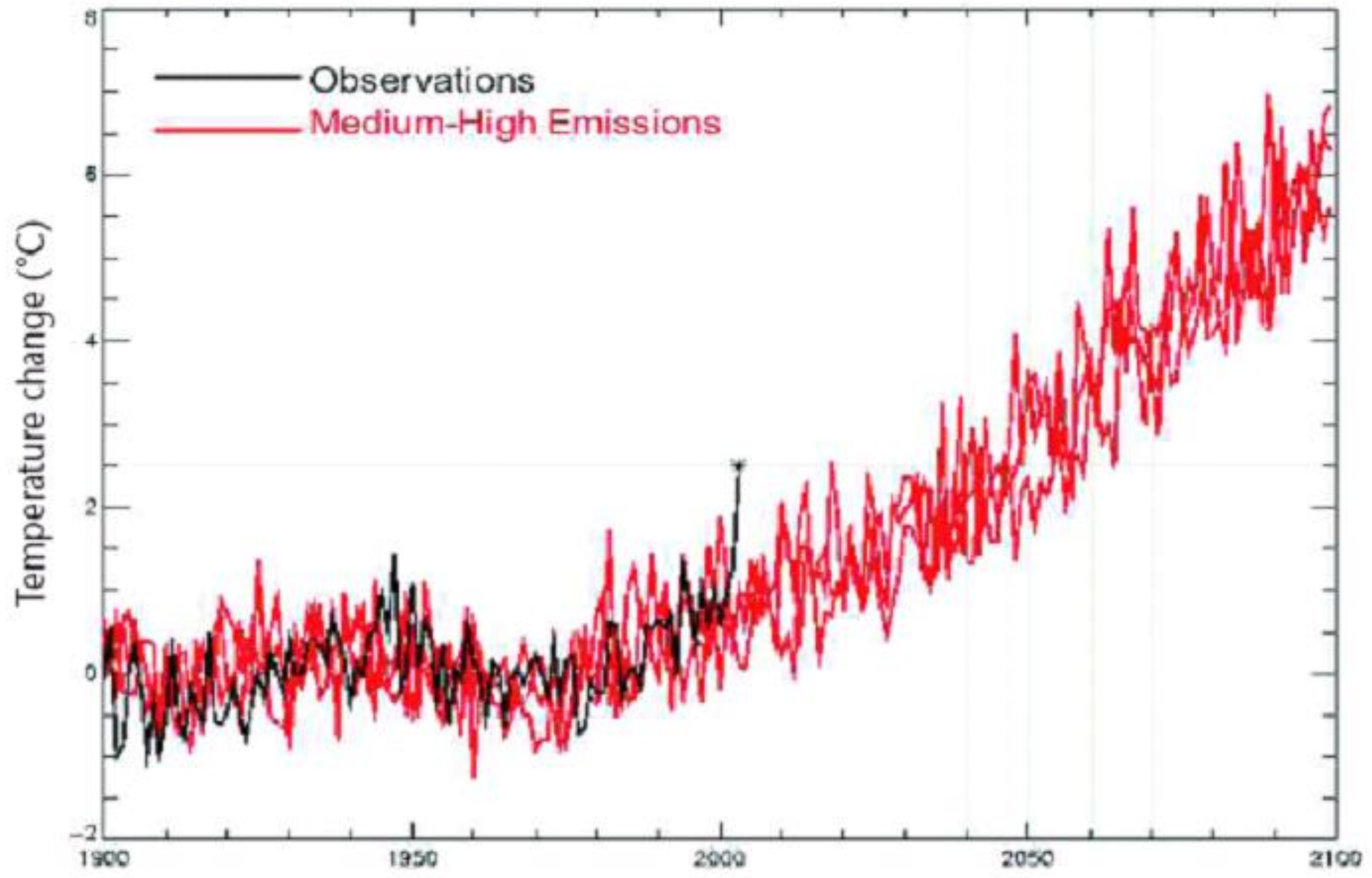
- Wednesday 18th April 2018

- Twitter: Sir_David_King



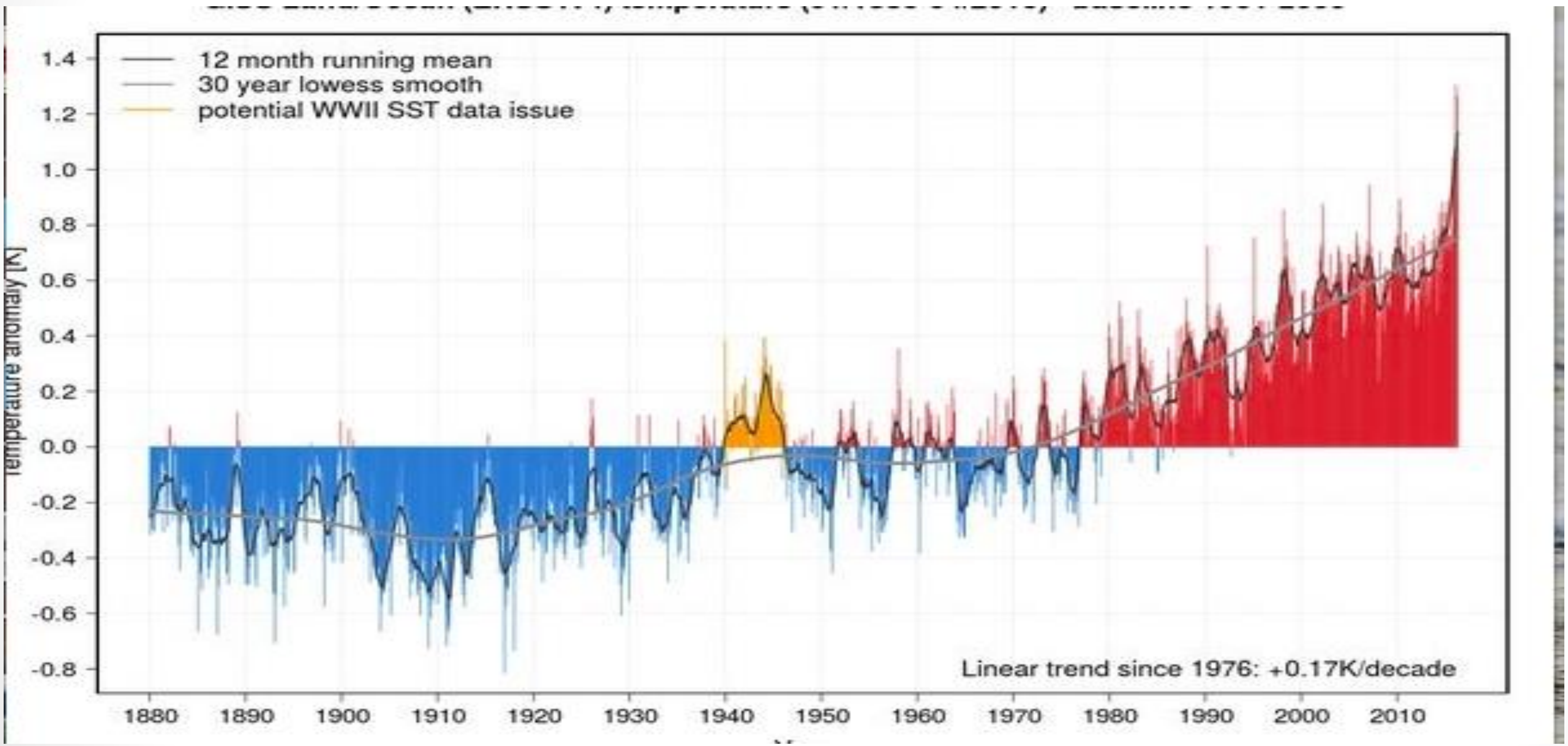
CO2 Concentration
CO2 (ppm)
400
300
250
200
Global Temperature
T Anomaly (°F)
+2
0
-4
-8
Eemian
Holocene
Last Ice Age
Sea Level
Sea Level (Ft.)
0
-200
-400
400
350
300
250
200
150
100
50
0
Time (thousands of years before present)
Adapted from Hansen & Sato

European Summer Temperatures 1900-2100



Source: Hadley Centre

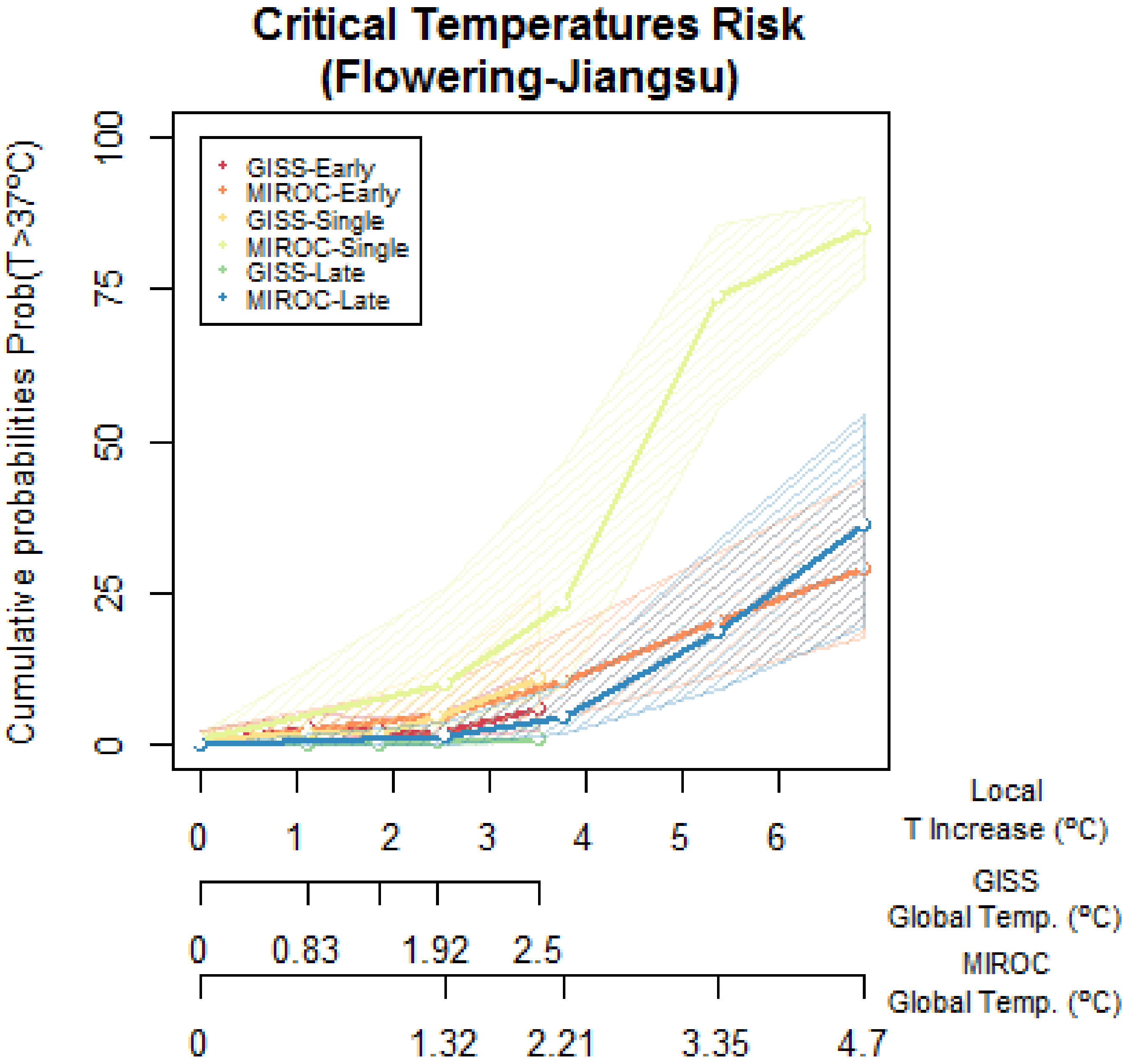
NASA GISS Temp. 01/1880 – 04/2016. Base 1901 - 2000



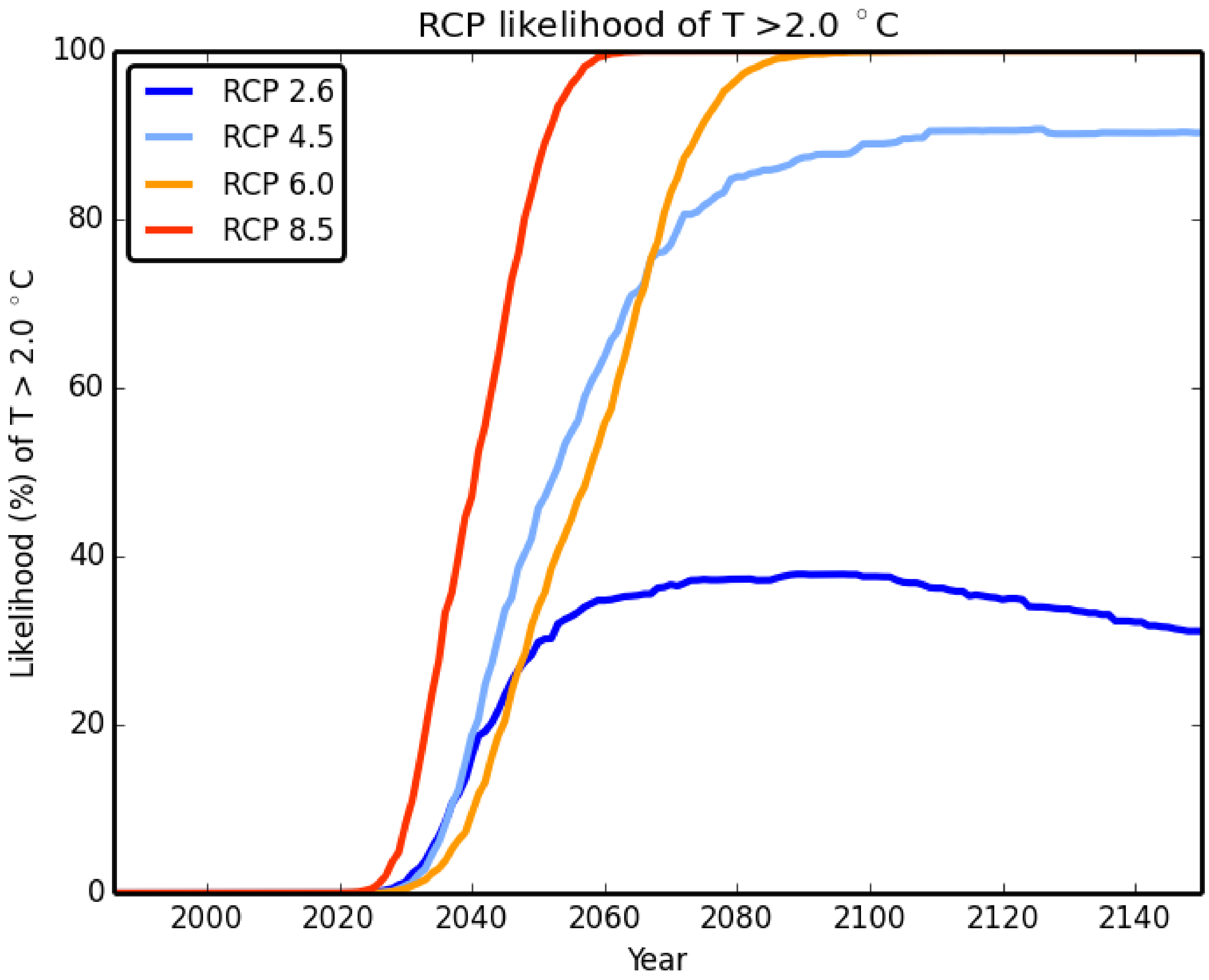
Climate change: the risks

Foreign & Commonwealth Office

Risk of Crop Failure (Rice)

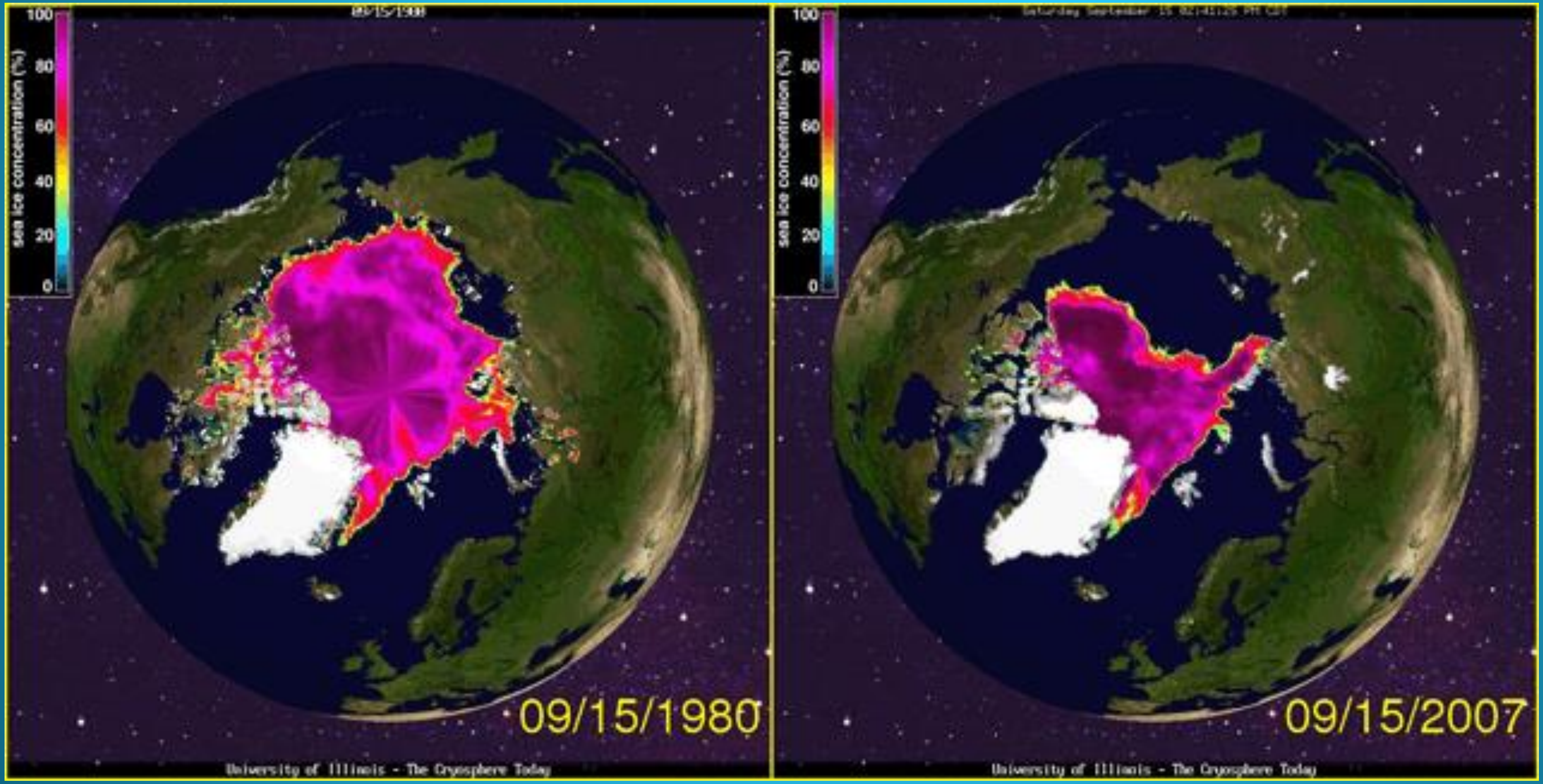


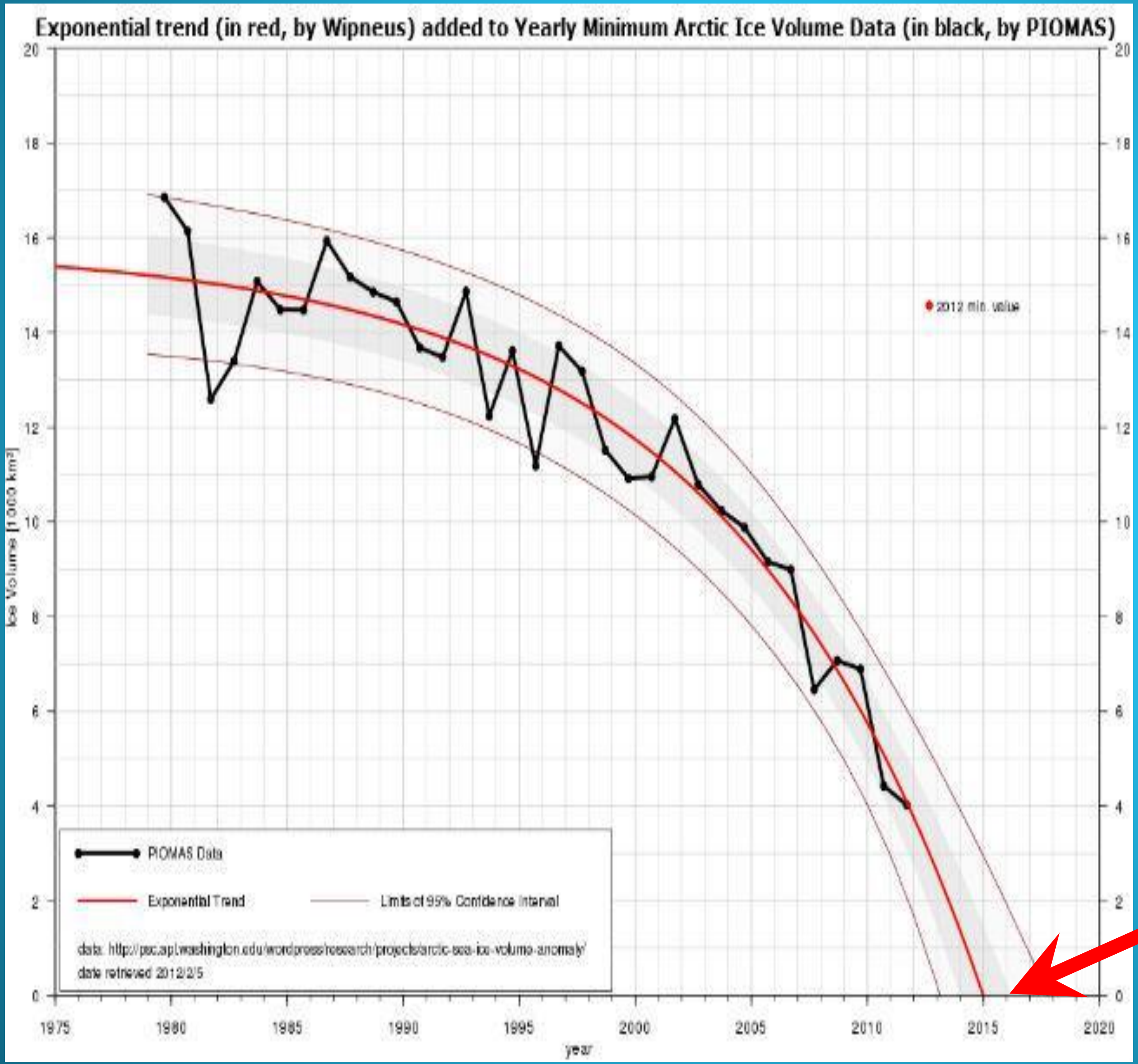
Proba



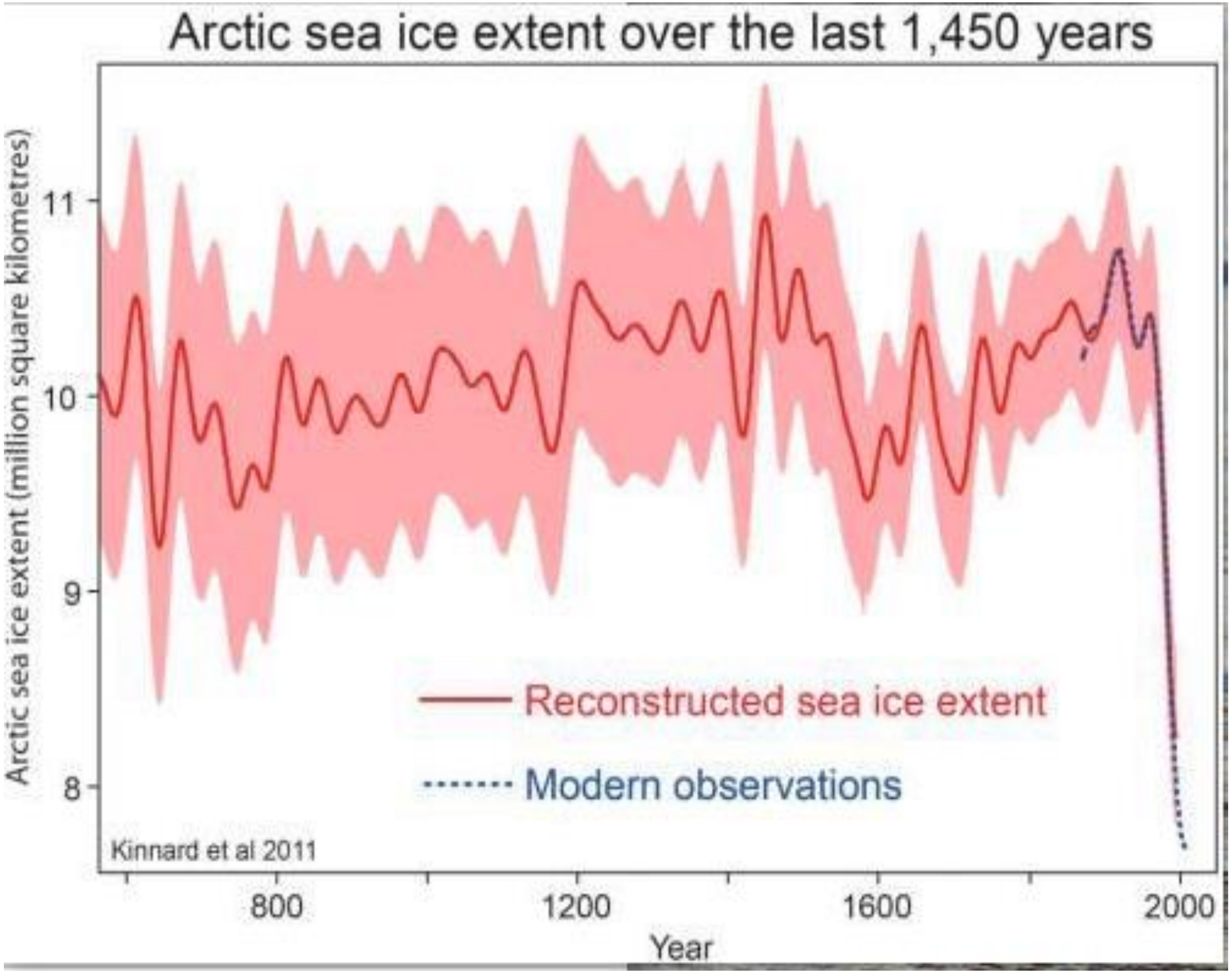
RCP likelihood of T >2.0 °C
Likelihood (%) of T > 2.0 °C
Year
RCP 2.6
RCP 4.5
RCP 6.0
RCP 8.5
0
20
40
60
80
100
2000
2020
2040
2060
2080
2100
2120
2140

Sea ice decline



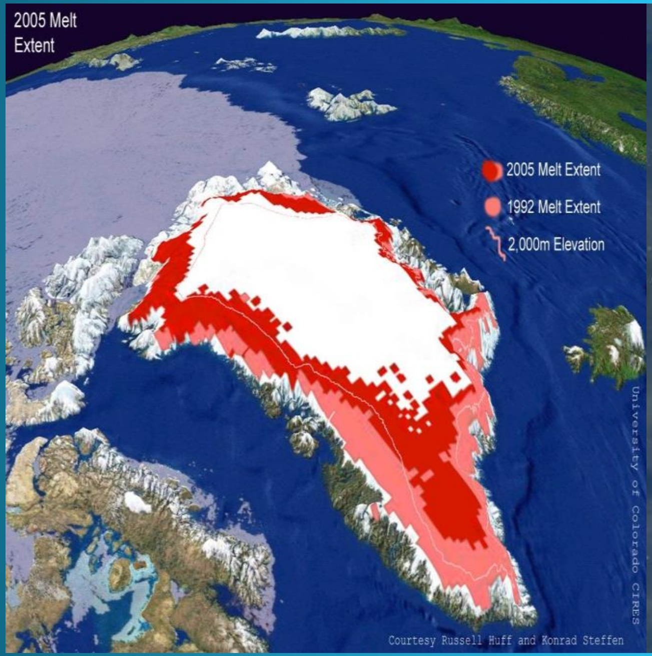


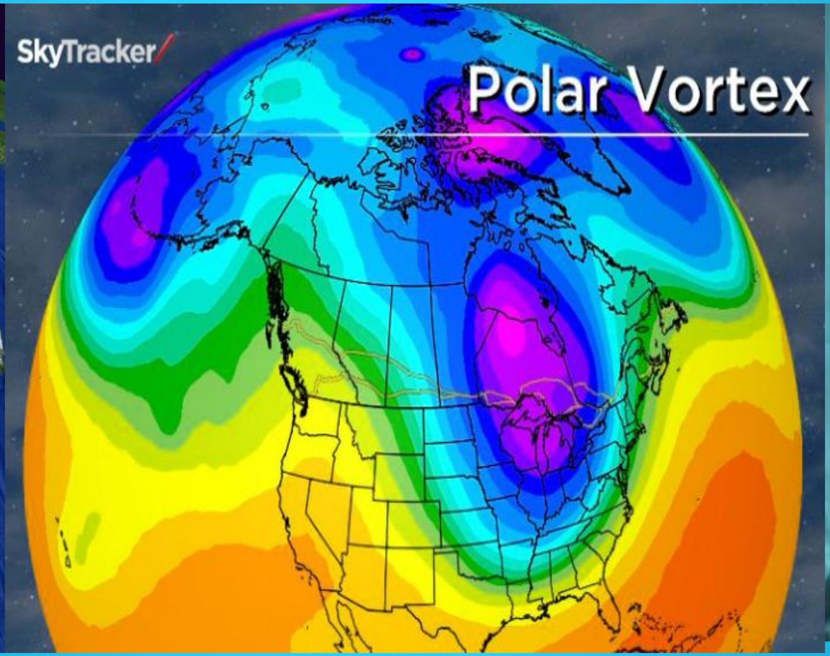
Arctic Sea Ice Gone 2016 ?



Arctic sea ice extent over the last 1,450 years
Arctic sea ice extent (million square kilometres)
11
10
9
8
Reconstructed sea ice extent
Modern observations
Kinnard et al 2011
800
1200
1600
2000
Year

Consequences of Arctic Warming





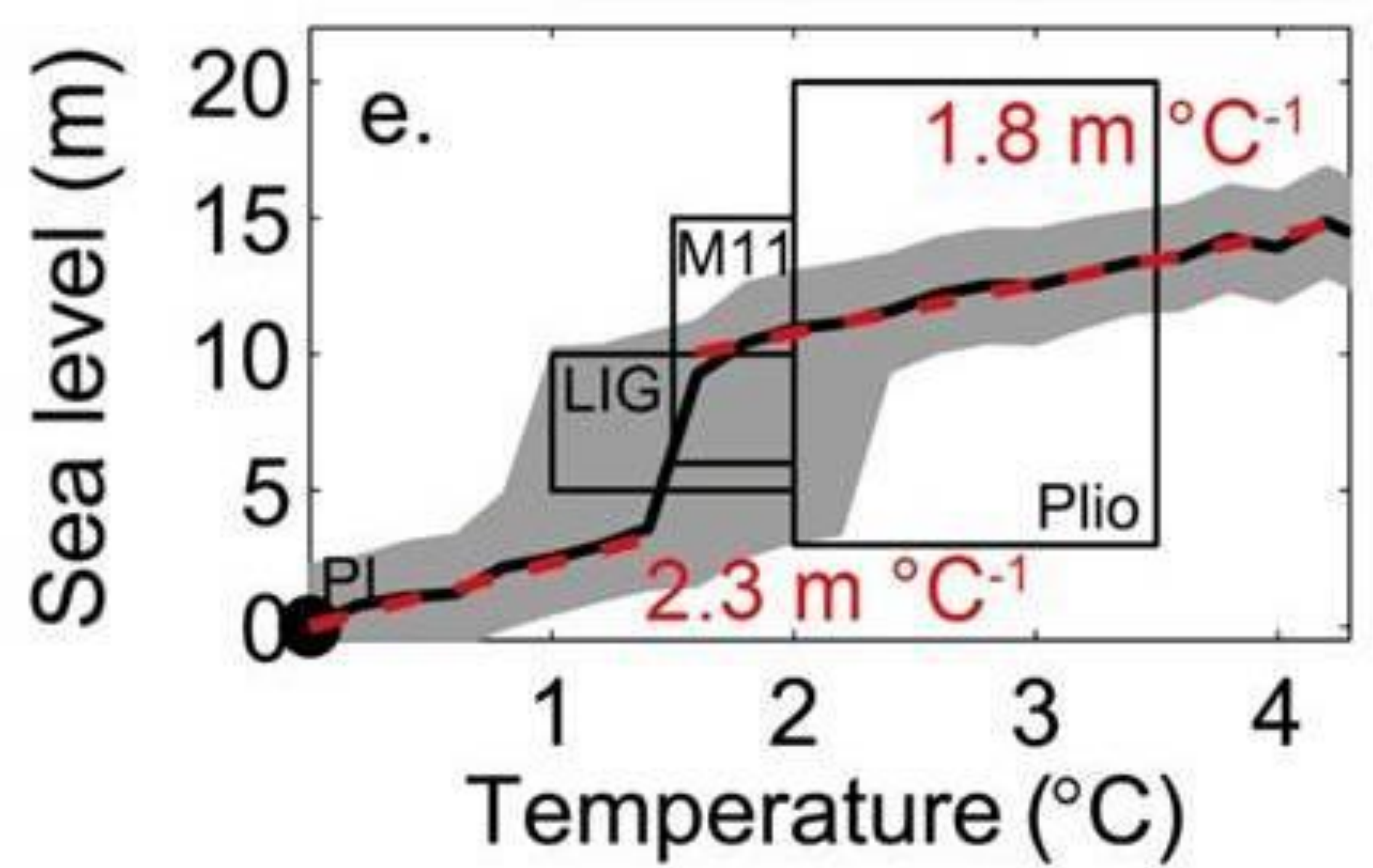
Meandering

Melting

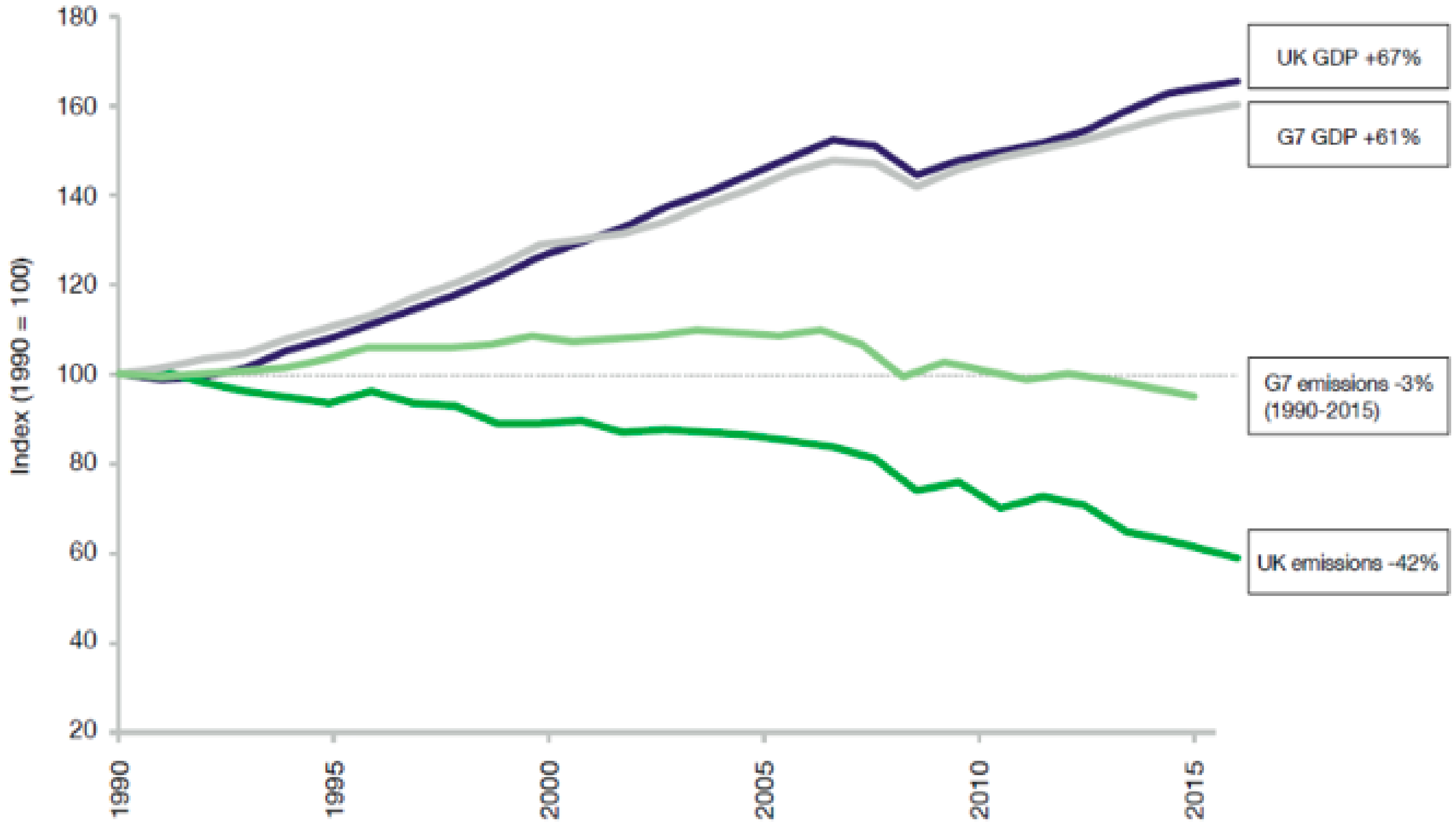
Methane

All Accelerating

Long-term commitment to sea level rise



1.1 Figure 1: UK and G7 economic growth and emissions reductions[8]



Source: UNFCCC; World Bank; BEIS

The Paris Agreement

Long Term Goal

The Paris agreement aims to hold the increase in global average temperatures well below 2°C and to pursue efforts to limit the increase to 1.5°C.

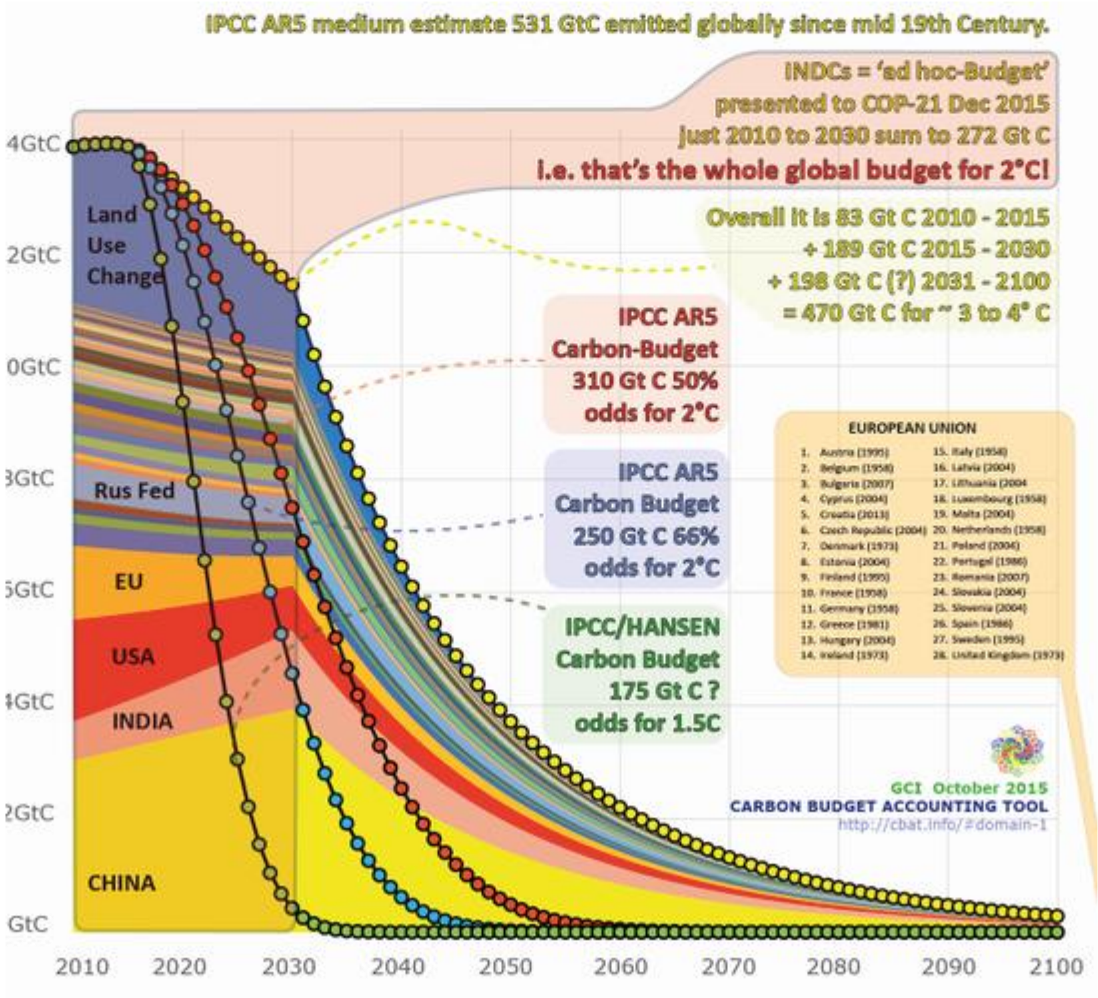
Emissions

To achieve the temperature goal greenhouse gas emissions should peak as soon as possible and rapidly reduce thereafter to achieve a balance between emissions and 'sinks' in the second half of this century.

Review Mechanism

Every five years Parties will update their Nationally Determined Contributions informed by a stock-take of global progress. Successive Contributions shall represent a progression beyond the existing Contribution.

COP21 International INDCs to 2030, compared with global carbon budgets




2015 saw a record-breaking
$367 billion invested in
renewable power.
TRACKING
THE ENERGY
REVOLUTION

A GLOBAL APOLLO PROGRAMME TO COMBAT CLIMATE CHANGE

David King, John Browne, Richard Layard, Gus O'Donnell,
Martin Rees, Nicholas Stern, Adair Turner

Mission Innovation

Foreign & Commonwealth Office

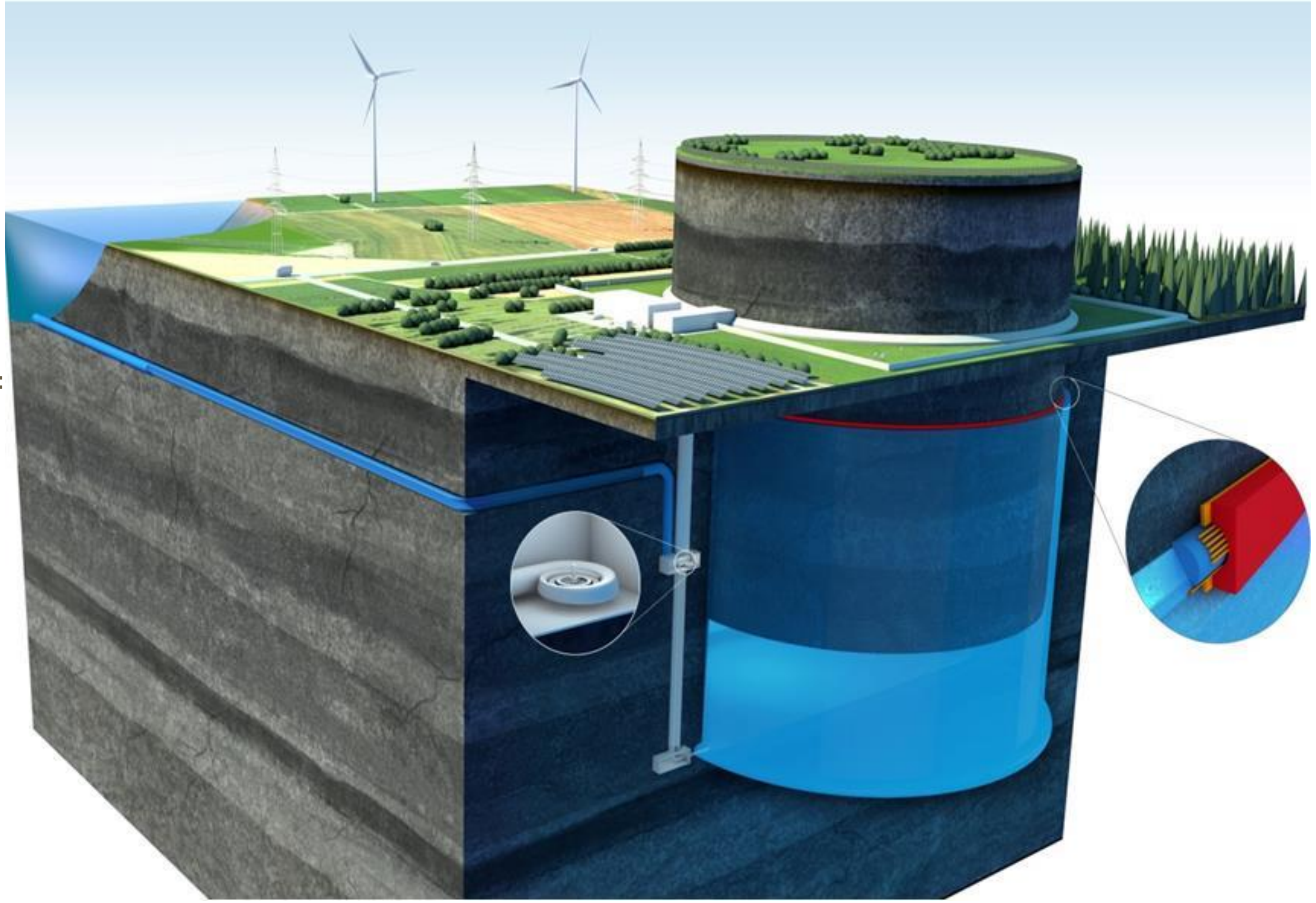
- High-profile initiative to **strengthen public funding of clean energy RD&D.**
- 22 nations, committed to doubling by 2020/2021: **annual spend of approx $30bn**.
- **Breakthrough Energy Coalition**, 29 investors pledged to invest $20bn in solutions.

The 7 initial areas for Collaborative Research

- 1. Smart grids, electricity & heat storage
- 2. Electricity access to off-grid communities
- 3. Capturing sunlight to create liquid fuels
- 4. CCUS
- 5. 2nd generation biofuels
- 6. Materials to replace steel, concrete
- 7. Heating & cooling

VariaLift Airship

Functionality:



UNLOCKING ACCESS TO COOLING

Ian Crosby, Cooling for All

#CoolWorldCongress
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Cooling for ALL!
Cool World Congress, Birmingham 18 April 2018

SUSTAINABLE ENERGY FOR ALL

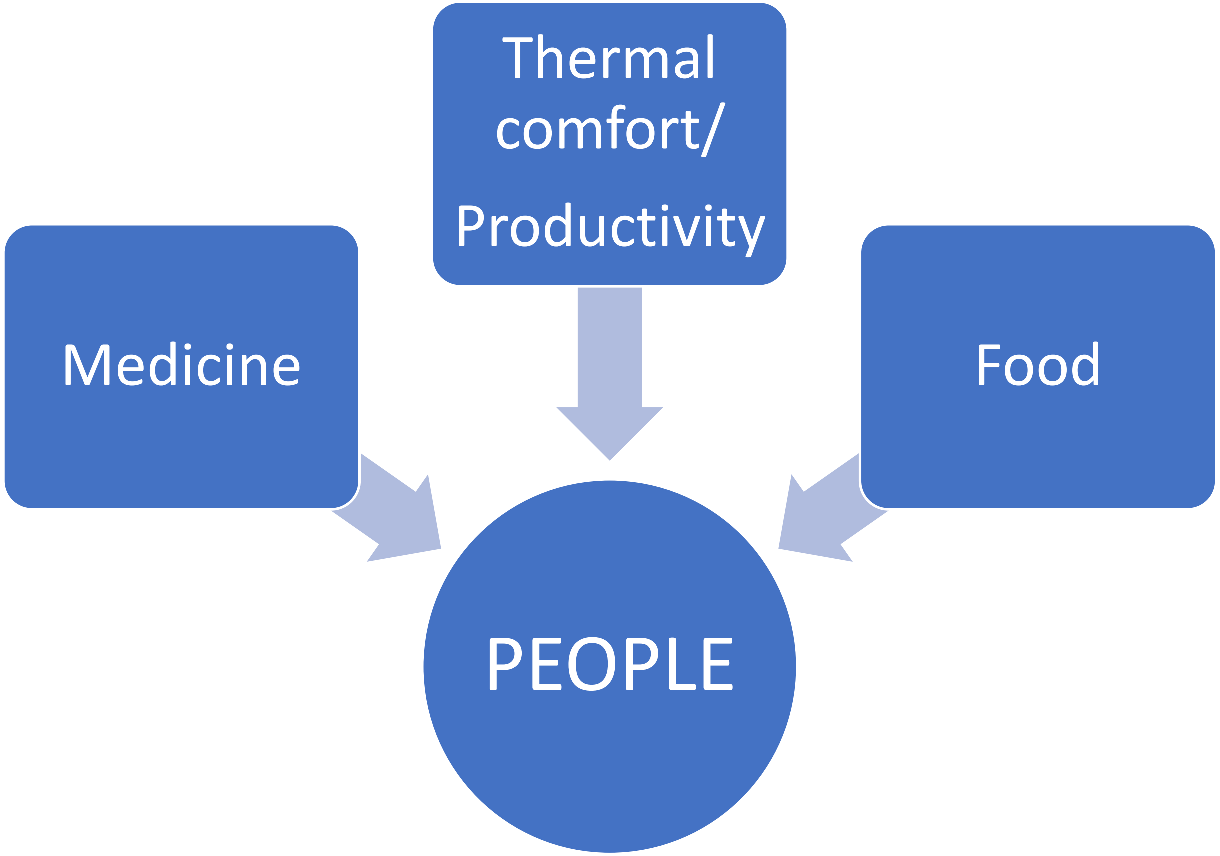
KIGALI
COOLING EFFICIENCY PROGRAM

Ian Crosby, Head of Energy Productivity and Cooling
Sustainable Energy for ALL

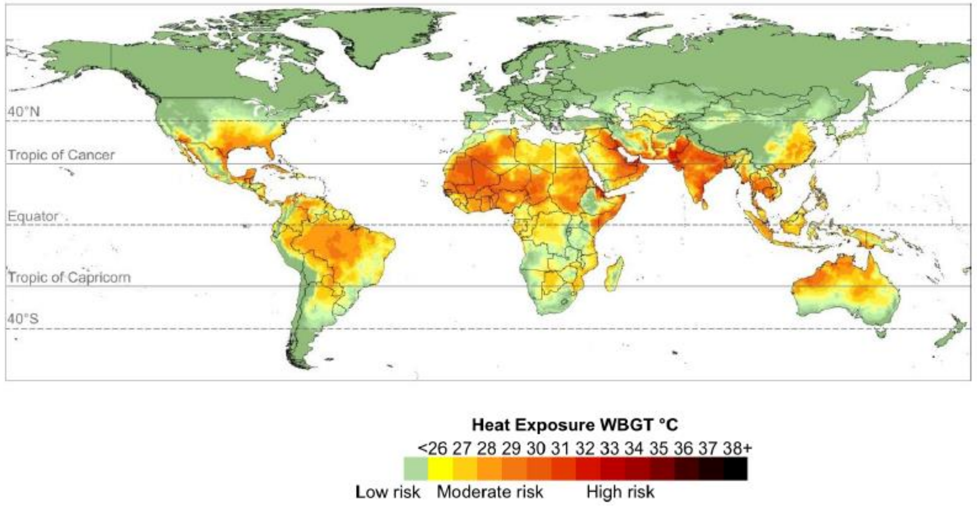
What is Cooling for All?

- Convened by SEforALL and funded by the Kigali Cooling Efficiency Program
- Global Panel draws on high level representatives from National Governments, International Organizations, Philanthropy, Academia, Industry
- Scoping Report to be produced outlining baseline data, barriers, solution pathways, technology options
- Final Report a call to action:
  - Increase awareness of the issues across a broad range of stakeholders
  - Increase the flow of funds into sustainable cooling solutions
- Draws on core competence of SEforALL: gather the evidence, understand the problems, issue a call to arms, convene partnerships

Focus Areas



Risk proxies: Heat exposure plus lack of electricity



Hottest month average level of occupational heat stress

Afternoon values in shade or indoors, 30-year averages 1980-2009

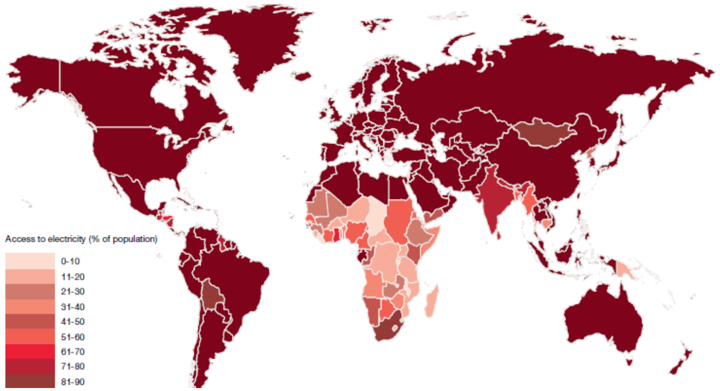
Not shown but important - Dangerous Heat Day = mean temperature > 35 C

More than 1 billion people lack access to energy

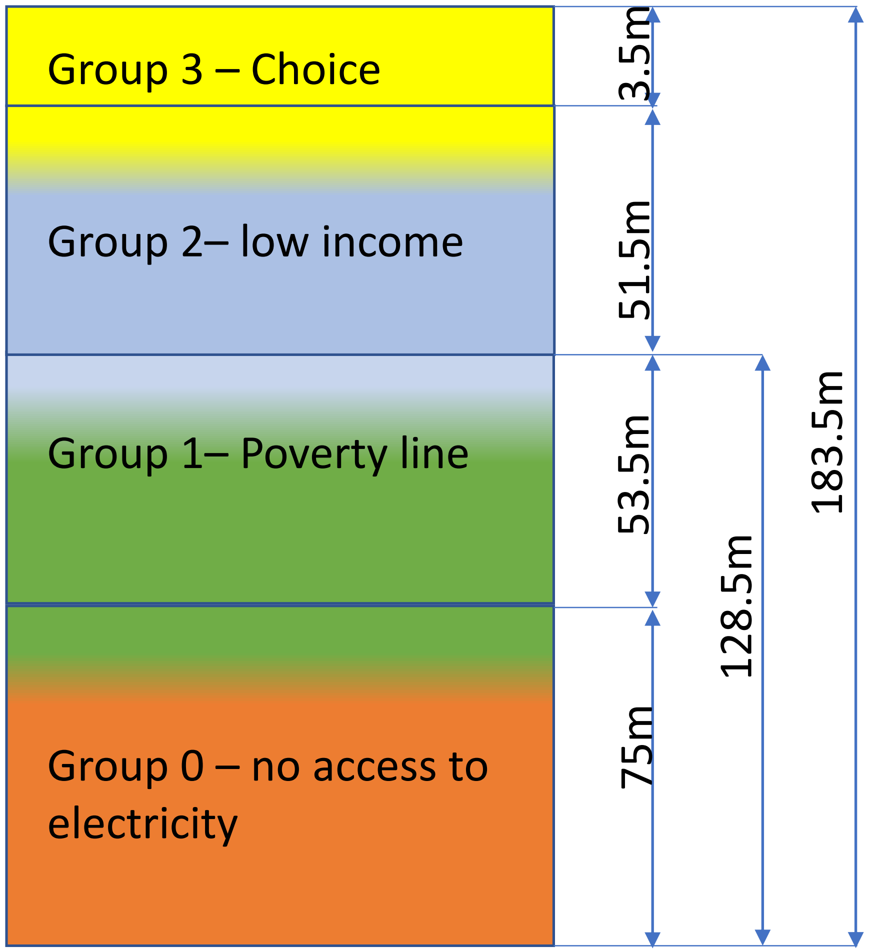
A crude proxy for access to cooling

Use to determine those most at risk

But how many really need cooling and why?



Constructing a Risk Model for Thermal Comfort - Nigeria



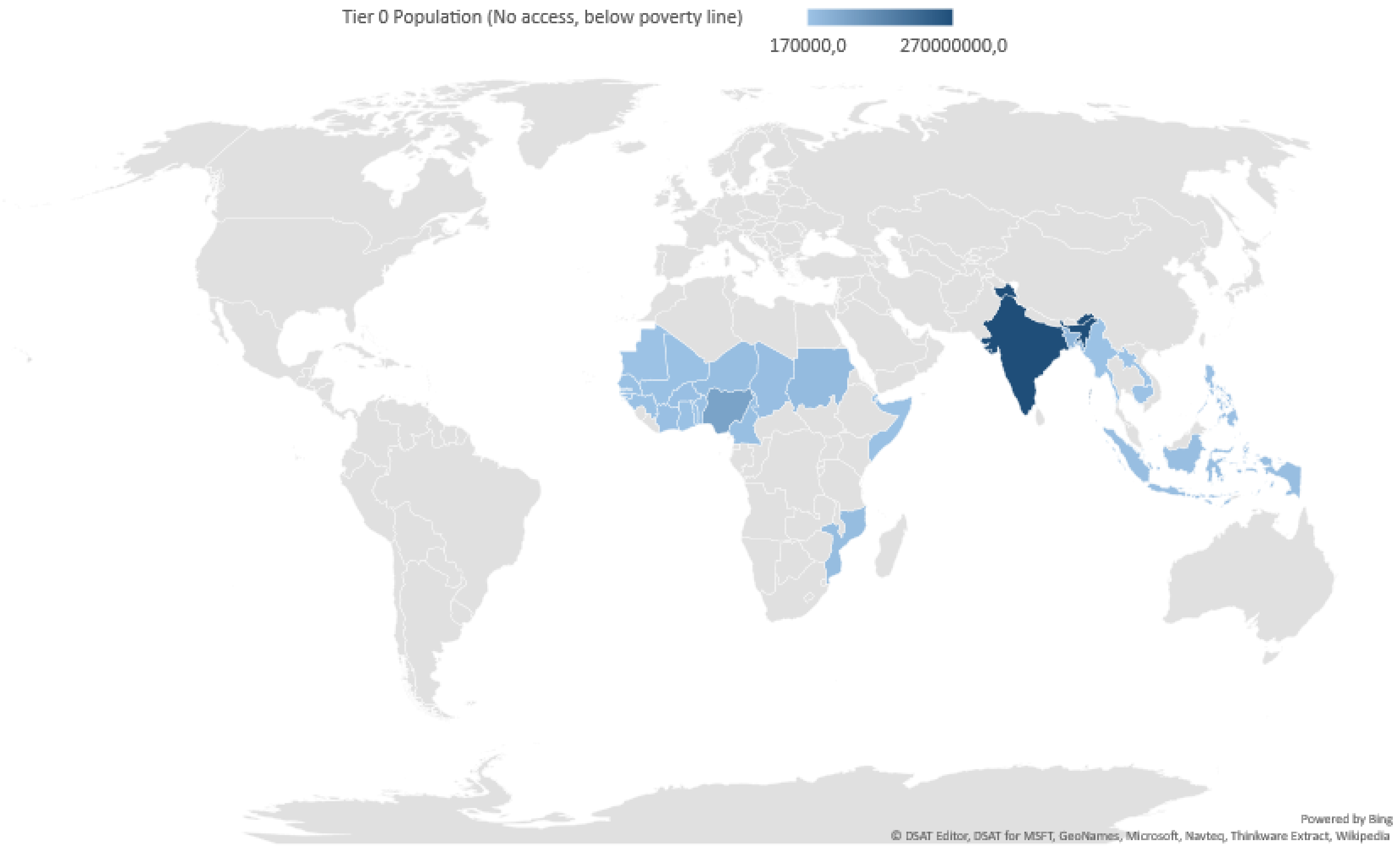
Group 3: 3.5 million Nigerians (1.9%) in middle-income level

Group 2: deduced from other numbers and total population = 51.5m

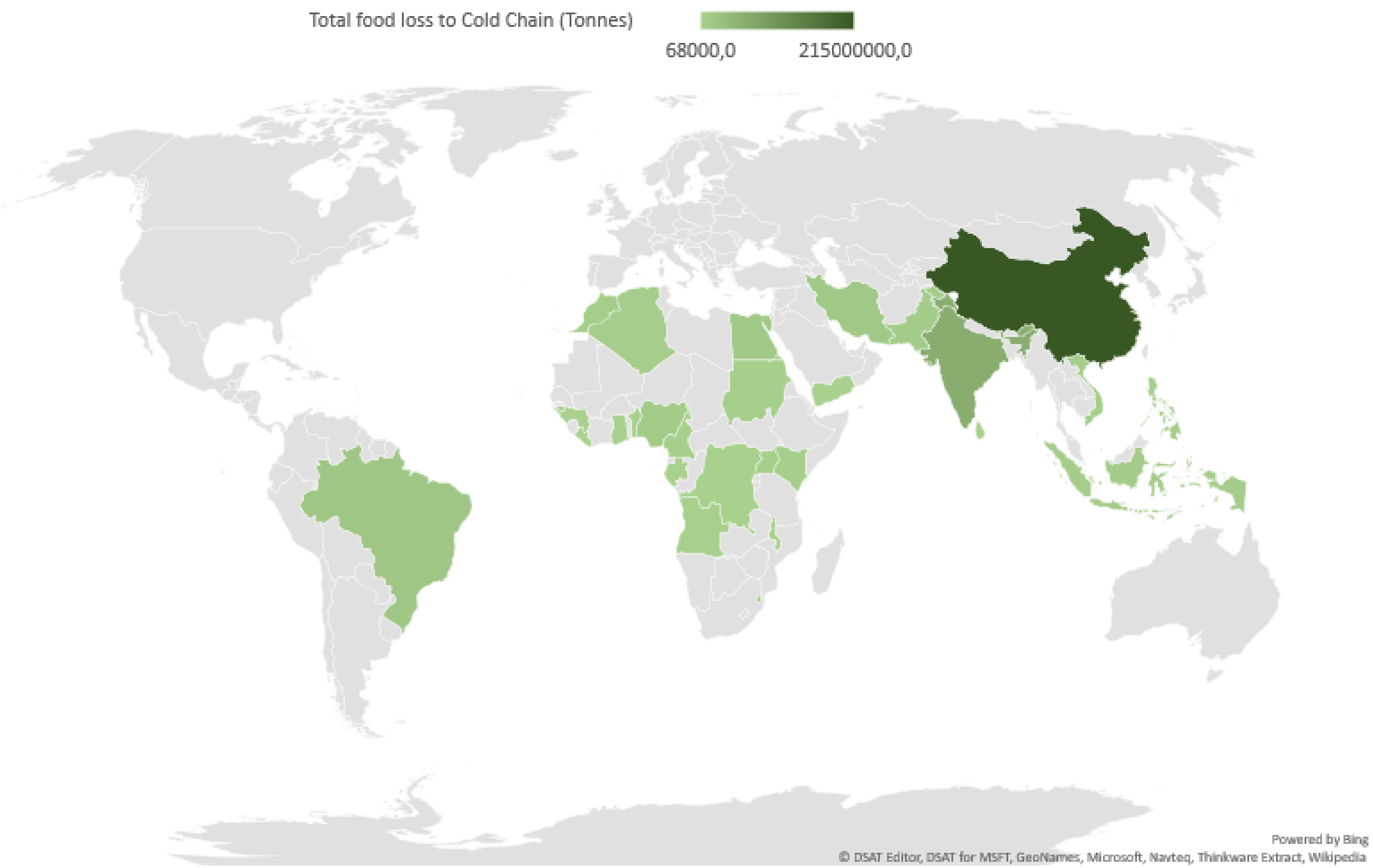
Group 1: 70% people live below poverty line, of which 75 million have no electricity = 53.5m

Group 0: 75 million without access to electricity

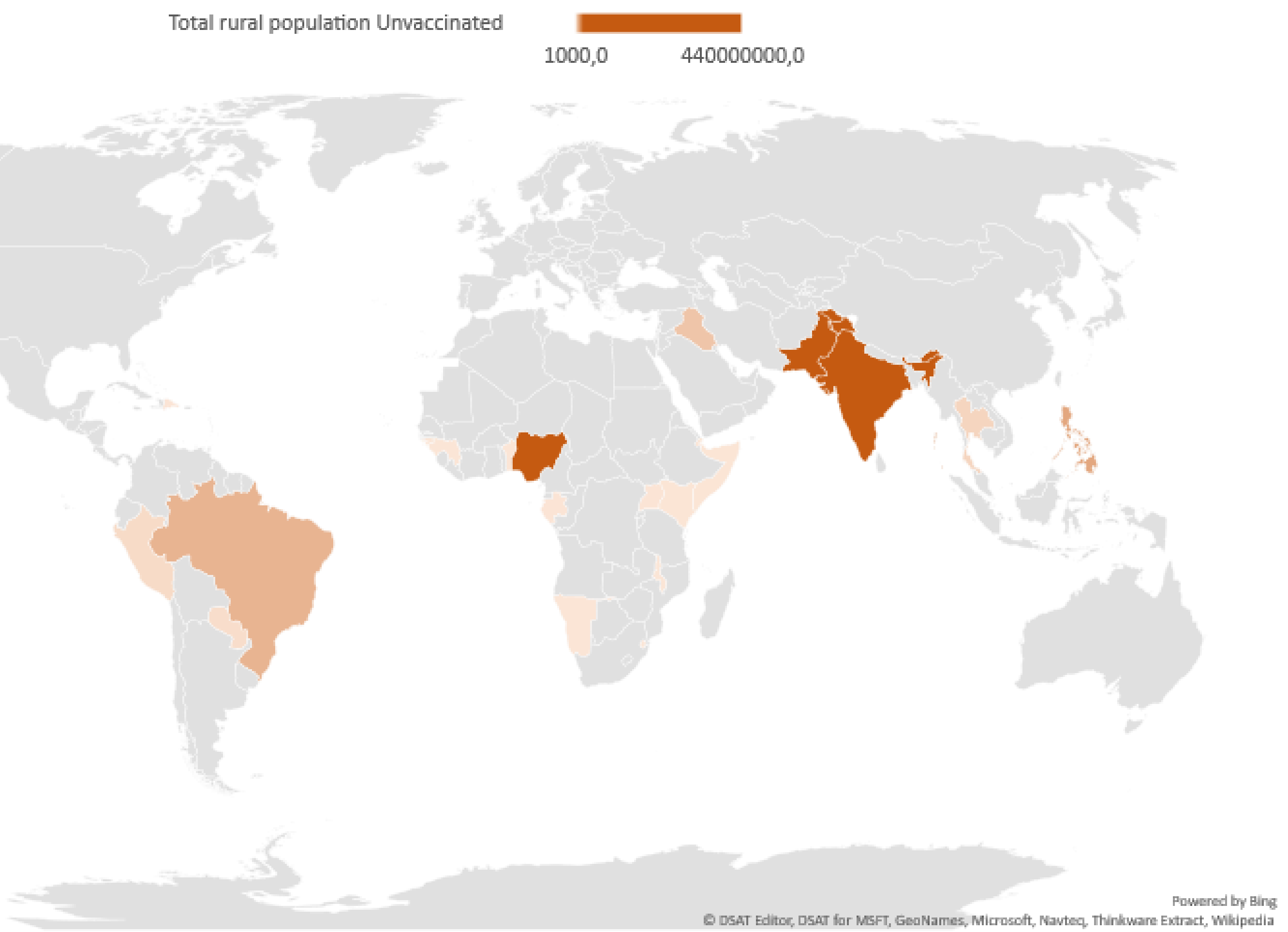
High Impact Countries
Buildings and Urban Environment



High Impact Countries
Cold Chain - Food Loss



High Impact Countries
Cold chain - Vaccines



Country Rankings based on Group 0

Top 5 countries in each ranking list

Top 5	1	2	3	4	5
Buildings	India	Nigeria	Bangladesh	Sudan	Niger
Food	China	India	Brazil	Iran	Egypt
Vaccines	India	Nigeria	Pakistan	Philippines	Brazil

Top 7 Countries that are present in all three risk categories

India, Nigeria, Philippines, Guinea, Benin, Guinea-Bissau

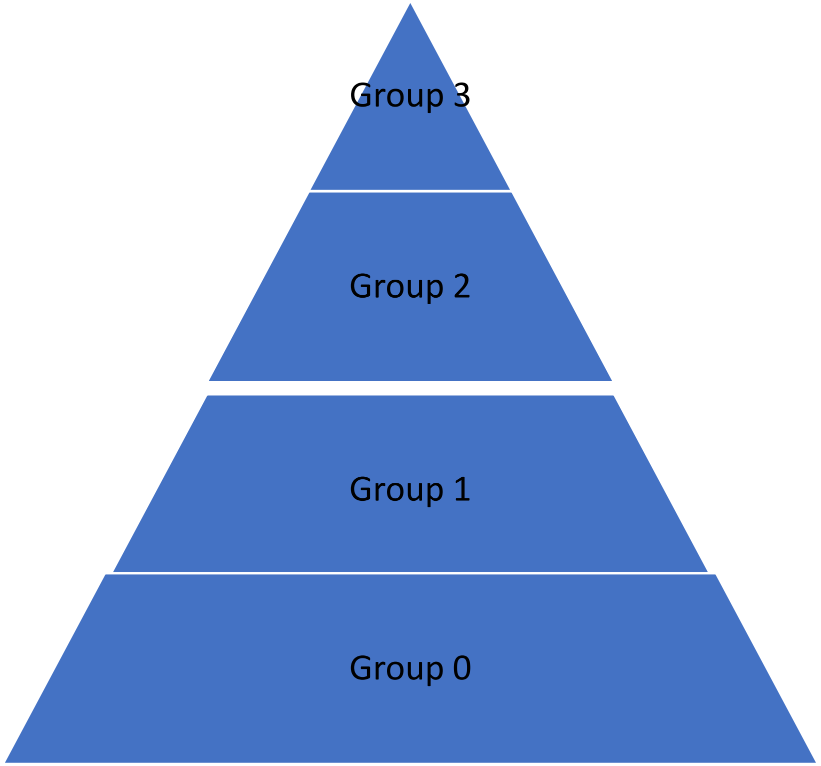
Aggregate Risks for Top 30 Countries

Category	Number	Unit
Buildings	523 million	people at risk
Food	410 million	Tons food wasted
Vaccines	581 million	# people not vaccinated

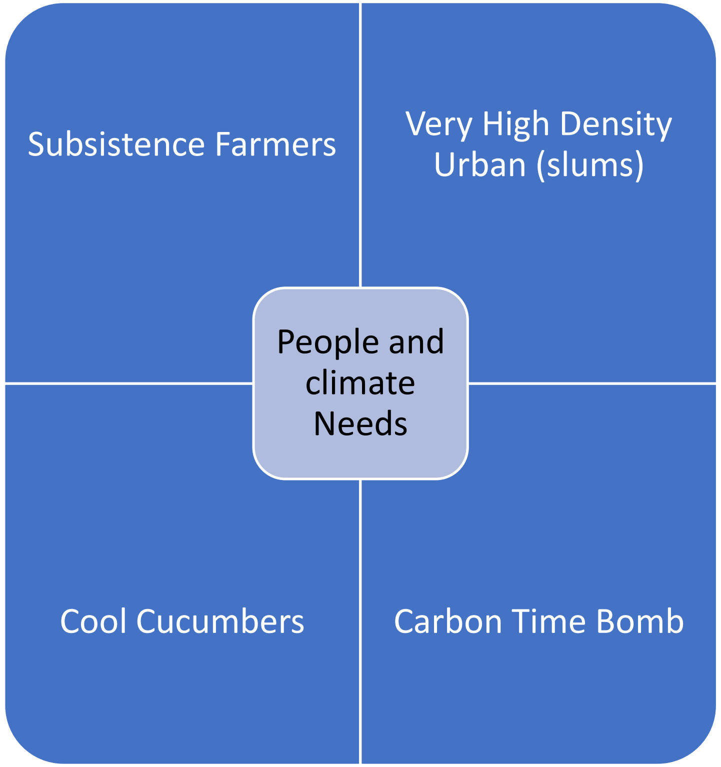
Two Broad Groups plus Groups ….

	Urban	Rural
Group 0	may have access to electricity but housing quality is very poor and their income may not be sufficient to purchase or run even a fan. They may own a fridge but intermittent electricity supplies may mean that food often spoils and there is a high risk of food poisoning.	may not have access to electricity and probably has no access to an intact cold chain which would enable them to sell their products at market at a high price. Medical cold chains may also not be intact putting lives at risk from spoiled vaccines. (perhaps 5-600 million people)
Group 1	An increasingly affluent lower-middle class that aspires to own an air conditioner but is on the brink of buying the cheapest and least efficient. Poor purchasing decisions by these people will see stratospheric increase in energy consumption generated by dirty technology.	Farmer Producer or Village Producer cold chains to urban consumption centres; but could be choosing traditional diesel intensive solutions
Group 2	People that already own an air conditioner but may be in the market to replace it. People that might be attracted to living in new housing developments that could be designed in a more sustainable way.	Transitioning to and investing in in agri-businesses creating growing, rural economies with multiple spin-out businesses; possible international trade

How to approach solutions?



Moving up a ladder?



Solving for the needs of each community in a systemic way

Four Broad Groups
Categorise Issues – and Response Strategies

Subsistence farmers	may not have access to electricity and probably has no access to an intact cold chain which would enable them to sell their products at market at a high price. Medical cold chains may also not be intact putting lives at risk from spoiled vaccines. (perhaps 5-600 million people)
Slum dwellers	may have access to electricity but housing quality is very poor and their income may not be sufficient to purchase or run even a fan. They may own a fridge but intermittent electricity supplies may mean that food often spoils and there is a high risk of food poisoning.
Carbon Time-bomb	An increasingly affluent lower-middle class that aspires to own an air conditioner but is on the brink of buying the cheapest and least efficient. Poor purchasing decisions by these people will see stratospheric increase in energy consumption generated by dirty technology.
Cool Cucumbers	People that already own an air conditioner but may be in the market to replace it. People that might be attracted to living in new housing developments that could be designed in a more sustainable way. Cooling part of leisure.

What is already being done?

Implementation:

- The majority government/international organizations bodies e.g. GIZ, FAO;
- Partnership approaches to promote and incentivize new or more efficient technologies/policies;
- Platforms for exchange of best practices, joint R&D and pushing a joint agenda;
- Local government heavily involved.

Gaps:

- Grass-root organizations or civil society organizations seem absent;
- Private sector development gets little attention;
- Few organizations have a core program which focuses solely on cooling
- Not yet considered a development priority.

Funding and finance:

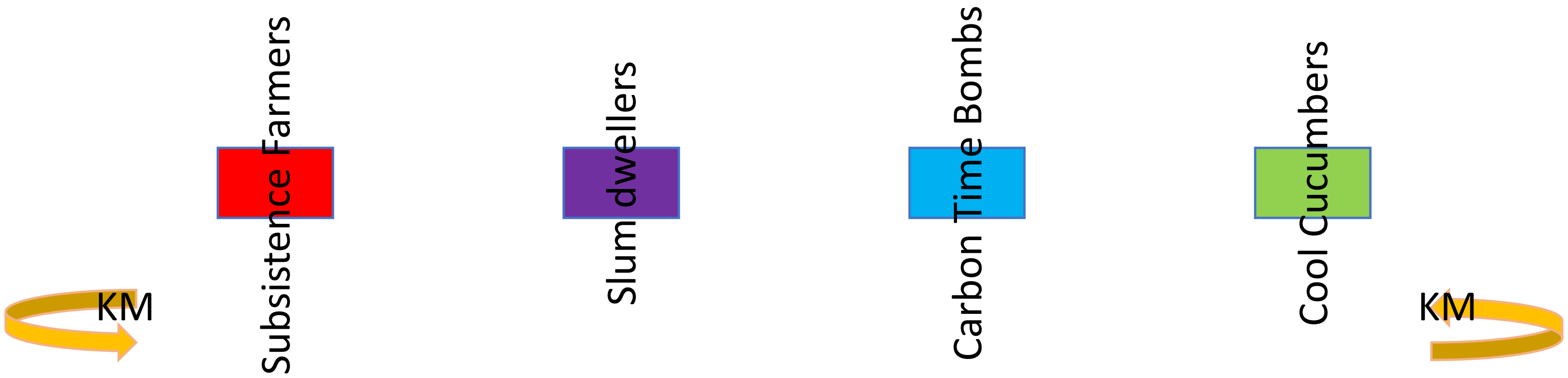
- Since 2000, an estimated US$886.5 million to cold chain ($610.5m), urban environment ($35m) and building sectors ($9m), multi-sector ($232m)– not all of which goes directly towards cooling;
- Funders: EU, Germany, UK, US governments. Bill & Melinda Gates Foundation, Global Environment Facility (GEF)

What is needed?

- Change perceptions: it is not “all about the box”. We need to ensure that new construction pays attention to passive design principles to reduce the cooling demand within a building.
- Think about the cooling needs of buildings and how they fit together as a system – if 40% of buildings in India are yet to be constructed then why not design urban areas for district cooling systems;
- Ensure that new appliances are designed to be efficient as possible and that the energy needed to power up some of these solutions is generated as sustainably as possible;
- Upgrade efforts to connect stakeholders, nurture new business models, provide education and training, create a fertile enabling environment. Well-designed and enforced policies are essential to transform markets;
- Encourage and support smaller, more local manufacturers to build to higher performance standards so that efficient technology is **affordable for all** and not just the better off;
- Shift mindsets and action on many fronts rather than merely a singular, technology focused approach;
- Create a platform for the honest brokering of information and creation of partnerships for action.

Core recommendation

Set of initiatives designed around core needs of demographic groups. Secured by funding for 36 months at least for each



Central Cooling for All Secretariat
Monitor progress, knowledge management, coordination of initiatives, strategic support on project design
Core funding to be secured for at least 40 months

Next Steps

- **May 2-3, SEforALL Forum, Lisbon:** discussion with stakeholders/audience to think through market solutions, test-drive some of the material and messaging, with comments feeding into the second draft of the public report **(HINT: COME TO LISBON, the climate is better than Birmingham)**;
- **July 9-13**, **High Level Political Forum, New York:** launch week for the public report. Announcement on secretariat?
- **September 2018, Climate Week** – announcement of first new programs

Thank You and See you in Lisbon

PLENARY DISCUSSION ONE

COOL CITIES GETTING READY FOR 6BN URBAN RESIDENTS

Ingo Wagner, CoolingEU (chair)

Professor Graeme Maidment, London South Bank University

Guillermo Martinez, Araner

#CoolWorldCongress
WWW.BIRMINGHAM.AC.UK/ACOOLWORLD

Cool (and heat) in cities -
Getting ready for 6Bn urban residents

Graeme Maidment
London South Bank University

London South Bank University
EST 1892

Content

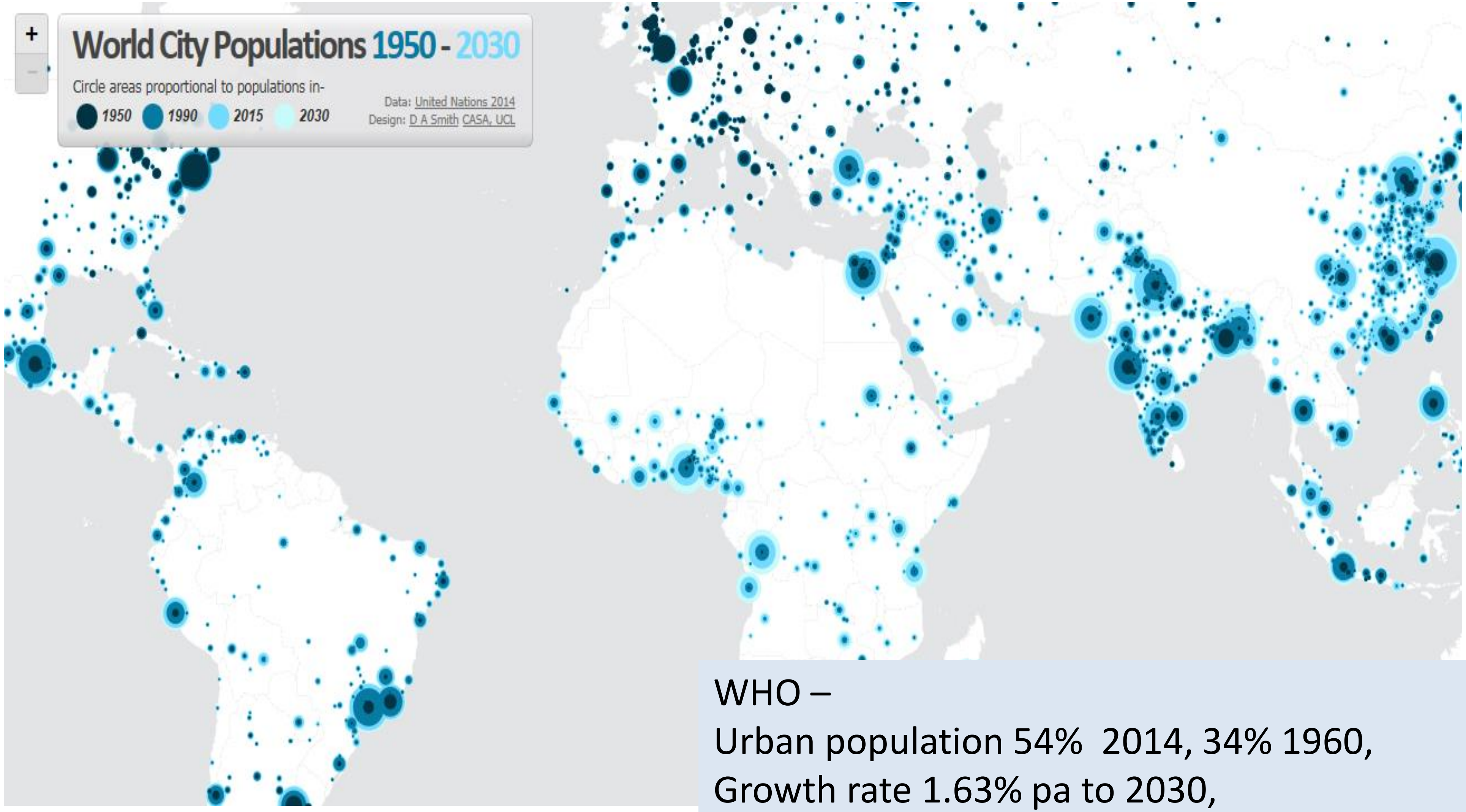
- Urbanisation - what it is and why it happens
- The challenges for cooling (and heating) for resilient urban areas
- Some potential solutions and ways forward

Urbanisation?

What is urbanisation

- ONS defines urban as >10,000 population

Trends in urbanisation

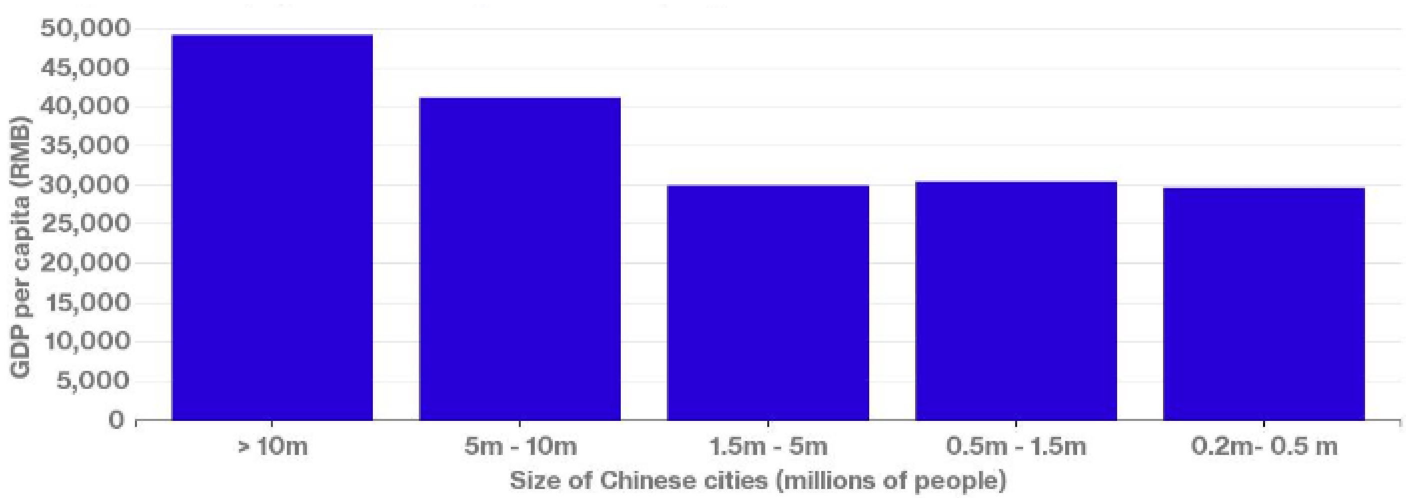


http://luminocity3d.org/WorldCity/#3/11.26/16.00

WHO –
Urban population 54% 2014, 34% 1960,
Growth rate 1.63% pa to 2030,
77million people pa moving to urban areas,
More movement in less developed regions

Drivers for urbanisation

- Security
- Infrastructure
- Transport
- Clustering
- Politics
- Productivity



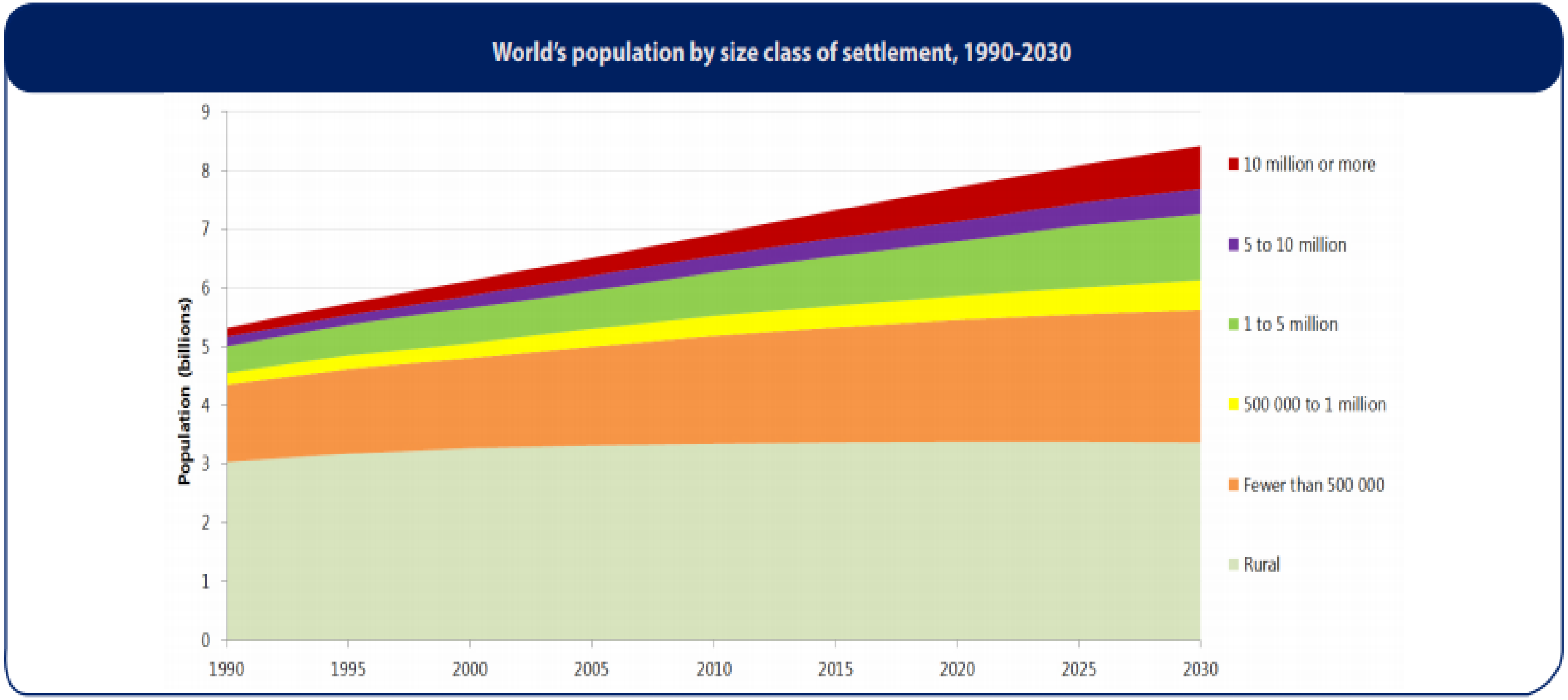
Source: OECD, based on data from National Bureau of Statistics of China

Urbanising the right way…

- Our current urban population of around 3.9 billion is expected to grow to around 6.34 billion by 2050
- If not done right results in urban sprawl, inefficiency and social inequality

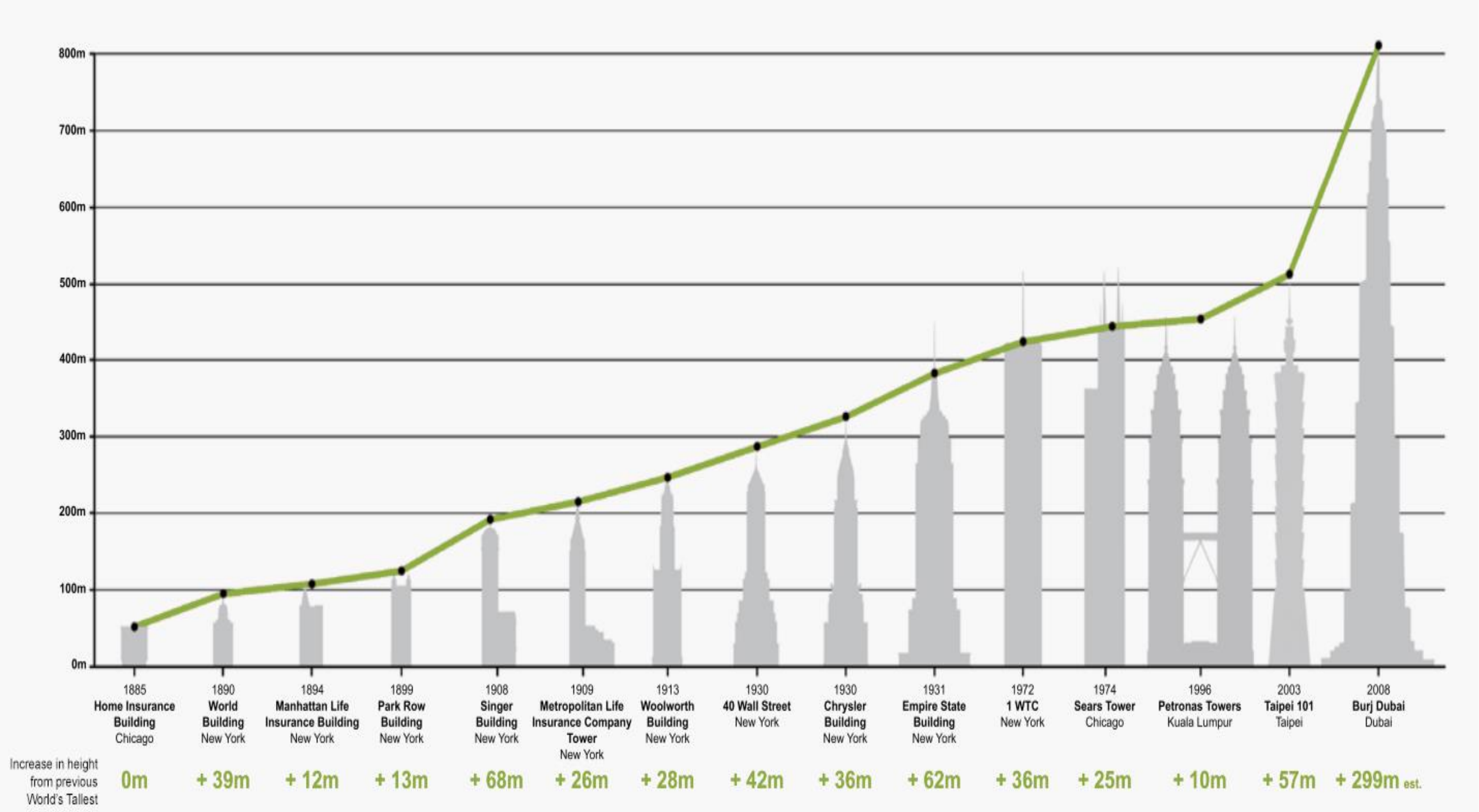
http://wcr.unhabitat.org/wp-content/uploads/2017/02/WCR-2016_-Abridged-version-1.pdf

Growth in mega-cities



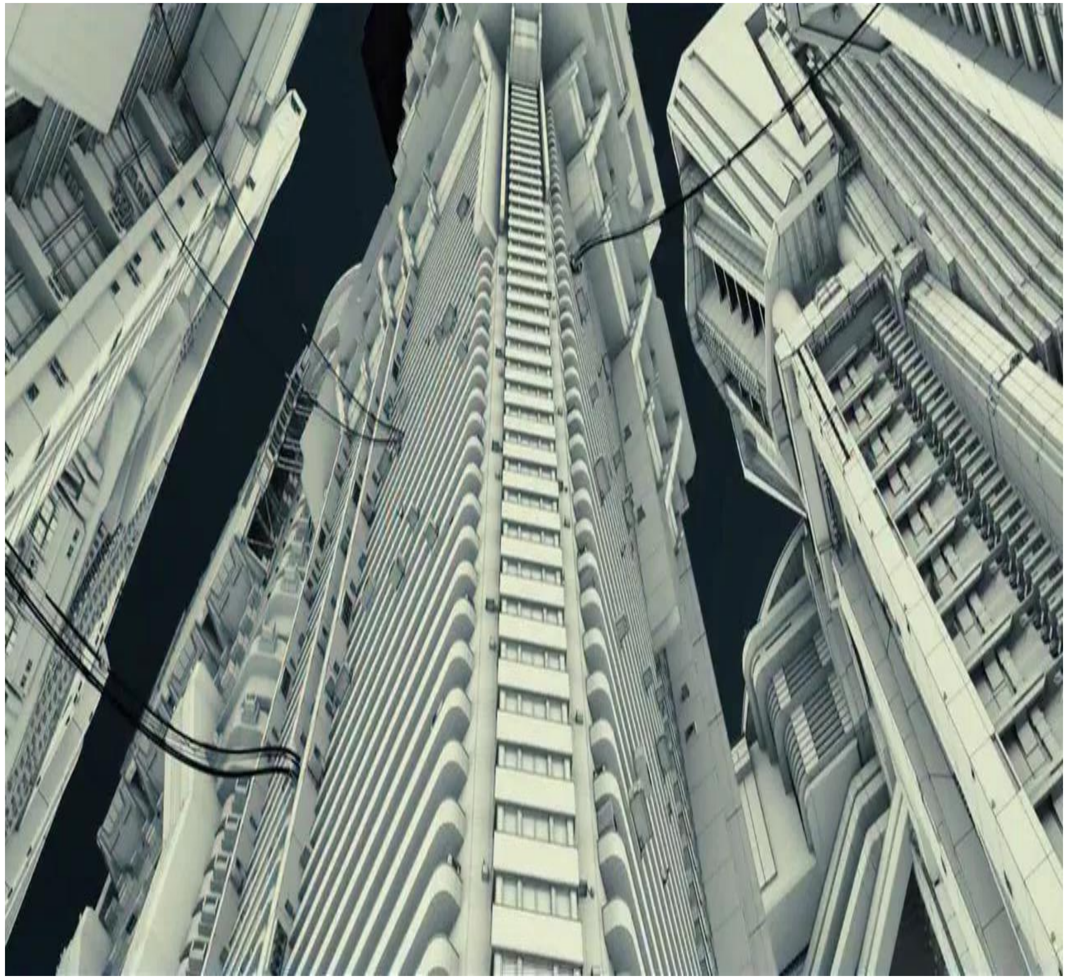
http://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf

Growth in mega-buildings



https://www.aurecongroup.com/-/media/images/aurecon/web-structure/thinking/latest/2015/tall-buildings-past-and-present-trends/tallest-buildings.ashx?la=en

A 2049 City?



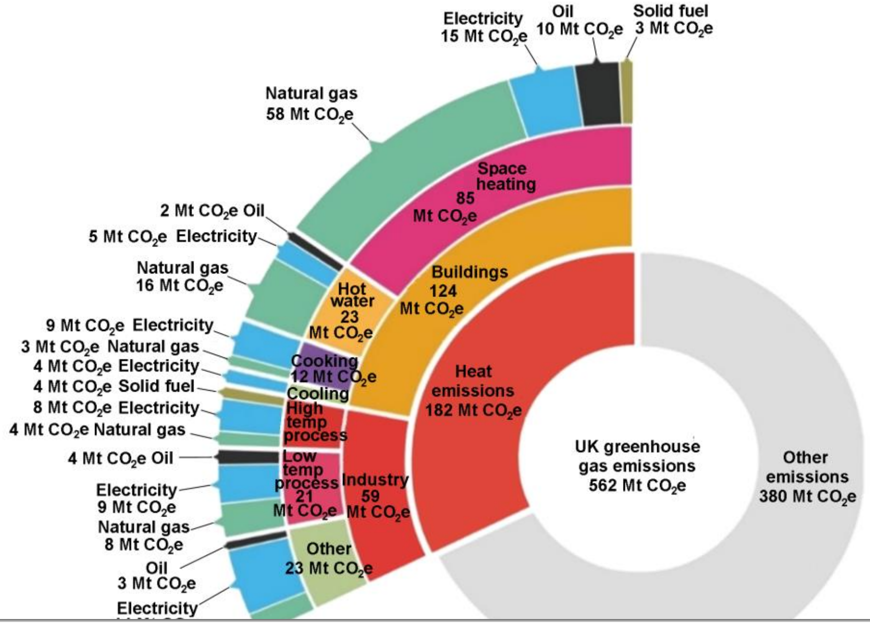
- Some cities will have a few buildings over 1km tall, possibly 10km + spaceport up to 30km high
- A 1km building could have 200 floors, shops, offices or services, 40,000 basic flats for 50,000 inhabitants

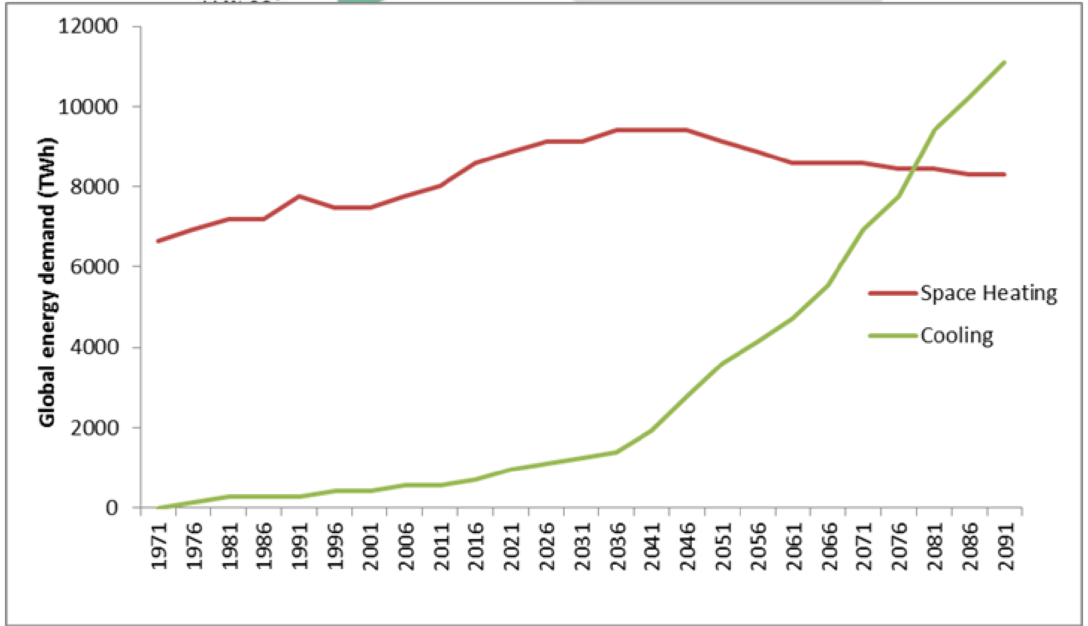
https://timeguide.wordpress.com/tag/mega-buildings/

The Cooling (and Heating) Challenge for resilience

Carbon emissions and energy use

- The Climate Change Act (UK) - 80% reduction in carbon emissions by 2050

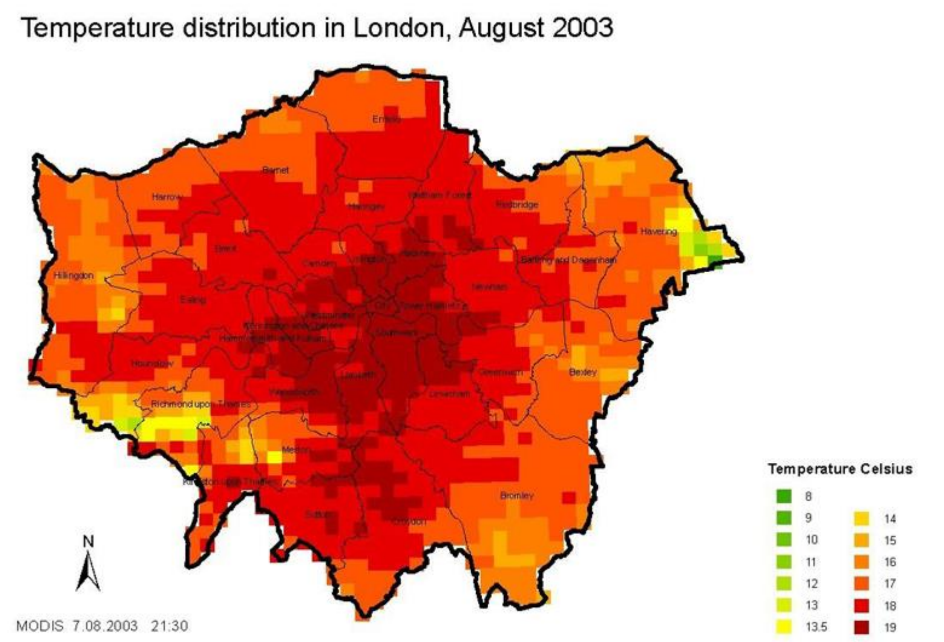


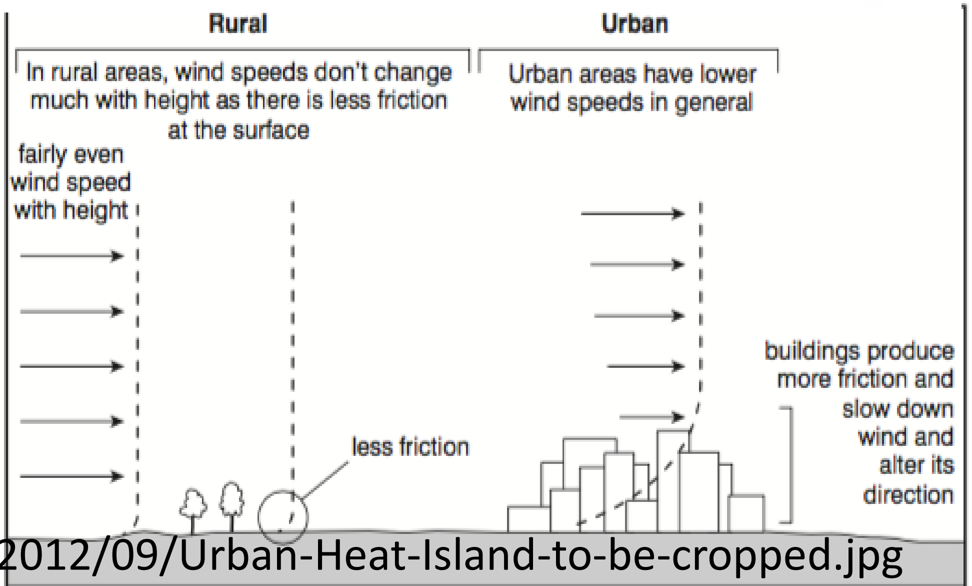


Weather extremes

- Hottest temp - 38.5 °C - Kent - August 2003
- Warmest month July 2006,
- Coldest Dec 2010
- Highest 2-day total rainfall 405 mm Thirlmere, Cumbria
- 2015Wettest June ever 2012

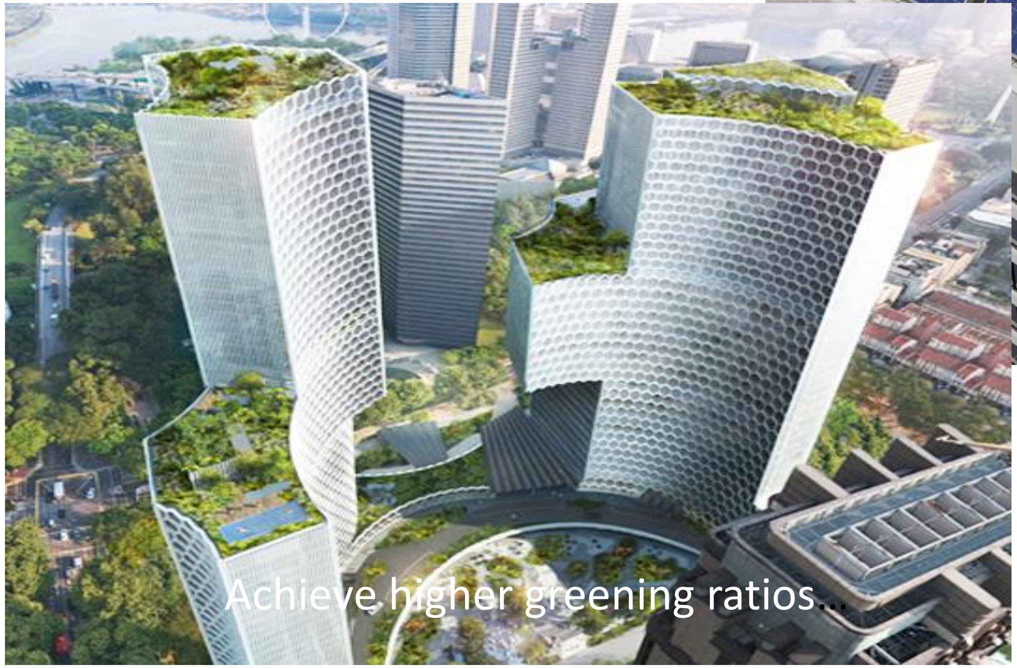
Heat island effect



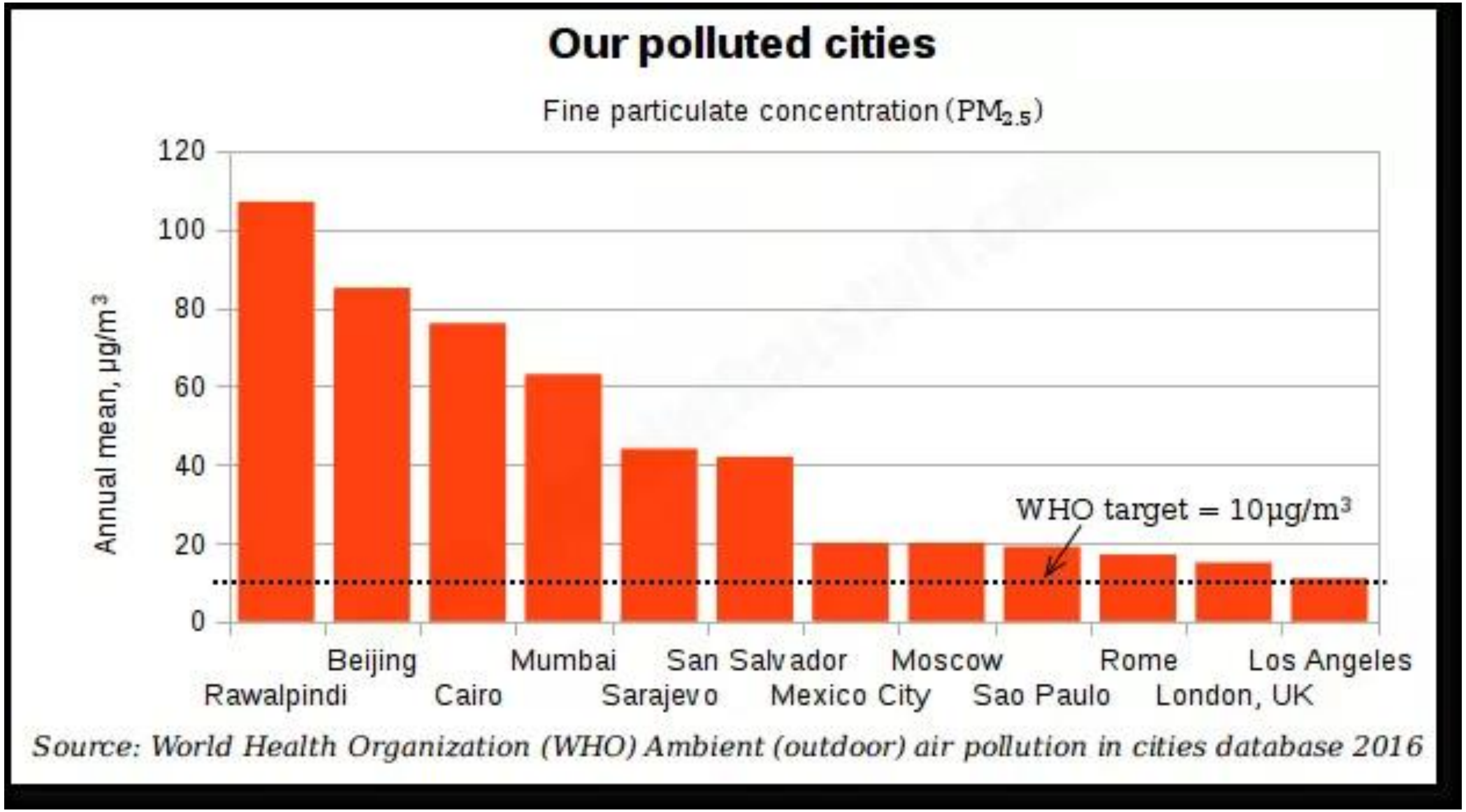


http://climatelondon.org/wp-content/uploads/2012/09/Urban-Heat-Island-to-be-cropped.jpg

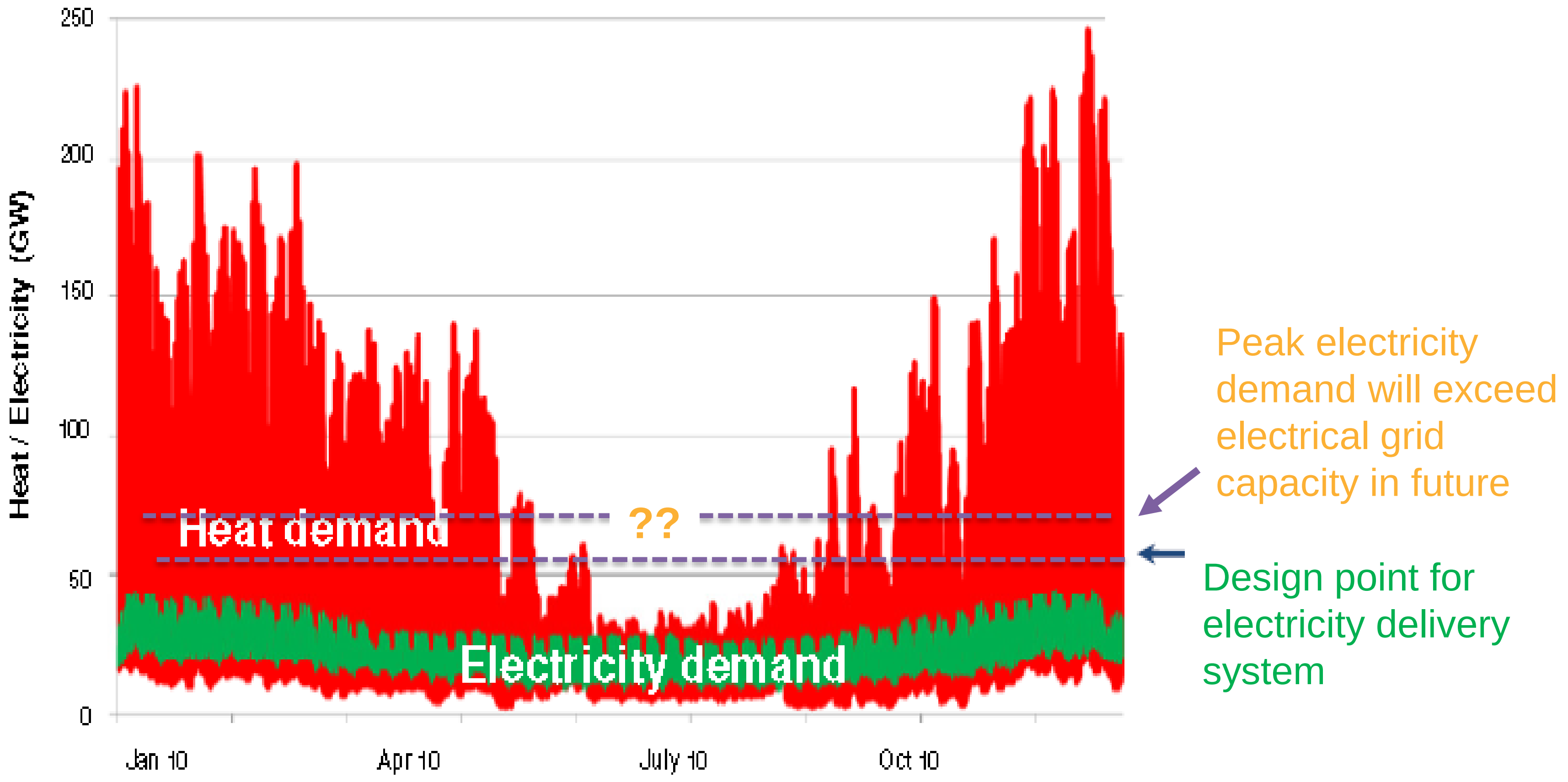
Space for plant



Local particulates



Limitations of the electricity grid



Source: Energy Technologies Institute, 2012

2010 UK heat & electricity hourly demand variability

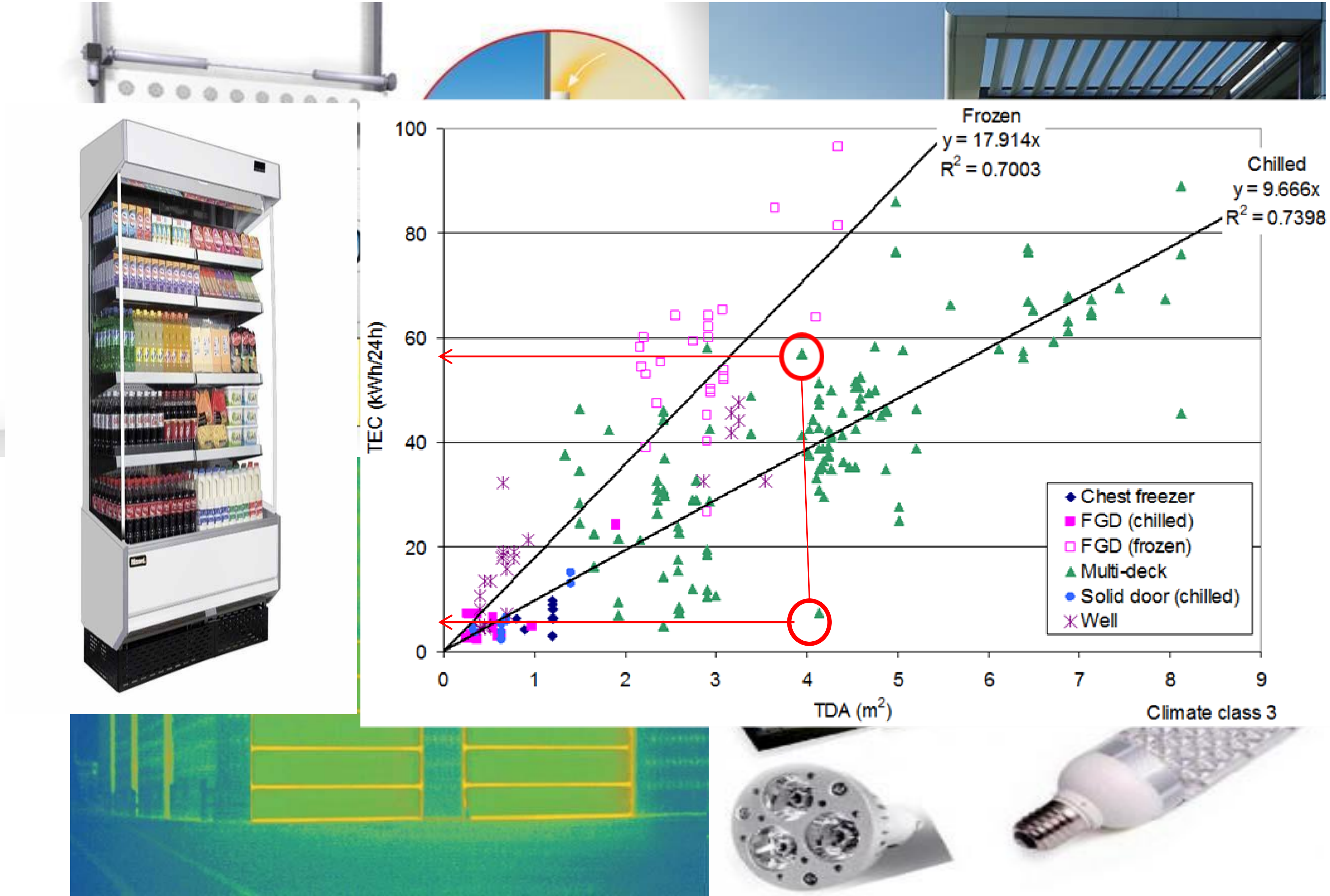
Some potential solutions and ways forward

A possible way forward

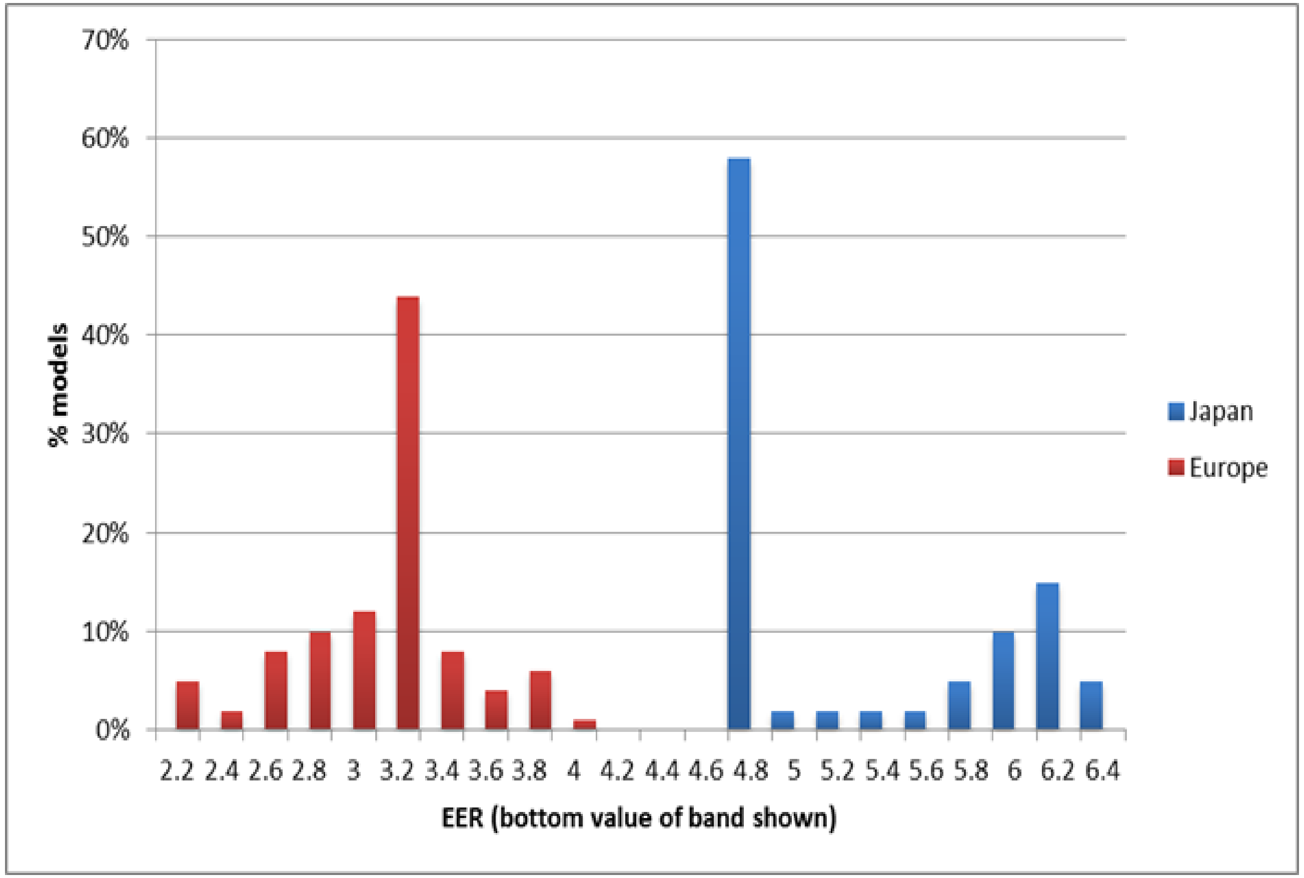
1. Reduced need for cooling - applications and components
2. Increased efficiency – components, systems and integration
3. Using lower carbon electricity - integration

An 80% reduction can be achieved by improving each of these 3 by 40% i.e. 0.6 x 0.6 x 0.6 = 0.216 or 78.4% reduction

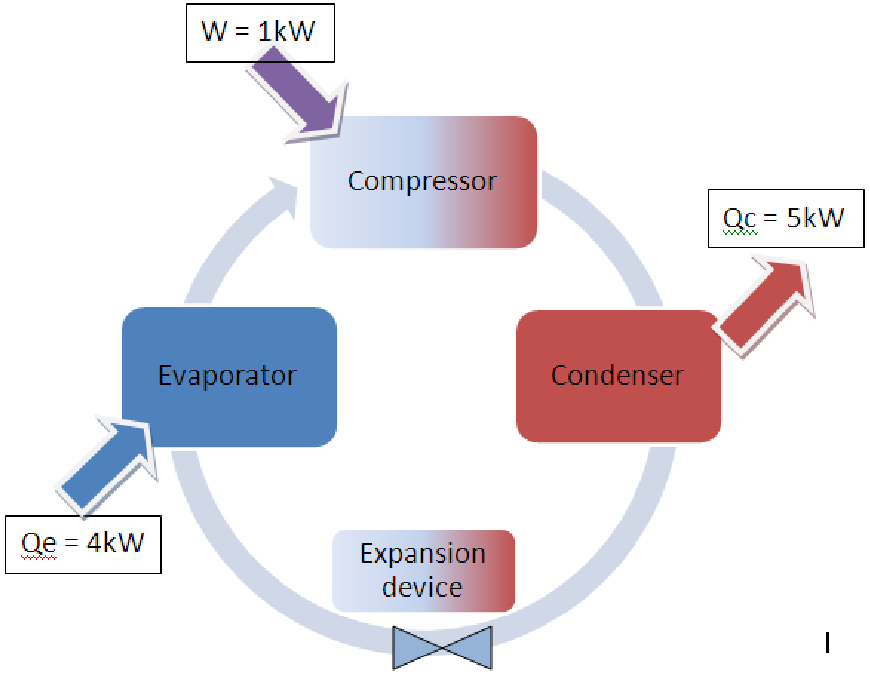
1. Reduced need for cooling - applications and components



2. Increased efficiency – components and systems



2. Increased efficiency through integrated heating and cooling

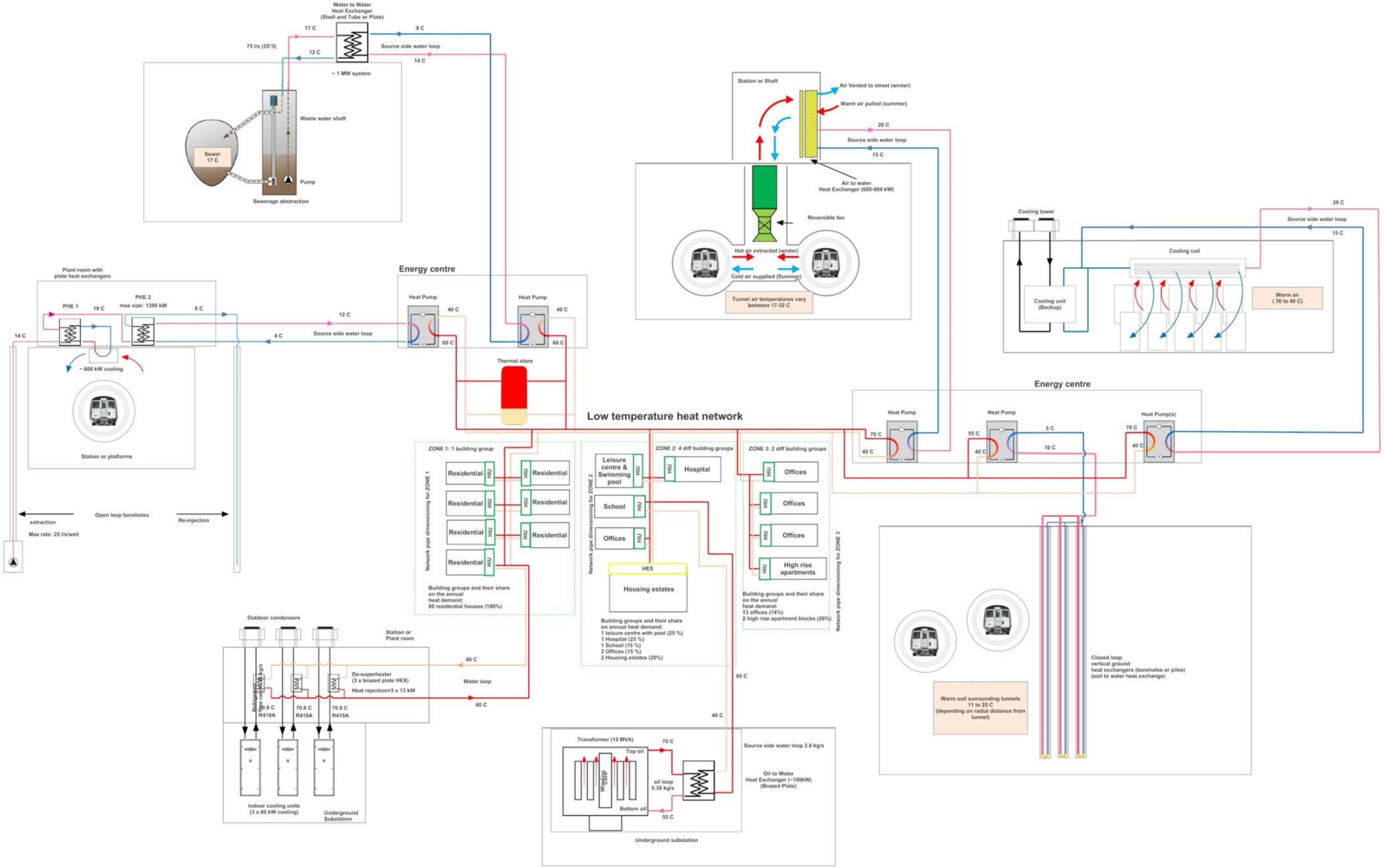


CoP_c = Qe/ W = 4/1

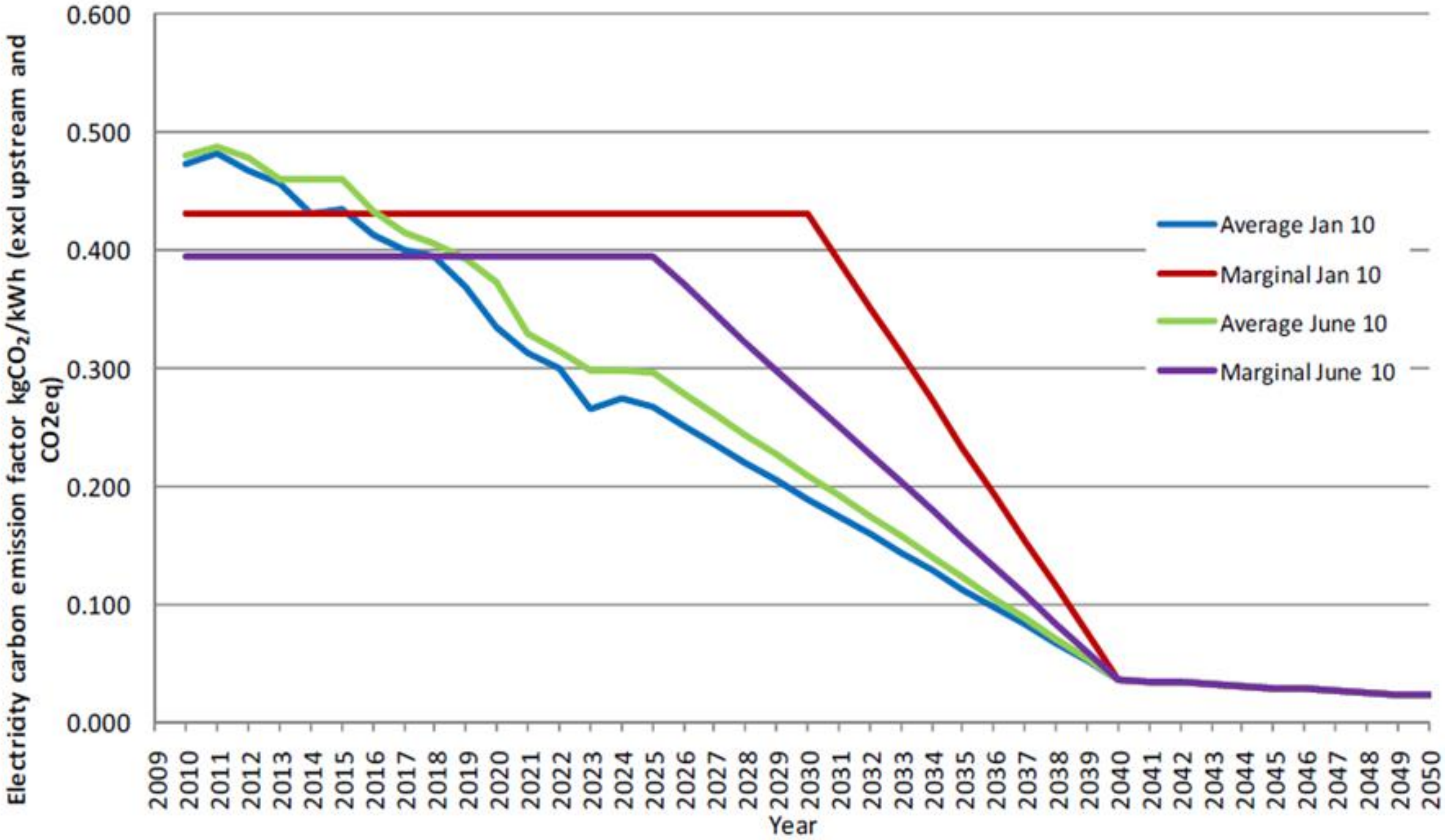
CoP_h = Qc/ W = 5/1

CoP_{h+c} = (Qc + Qe)/ W =9

Project LUSTER – City Wide integrated heating and cooling



3. Using low carbon electricity - integration



CryoHub – integration with renewables

- Developing Cryogenic Energy Storage at Refrigerated Warehouses as an Interactive Hub to Integrate Renewable Energy in Industrial Food Refrigeration and to Enhance Power Grid Sustainability
- Horizon 2020 project (H2020-LCE-2015-3)
- Large scale energy storage
- 42 month project
- Started April 2016
- ~8.1 € million funded (7€ million grant)
- 14 partners across Europe

Cooling and heating in our cities in 2050?

Questions

Londons tunnelbana värmer bostäder

STORBITANNIEN. Passagerare och tågmotorer i tunnelbanesystem genererar avsevärda mängder värme. Under 2006 nådde temperaturen på Central Line i Londons tunnelbanesystem hela 47 °C (BBC 2006).

Skulle denna värme kunna återvinnas samtidigt som tunnelbanan blev svalare? Två sådana system, ett under uppbyggnad och ett annat i planeringsstadiet, finns i London.

Enligt professor Graeme Maidment från London South Bank University, installeras ett system vid den oanvända stationen City Road på Northern Line. Värme mellan temperaturerna 17 °C till 28 °C kommer att utvinnas från ventilationsschakten. En ammoniakvärmepump kommer att förse 500 bostäder i bostadsområdet Bunhill med 75 °C värme via ett fjärrvärmenät. Systemet har effekten 380 kW och kompletterar det befintliga värme- och elsystemet.

Ett nytt projekt i planeringsfasen har fått namnet Micah (Metropolitan Integrated Cooling and Heating). Det kommer att installeras på Piccadilly Line och ska förse lägenheter och en simhall med värme. Kyleffekten är 900 kW. En specialbyggd ammoniakvärmepump levererar 70 °C värme till lägenheterna och simhallen.

Jeffrey Spitler
Översättning: Signhild Gehlin

Graeme Maidment.
FOTO: JEFFREY SPITLER

46 ENERGI&MILJÖ NR 6-7 JUNI-JULI 2017

Reducing Energy Demand | Research Councils UK

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TUNNEL VISION - TAKING HEAT FROM BENEATH THE STREETS

July 24, 2017

Members of the i-STUTE and CEE teams have won a £200k grant to investigate recovering heat from London's subterranean tunnels.

Mail Online News

Home | News | U.S. | Sport | TV&Showbiz | Australia | Femail | Health | Science | Money | Video | Travel | Fashion Finder

The Tube as you've never seen it before: Amazing picture of London underground workers is among the winners in science photo contest

- Photo, taken by Akos Revesz, won second place in Engineering and Physical Sciences Research Council contest
- Judging panel of the EPSRC science photo competition consider images that demonstrate research in action
- Categories of contest, which is in its third year, include 'People', 'Weird and wonderful', 'Eureka' and 'Innovation'
- The winning photos include images of computer chips, brain cells, mating Costa Rican frogs and a robot teacher

LSBU's Akos Revesz presented his i-STUTE work on waste heat recovery at an event in Xi'an China.

TUNNEL VISION - TAKING HEAT FROM BENEATH THE STREETS

July 24, 2017

Members of the i-STUTE and CEE teams have won a £200k grant to investigate recovering heat from London's subterranean tunnels.

Underground river to cool passengers on sweltering Tube

By Ben Webster
Transport Correspondent

Mail Online News

Home | News | U.S. | Sport | TV&Showbiz | Australia | Femail | Health | Science | Money | Video | Travel | Fashion Finder

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LATEST COOLING TECHNOLOGIES

DISTRICT COOLING INTEGRATION

A Cool World

1st International Congress on Clean Cooling

18th - 19th April, University of Birmingham

UNIVERSITY OF BIRMINGHAM | BIRMINGHAM ENERGY INSTITUTE

ARANER

AGENDA

- Introduction to District Cooling
- Integrating the Production of Different Energy Types
- Integrating different consumers in the same central cooling plant
- Integrating the central cooling plant with the environment

AGENDA

- **Introduction to District Cooling**
- Integrating the Production of Different Energy Types
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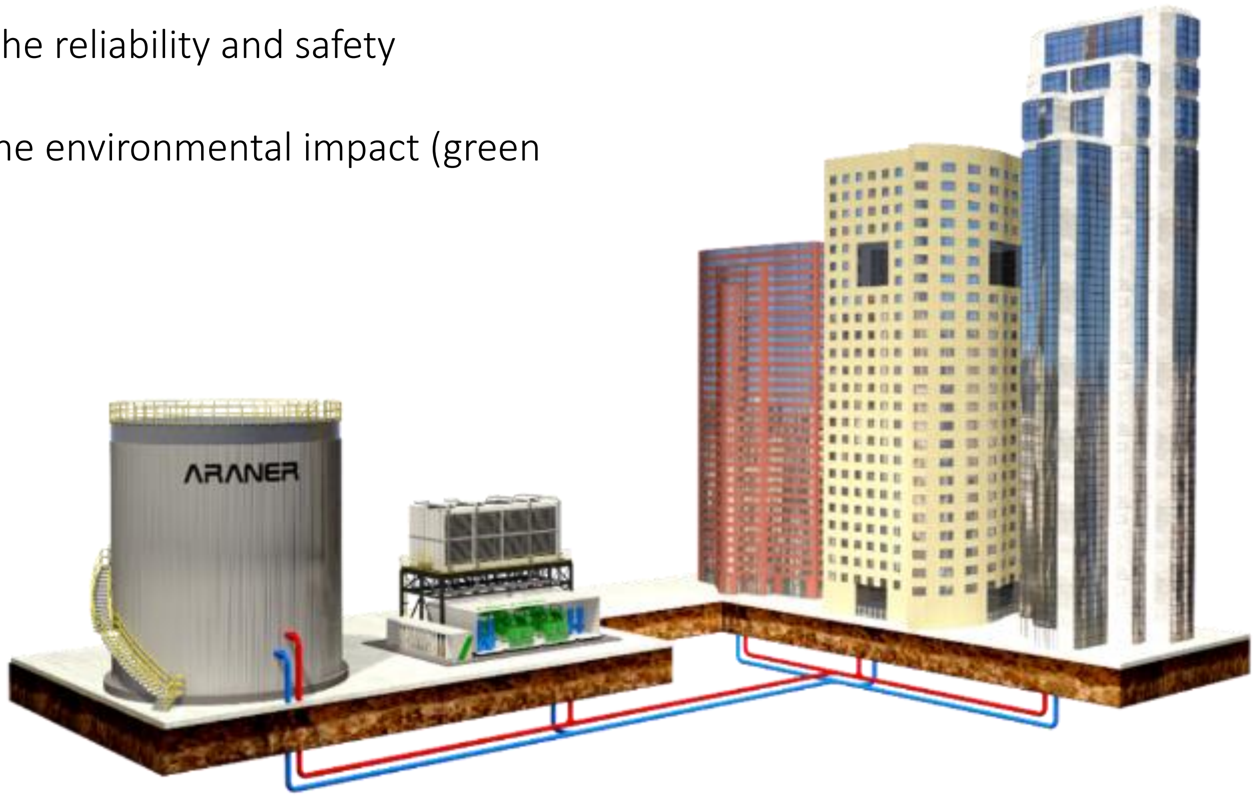
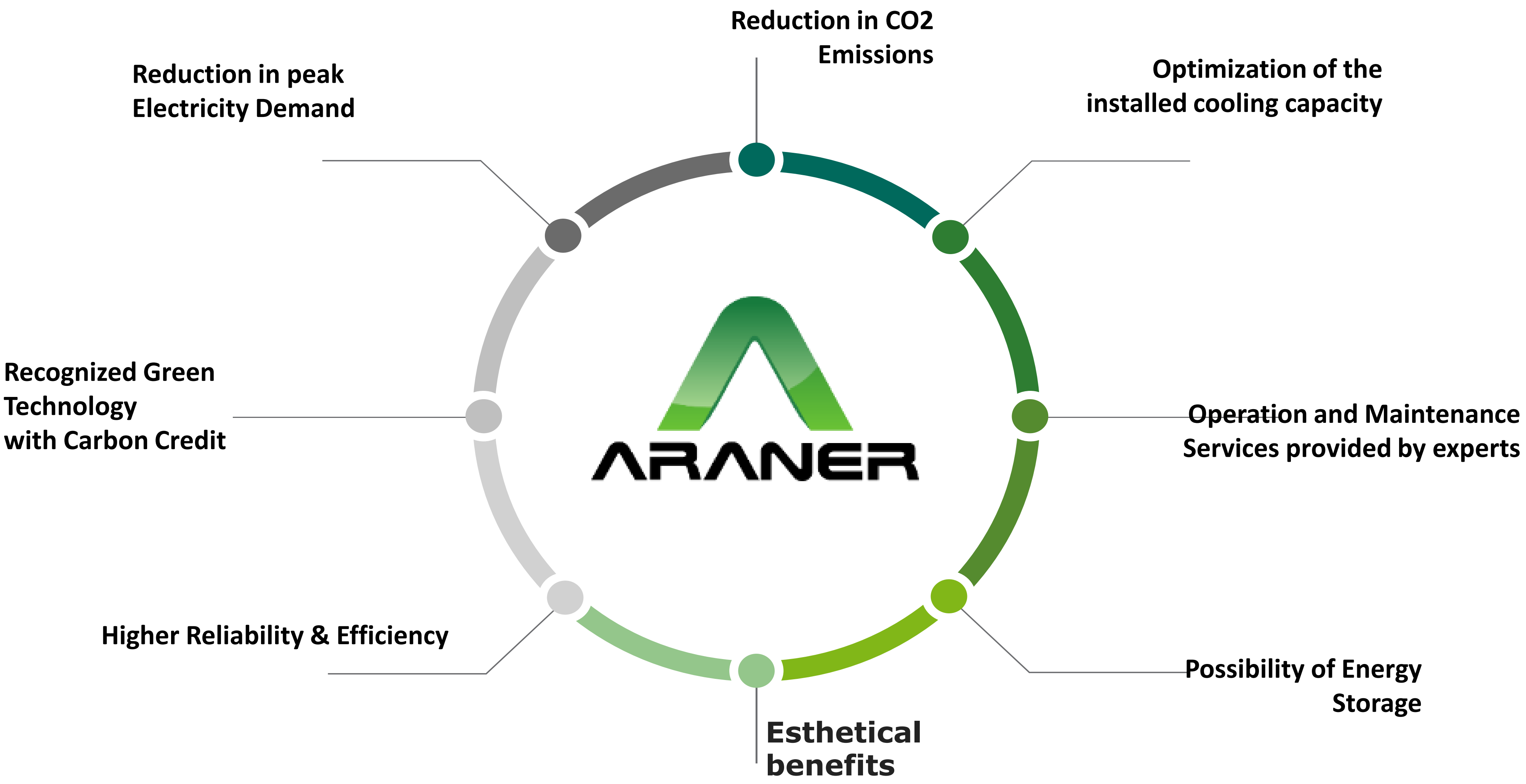
DISTRICT COOLING

- Centralized production and distribution of Cooling Energy
- District cooling is an integral energy infrastructure to reduce strain on the electric grid caused by increasing demands for air conditioning, which typically create 50%-70% of peak electricity demand
- Industrial-grade equipments and industrial practices ensure the reliability and safety
- Adding a thermal energy storage can reduces the costs and the environmental impact (green technology)



BENEFITS OF DISTRICT COOLING



AGENDA

- Introduction to District Cooling
- **Integrating the Production of Different Energy Types**
- Integrating different consumers in the same central cooling plant
- Integrating the central cooling plant with the environment

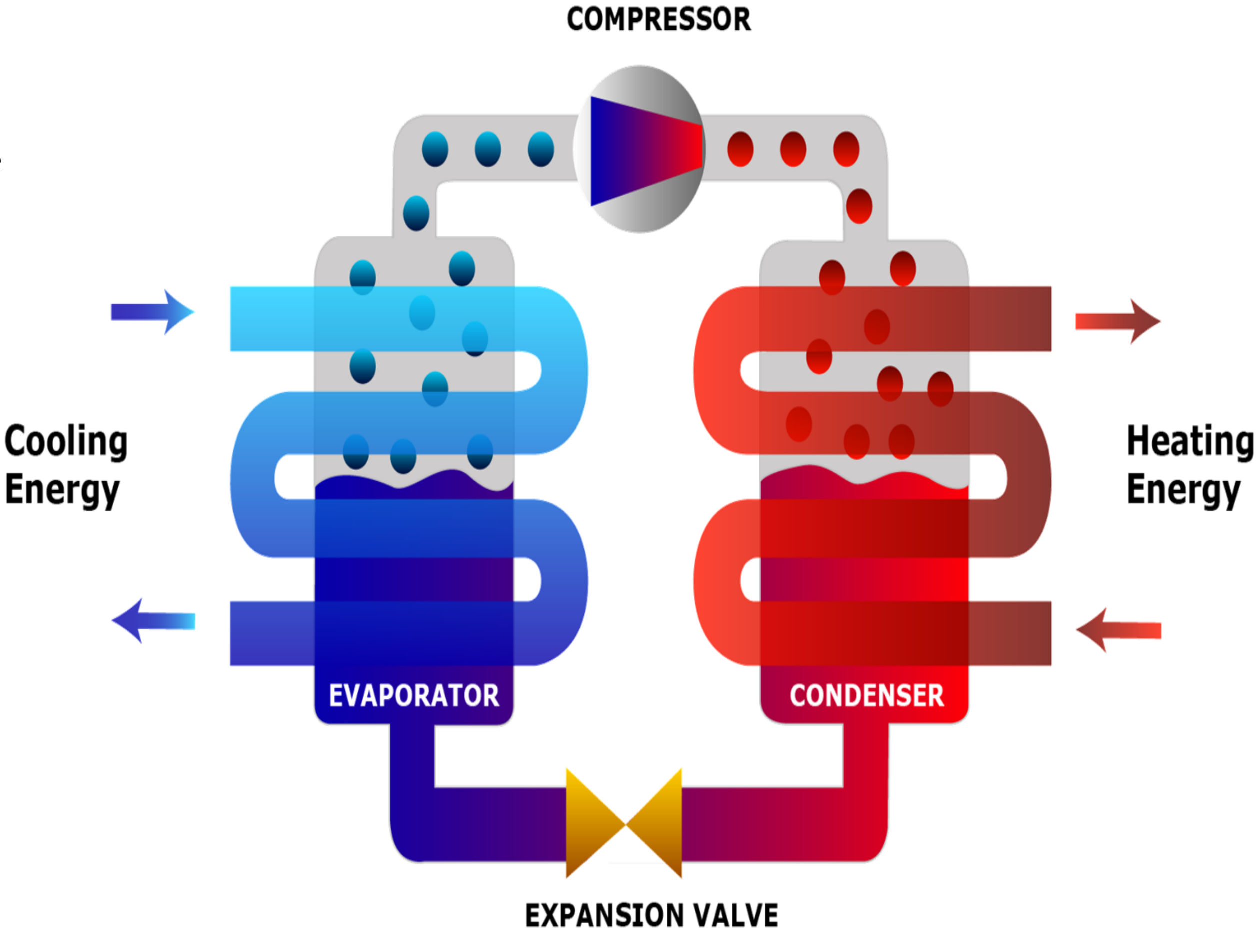
BIGENERATION: HEAT PUMP

BIGENERATION

- A lot of consumers need heating and cooling energy at the same time: eg. Hotels, Hospitals
- Combining the production of both can result in a very efficient solution.

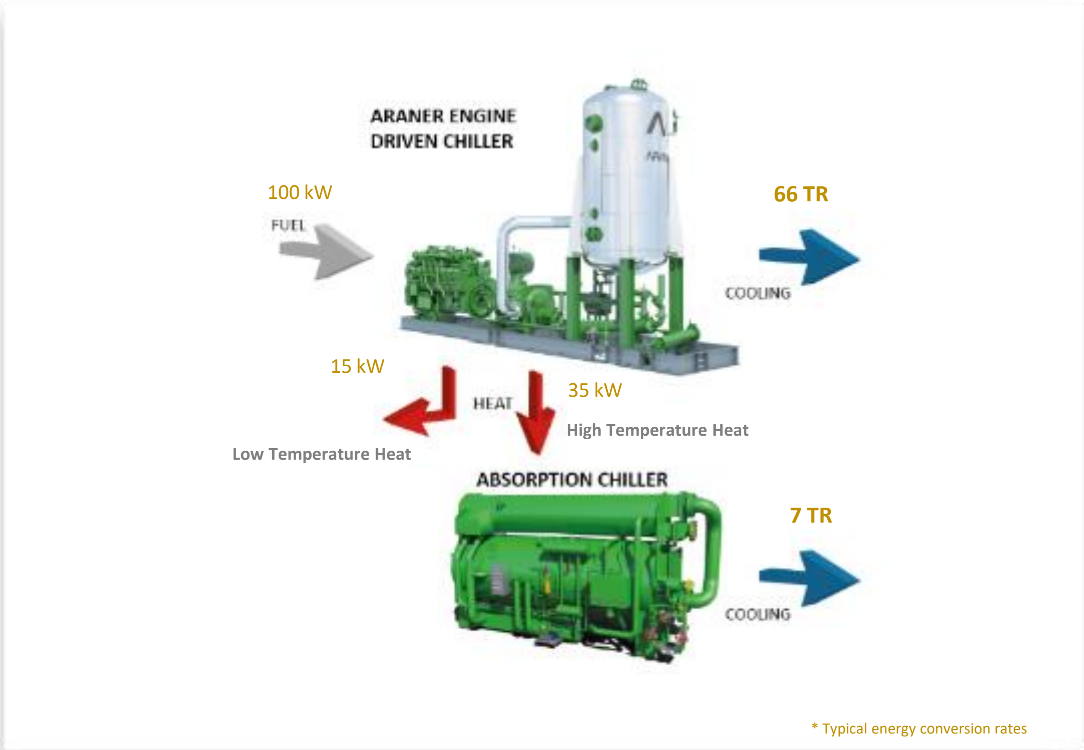
HEAT PUMP

- Production of cooling and heating energy from electrical source
- Cooling and heating energy must be balanced
- It can be combined with Thermal Energy Storage



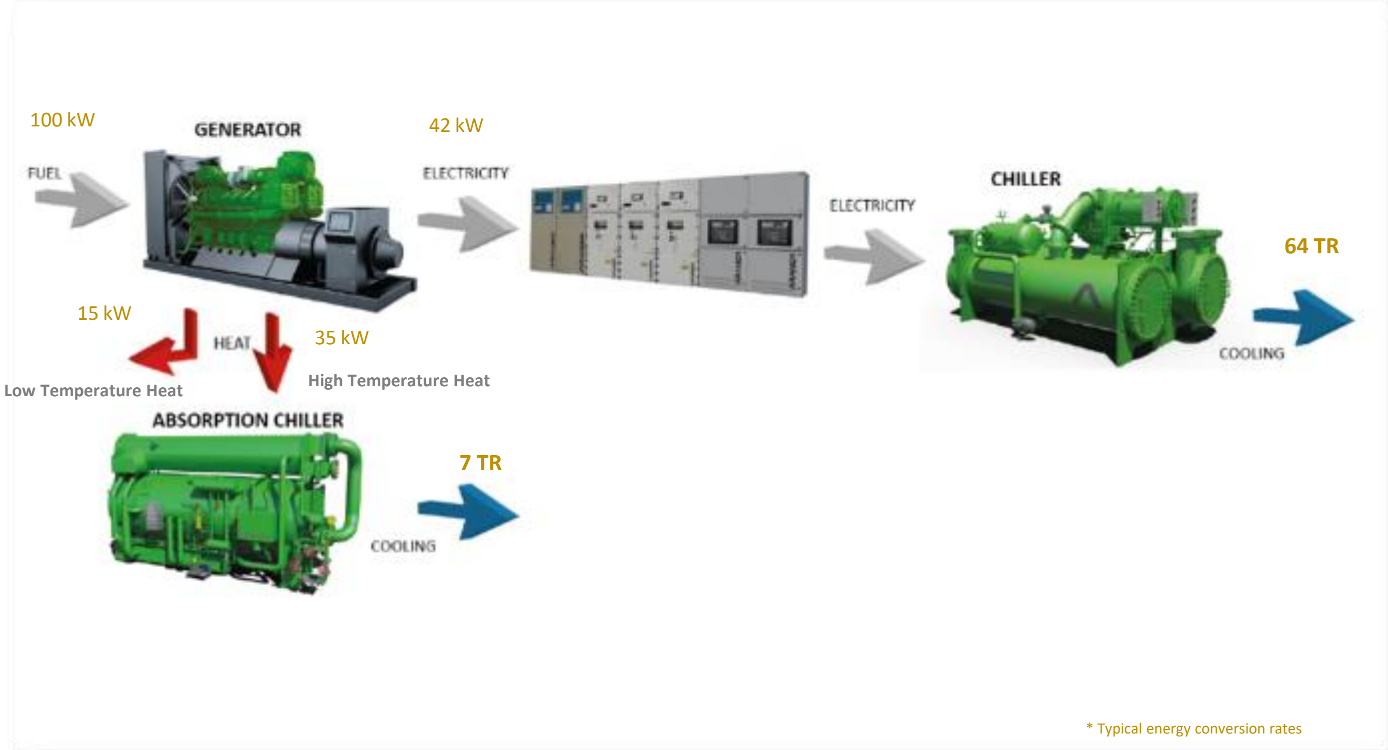
ABSORPTION

BI-GENERATION

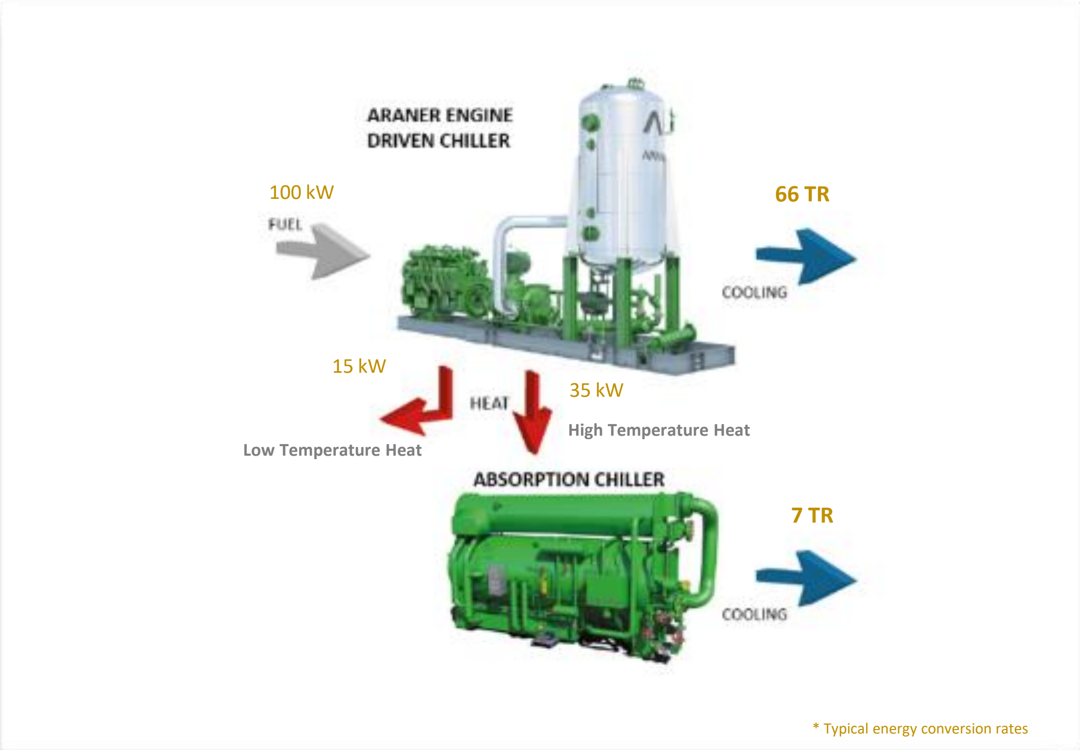


	Absorption	Bi-generation
FOOTPRINT	Medium	Medium
WATER CONSUMPTION	High	Medium
FUEL EFFICIENCY	Medium	Very High
MAINTENANCE	Medium	Medium

TRI-GENERATION



BI-GENERATION



	Tri-generation	Bi-generation
FOOTPRINT	High	Medium
WATER CONSUMPTION	Medium	Medium
FUEL EFFICIENCY	High	Very High
MAINTENANCE	High	Medium

BIGENERATION: HEAT PUMP

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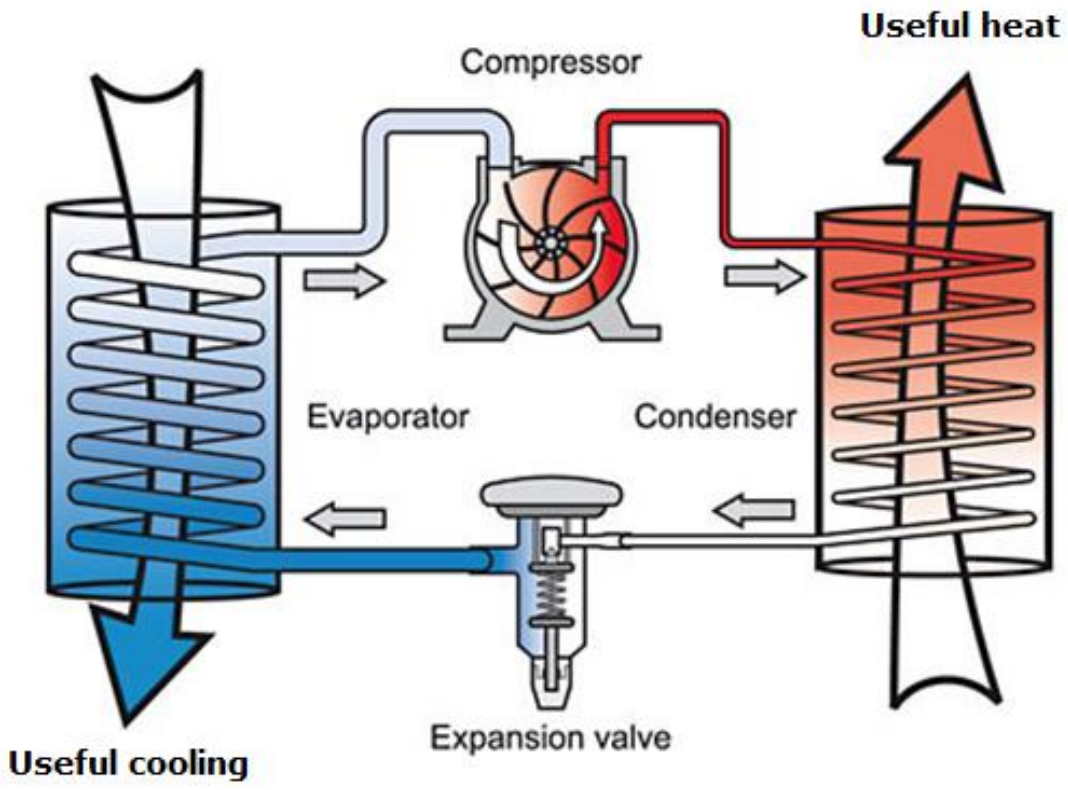

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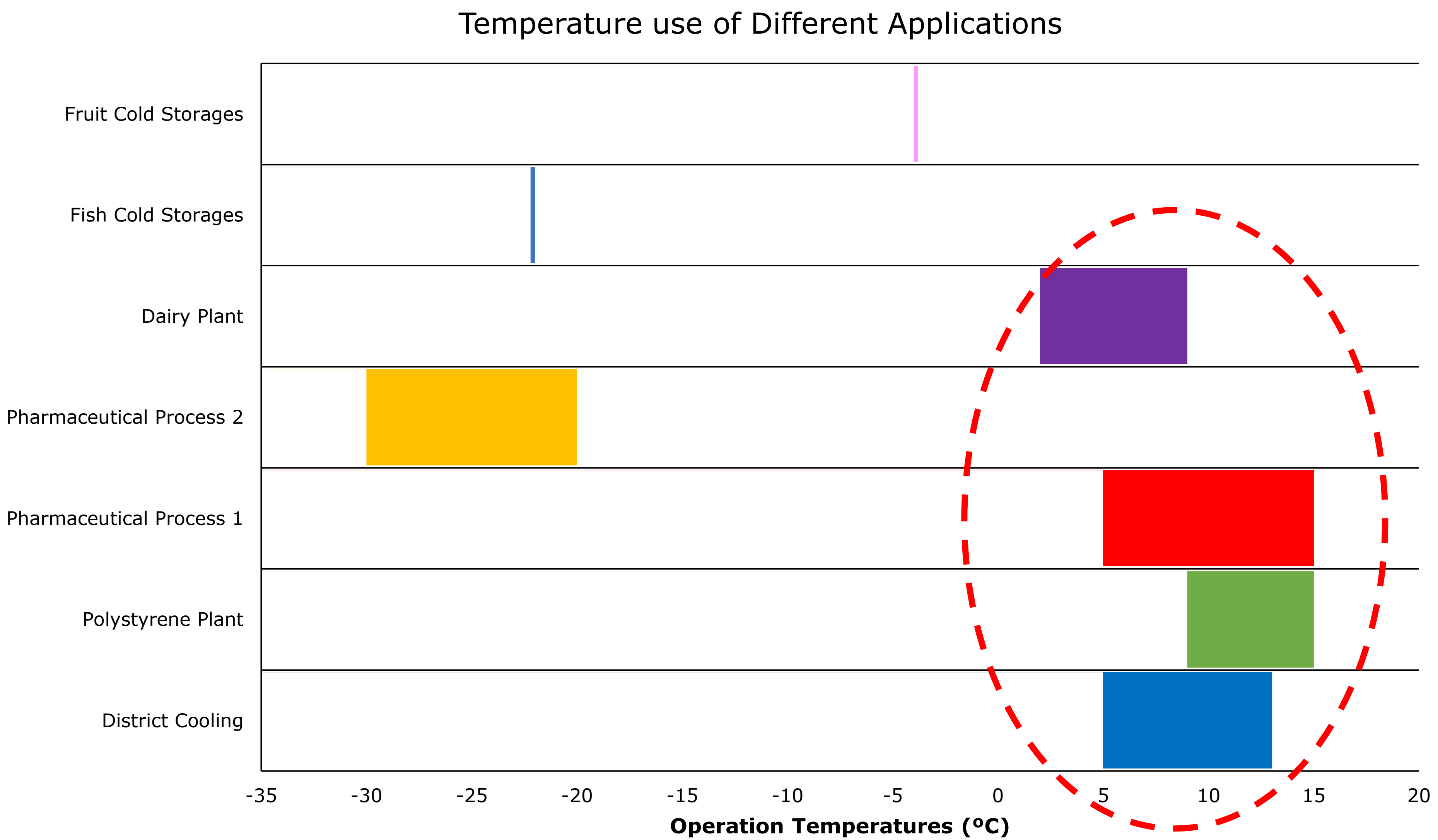
ARANER

DIFFERENT INDUSTRIES NEED COOLING

TYPICAL TEMPERATURES OF DIFFERENT APPLICATIONS

- District Cooling Temperatures: 5 / 13 ºC
- Polystyrene Plant: 9 / 15 ºC
- Pharmaceutical Process 1: 5 / 15 ºC
- Pharmaceutical Process 2: -30 / -20 ºC
- Dairy Plant: 2 / 8 ºC
- Fish Cold Stores: -23 ºC (evaporation at -30 ºC)
- Fruit Cold Stores: 5 ºC (evaporation at -2 ºC)

DIFFERENT INDUSTRIES NEED COOLING



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ARANER

DISTRICT COOLING HEAT REJECTION

ARANER

COOLING TOWER EVAPORATIVE

- Low electrical consumption
- High water consumption (can work with TSE)
- Cooling Water required
- Periodical chemical treatment required
- Potential risk of Legionella Contamination

DRY CONDENSATION

- Higher Electrical Consumption
- Better efficiency at night with low peak tariff
- No water consumption
- No Cooling Water pumps
- Low and economical operation and maintenance
- Clean system with no potential risk of contamination

SEA WATER

- Low Electrical Consumption
- No water consumption (water is passed through)
- Special materials are needed (Titanium)
- The river or the sea water must be close to the power plant

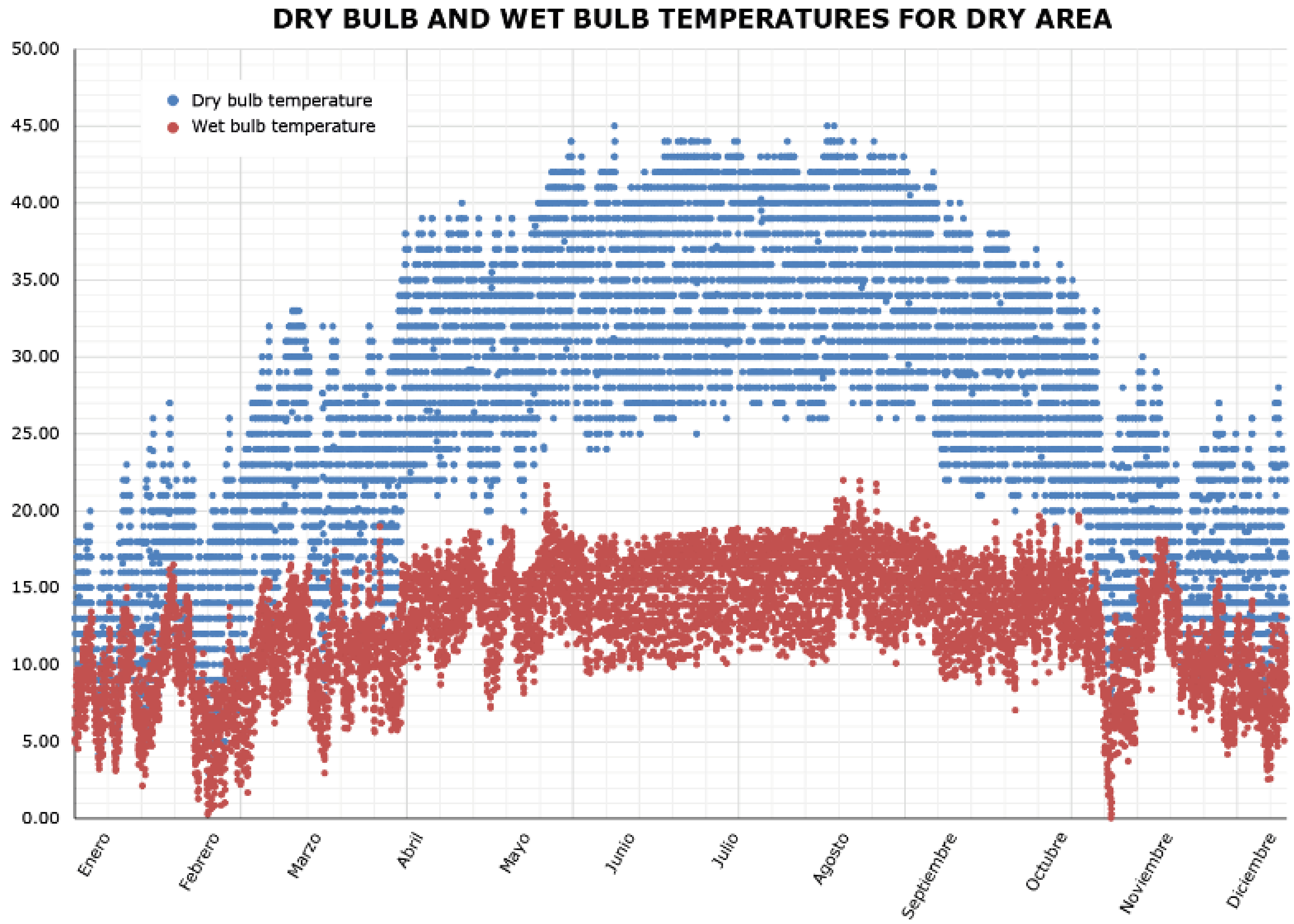
DISTRICT COOLING HEAT REJECTION

COMPARISON OF TECHNOLOGIES

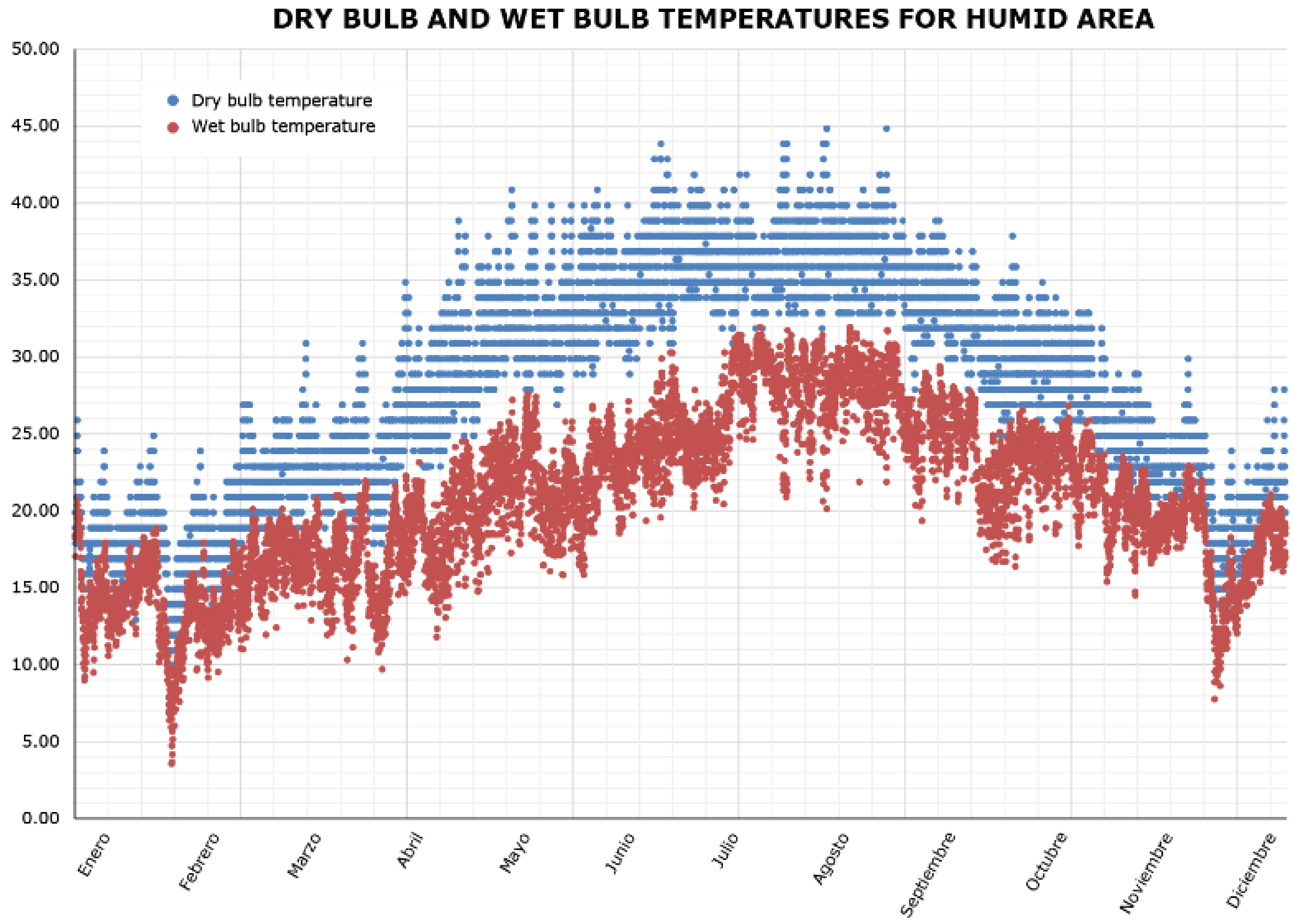
WORST DESIGN CONDITIONS (WB: 31 ºC, DB:47 ºC, SW TEMP: 33 ºC)

	Electrical Consumption KW/TR					Water Cons l/TRh
Technology	Chiller	CW Pumps	Fans	CHW Pumps	Total	for TSE water
Cooling Tower + Water Cooled Chiller	0.65	0.04	0.03	0.12	0.84	12.00
Air Cooled Industrial Direct Condensation	0.98	0	0.13	0.12	1.23	0
Sea Water Cooled Chillers Ti Condensers	0.63	0.05	0	0.12	0.8	0

DISTRICT COOLING HEAT REJECTION



DISTRICT COOLING HEAT REJECTION



DISTRICT COOLING HEAT REJECTION

COMPARISON OF TECHNOLOGIES

YEARLY AVERAGE

	Electrical Consumption KW/TR					Water Cons l/TRh
Technology	Chiller	CW Pumps	Fans	CHW Pumps	Total	for TSE water
Cooling Tower + Water Cooled Chiller	0.58	0.04	0.03	0.12	0.73	12.00
Air Cooled Industrial Direct Condensation	0.74	0	0.13	0.12	0.99	0
Sea Water Cooled Chillers Ti Condensers	0.52	0.05	0	0.12	0.69	0


THANK YOU FOR YOUR
ATTENTION
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COLD CHAIN DEVELOPMENT FOR RURAL TRANSFORMATION

Rosa Rolle, UNFAO

#CoolWorldCongress
WWW.BIRMINGHAM.AC.UK/ACOOLWORLD

Food and Agriculture Organization
of the United Nations

Cold Chain Development for Rural Transformation

Rosa S. Rolle, Ph.D
Senior Enterprise Development Officer
Nutrition and Food Systems Division

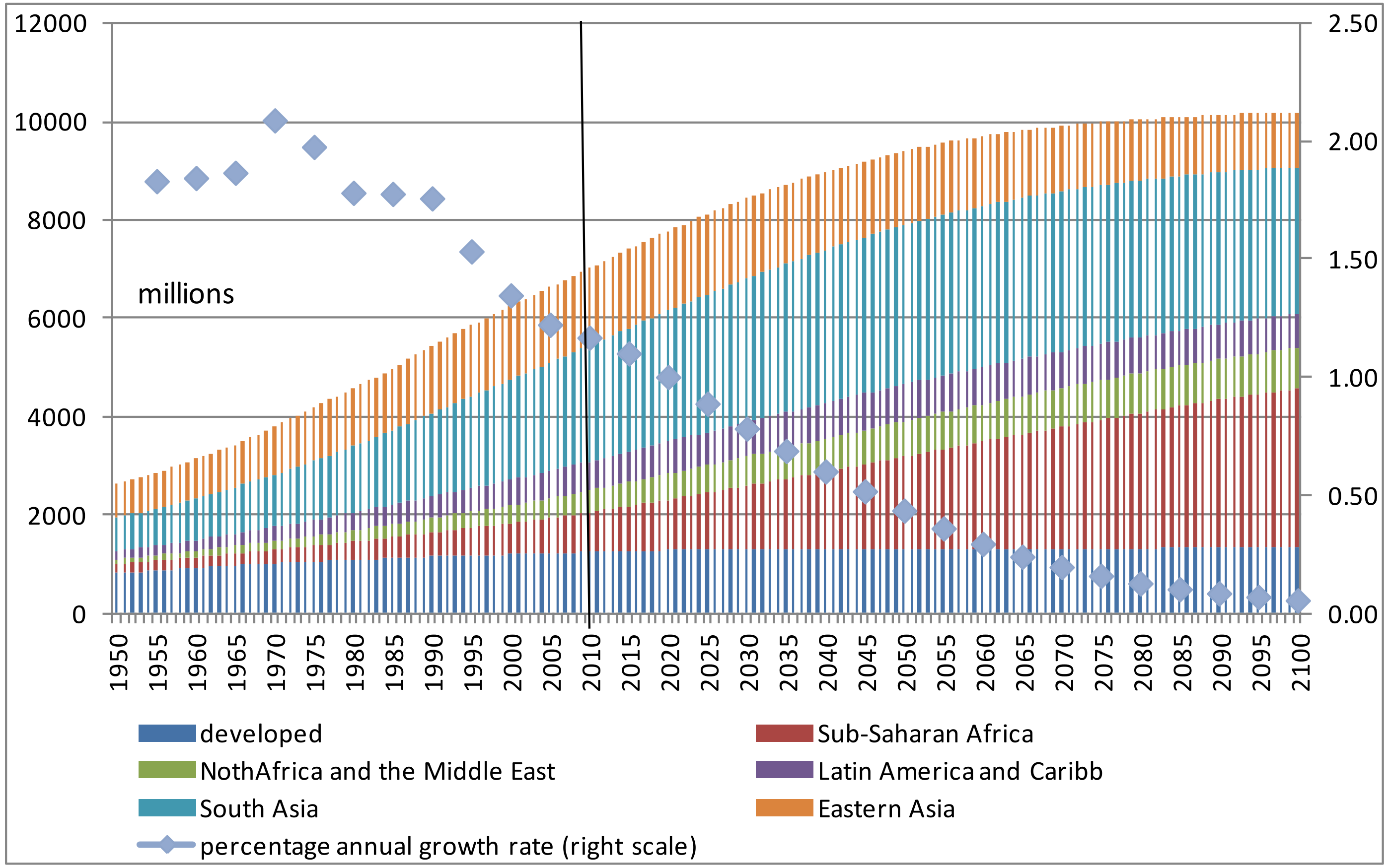
Overview

- Overview of trends that create opportunities and which warrant the development of cold chain systems.

- Cold chain systems and their contribution to rural transformation.

Food and Agriculture Organization of the United Nations

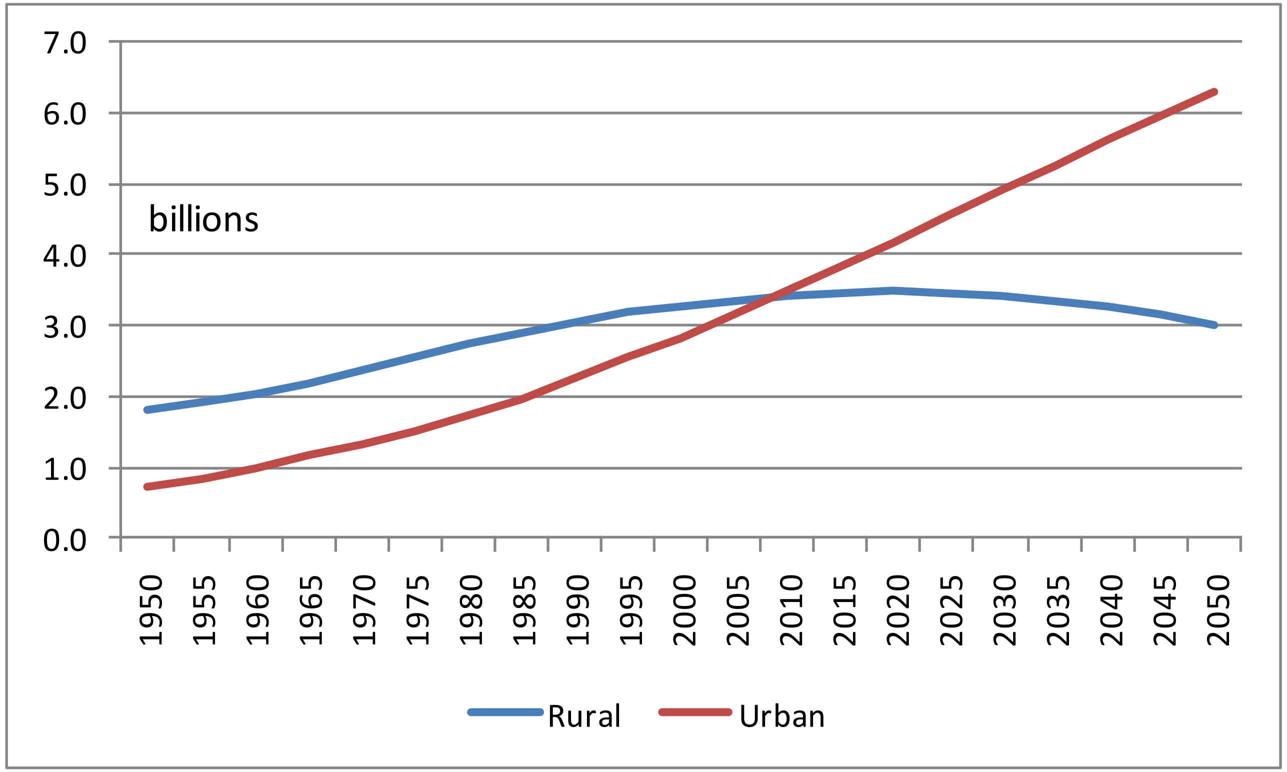
Population Growth is Taking Place Across All Regions of the Globe



Source: UN,2011

Food and Agriculture Organization of the United Nations

Rapid Urbanization is taking place in developing countries



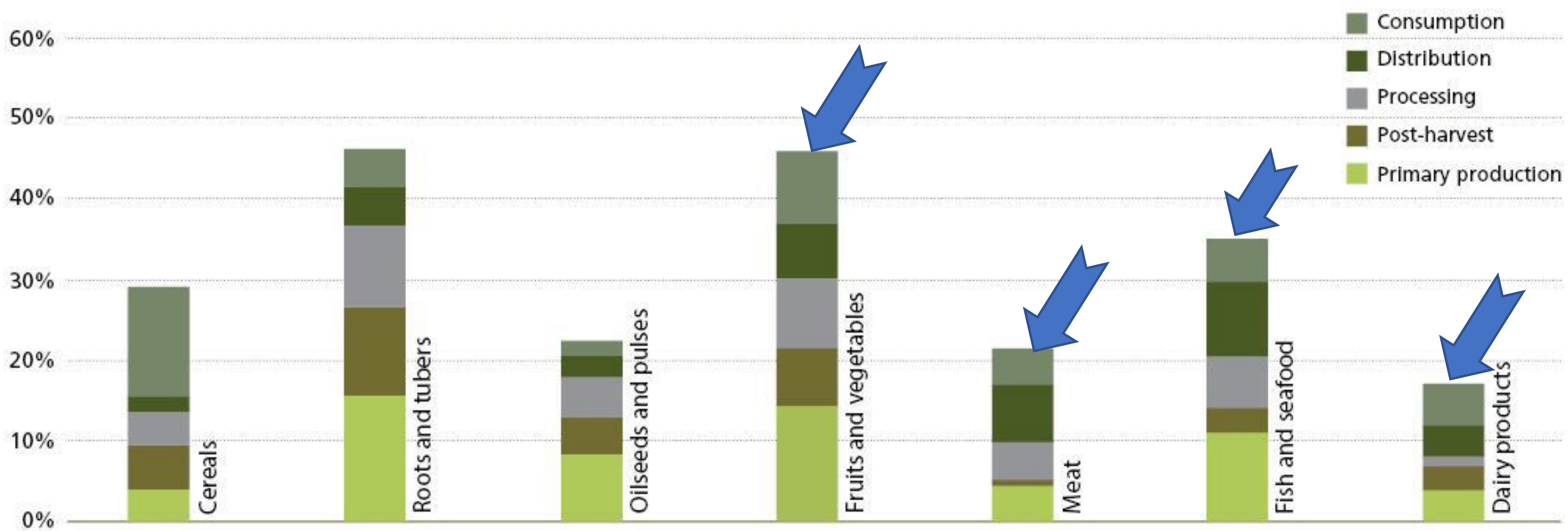
Source: UN, 2011

Linked to :

- Increased incomes
- Changing lifestyles and diets
  - Demand for food that is safe and of good quality;
  - Demand for convenience
  - Emphasis on environmental sustainability

Changing Retail Landscape in Urban Centers of Developing Countries

High levels of losses in perishables: a major challenge to be tackled



Source: FAO. 2011. *Global food losses and food waste – Extent, causes and prevention*. Rome.

Food and Agriculture Organization
of the United Nations

Underlying causes of losses in developing regions

Modern Supply Chains	Traditional Supply Chains
• Consumer/demand driven • **Logistics and cold chain systems** • Make use of post-harvest technology • High level of efficiency • **Low level of losses**	• Production oriented • **Lack of a cold chain** • Limited use of post-harvest technology • High level of inefficiency • Poor quality • Questionable safety • **High levels of losses**

Perishables in Developing Countries are Handled Under Ambient Conditions

Food and Agriculture Organization
of the United Nations

Rising temperatures driven by **climate change** could contribute to an **increase in post-harvest losses** in many developing countries

Implications of these trends?

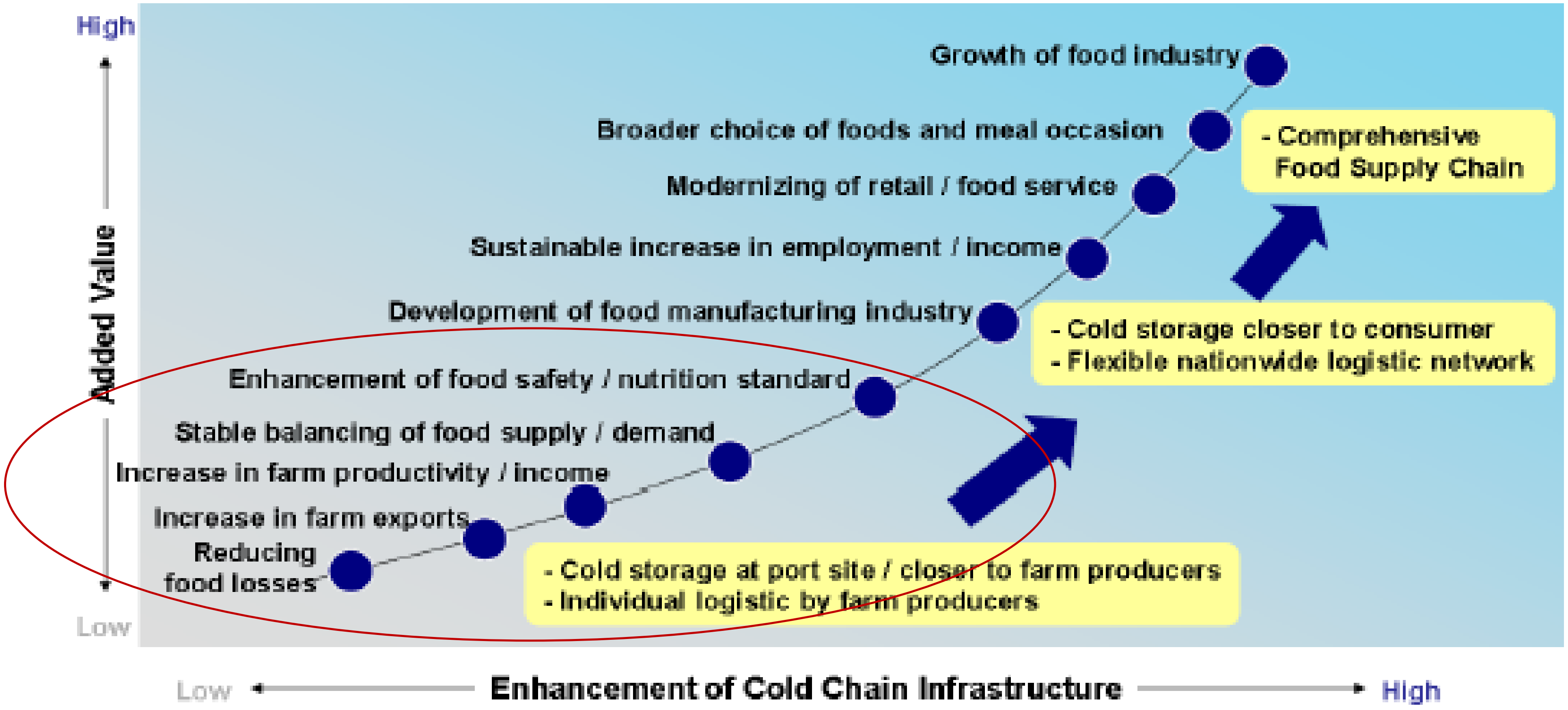
Needs:

- ❑ Make more efficient use of the natural resource base.
- ❑ Improve efficiency and sustainability in supply chains.
- ❑ Develop supply chains that deliver on quality and safety.

Cold Chain Systems Empower Agriculture:

- Improve supply chain efficiency.
- Reduce farm to market losses.
- Maintain the quality and safety of food.
  - Ensure the health security of populations.
- Create added value

Cold Chain Systems Create Added Value



Source: Kato (2013) Cold Chain Infrastructure and related Industries -Contribution to food losses / waste reduction-, presented at Symposium on Human Resource Development in Food-related Area through Partnership with ASEAN Universities Jakarta, Indonesia, January 21, 2013

Cold Chain Systems: Generate Economic Development

- Connect farmers to higher value market options (urban and export).
- Contribute positively to income growth in rural areas.

Case of Value Chain Development in Champasak Province, Lao PDR

- **Small farmer groups organized** and capacitated to produce certified (GAP and organic) high value produce.
- Land donated by the Government for construction of a (project-funded) GMP compliant pack-house facility.
  - Equipment and installation of electricity undertaken by the project.

Case of Value Chain Development in Champasak Province, Lao PDR

- Smallholder **produce pre-cooled**, prepared and retail-packaged at the pack-house.
- Packaged produce is **transported via a cold chain** to the airport in Bangkok, **for export.**



Benefits Derived

- **Reduced post-harvest losses**, **reduced transport and logistic costs** and **improved quality**.
- **Improved market access** for farmers (EU and middle East).
- **New employment opportunities** were created in a very rural location.
  - A majority of new employees are women.
- Leasing income generated for the Provincial Agriculture and Forestry Office (PAFO).

FAO-RAP 2016

Success Factors: Public and Private Sector Investments were Vital Inputs

PPP Agreement signed to lease the pack-house and **operate**
a cold chain system

Key Elements of the Enabling Environment To Support Cold Chain Development

- Government support for the **development and strengthening of small holder organizations**.

- **Public goods that support cold chain** development.
  - Rural infrastructure, electricity, transport systems, communication technology

- Mechanisms to facilitate
  - the **ease of doing business**
  - **access to finance**

Cold Chain Benefits

Economic:

- Presents economic benefits for entrepreneurs.
- Increased incomes for producers

Environmental:

- Efficient use of valuable raw materials and resources
- Reduce pollution and waste

Social:

- Increased food security
- Increased nutrition and health
- Increased employment

It follows that….

- Cold chain systems offer considerable potential for rural transformation.

- Greater attention is needed to scale up and develop these systems toward maximizing value added toward enhancing rural transformation.

Thank You

Rosa.Rolle@fao.org

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PLENARY DISCUSSION TWO

COOLING IN THE DEVELOPING WORLD – MAKING LIVELIHOODS

Dr Tim Fox, IMechE (chair)

Dr Lisa Kitinoja, The Postharvest Education Foundation

Sean Roche, ICL

#CoolWorldCongress

WWW.BIRMINGHAM.AC.UK/ACOOLWORLD

COOLING IN THE DEVELOPING WORLD
MAKING LIVELIHOODS

Institution of MECHANICAL ENGINEERS

Dr Tim Fox CEng FIMechE

Chair, IMechE Food and Drink Engineering Committee

Independent Consultant

18 April 2018

www.imeche.org

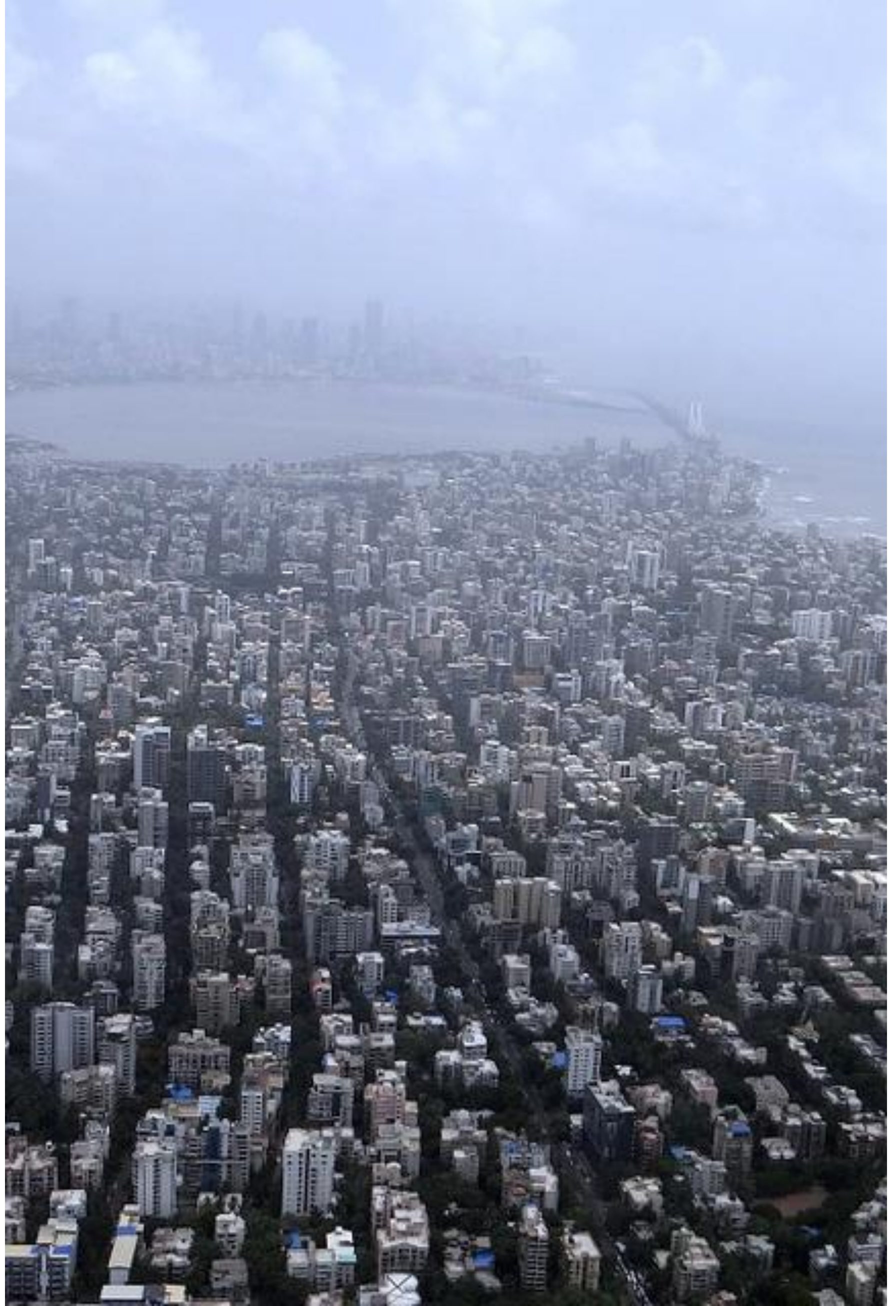
Improving the world through engineering

Food loss

- Rather than a major problem
- Different perspective
- Consider food loss not as a problem but as an opportunity to make livelihoods and improve well-being.
- Size of the opportunity
- Possibly 650-700 million tonnes or more of produce per annum.
- Globally US$100's billion per annum of lost economic value.
- Engineering knowledge and technologies
- Plenty of engineering knowledge and technology available to use to take the opportunity, increasingly including cleantech and sustainable options.

Access to markets

- Economic opportunity
- Asia and Africa projected to experience biggest growth in absolute population numbers.
- Increased urbanisation on these continents drives demand for more rural-urban food supply chains.
- Increased affluence driving dietary preference changes and demand for higher quality food products and convenience foods – frozen; chilled; semi-chilled.
- Urban infrastructure development increasing availability of ports and airports with gateways to export markets.



Making livelihoods

- What does it mean?
  - Understand what making livelihoods means in an economic sense - reduced poverty; more job opportunities; increasing incomes; gender equality; improved health; reduced migration?
  - What are the possible unintended outcomes, who will be the losers, what might be the potential ripple effects through rural communities and society?
  - Most farmers are smallholders and often unaware of available technologies and business models, unlikely to invest alone in new innovative technologies.
  - Access and adoption requires affordable, reliable and scalable technologies, awareness, cooperation, viable business models and demonstrated benefits.
  -

Business Models

- Increasing levels of sophistication
- Business model case studies
- Dr Lisa Kitinoja will explore three business model examples for clean cooling enterprises in the developing world.
- The role of the technology developer
- Sean Roche will share his experience of developing affordable, reliable and scalable technology with viable business models and demonstrated benefits.
- The needs for education and training
- Dr Ali Mohammed Ibrahim’s insights into the role of education and extension support.

Business models for clean cooling enterprises in the developing world

Dr. Lisa Kitinoja

The Postharvest Education Foundation

A Cool World– International Clean Cooling Conference

University of Birmingham, UK. 18-19 April 2018

POSTHARVEST EDUCATION FOUNDATION

On-farm cooling options

Low cost options

- Use of shade
- Evaporative cooling

Benefits

- Reduced food losses
- Extended shelf life
- Increased marketing options
- Increased income

Kitinoja 2018

Postharvest Education Foundation

Higher cost cooling/cold storage options

- Small-scale off-grid solar powered cold rooms (with batteries or phase change material based storage)
- CoolBot equipped cold rooms
- CoolBot equipped trailers
- Reefer vans (traditionally diesel powered)

Matched with a window style A/C unit

Solar Freeze @freeze_solar · 12h
Climate smart innovation in the cold chain sector to help smallholder farmers reduce food loss. #solar #coldchain #postharvest

Kitinoja 2018

Postharvest Education Foundation

Business Model 1: Individual farms

Low cost, low tech cooling options such as ZECC or charcoal cool room

- Capital cost: US$100 to $300 per unit including shade structure
- Operating costs: water, labor
- Low environmental impacts
- Best results in dry areas, where there may be limited water

Zero Energy Cool Chamber (ZECC)
100kg to 1 MT capacity

Kitinoja 2018

Postharvest Education Foundation

Business Model 1: Individual farms

Low cost, low tech cooling options such as ZECC or charcoal cool room

- Benefits: Storage temperature decreased by 15 to 20 C from 35 C
- Shelf life increased by 2 to 3x compared to ambient
- Reduced postharvest losses
- Quality maintained, good market price maintained
- Provide increased access to markets

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Business Model 2: Small business enterprises

Off-grid solar powered cold room

- Capital cost: US$20,000 to $50,000 or more per unit (depends on capacity)
- Operating cost: labor
- Customers pay a fee per crate
- Low environmental impacts

Additional Support Services

- Packing into plastic crates
- Refrigerated transport
- Links to markets

Nigeria: COLD HUBS "Keeping it Fresh"
www.coldhubs.com

Business Model 2: Small business enterprises

Off-grid solar powered cold room

- Benefits: Storage temperature decreased to 15 to 20 C from 35 C
- Plastic crates reduce physical damage to less than 5%
- Shelf life increased by 4x or more compared to ambient
- Reduced postharvest losses
- Quality maintained, good market price maintained
- Access to new markets
- Provides increased incomes (evaluated to be 25% higher)
- an integrated ‘clean’ cold chain solution with a ‘service’ (‘Cold Economy’) approach

Nigeria: COLD HUBS
“Keeping it Fresh”
www.coldhubs.com

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Business Model 3: Cooperative business enterprises

Agricultural value addition centers

- Offers cooling/cold storage options, processing options, training
- Capital cost: US$200,000 or more per unit
- Operating cost: electricity, labor, training staff, market linkage staff
- Self-help group members pay a fee per crate or kg

Cooling/cold storage services

- Zero Energy Brick/sand Cooler 1.5 MT
- Charcoal cool room 3 MT
- CoolBot Cold Room 5 MT

Processing options for mangoes

- Solar drying, jam, pulp, juice

Kenya: Smallholder Horticulture Aggregation and Processing Center at Karurumo, Embu County

Kitinoja 2018

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Business Model 3: Cooperative business enterprises

Agricultural value addition centers

- Benefits: Storage temperature decreased to 15 to 20 C from 35 C
- Storage in plastic crates
- Shelf life increased by 4x or more compared to ambient
- Reduced postharvest losses
- Quality maintained, good market price maintained
- Processing and packaging to add value
- Potential access to export markets
- Provides increased incomes

Kenya: Smallholder Horticulture Aggregation and Processing Center at Karurumo, Embu County
Video link
https://www.youtube.com/watch?v=bnNu9njlejg

Kitinoja 2018

Postharvest Education Foundation

ICL
www.vacuumcooling.eu

UNIVERSITY OF EXETER

Inviro Choice Limited

Introduction

Vacuum Cooling

Bespoke design and manufacturing new machines (2015)
Service and maintenance of Vacuum Cooling machines
Parts sales and distribution

Air conditioning

Installation
Service and maintenance

What is vacuum cooling?
Vacuum cooling is the most rapid and efficient cooling technique for **most porous produce that contain water.**

- **Pressurised reinforced chamber**
- **Vacuum Pulled**
- **Boiling point of water reduced**
- **Phase change takes place**
- **Latent heat provides energy**
- **Field heat removed within 30 min**
- **Vapour is caught and condensed on evaporator coil**

Benefits of vacuum cooling

Reduces post harvest loss by up to 100%

Extends shelf life of the product

Increases the product demand

Opens doors to exporting as the product can last longer during transportation

Reduces water waste

Relieves duty required on the rest of the cold chain

Reduces C02 Emissions

www.vacuumcooling.eu

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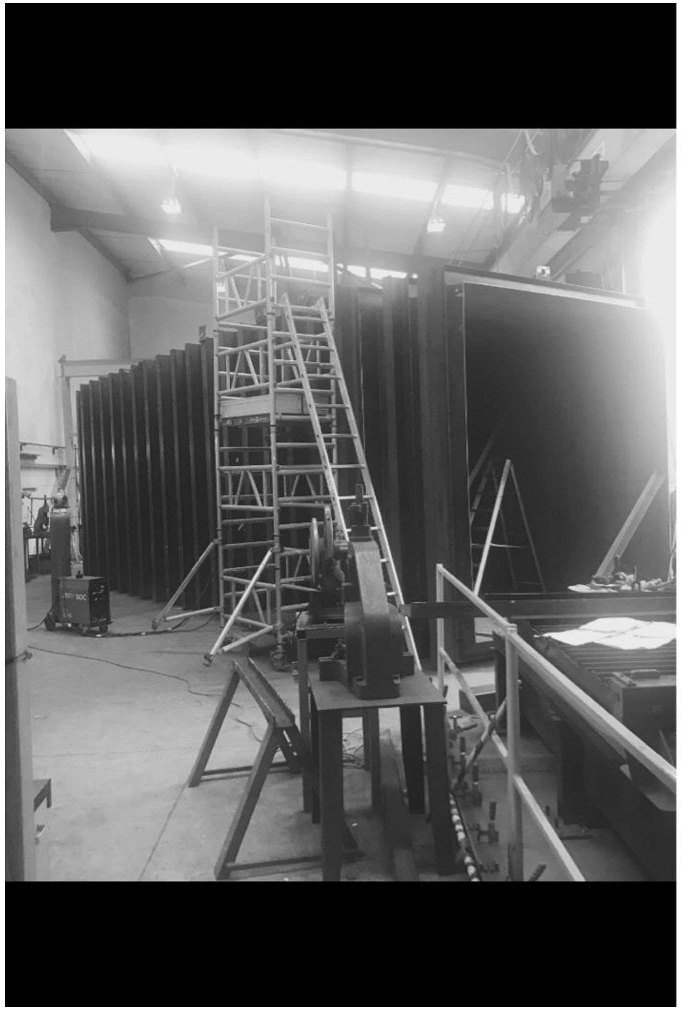


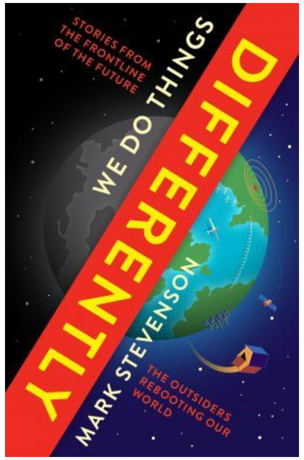

CO-OP


ICEBERG LETTUCE

2015 onwards

ICL
www.vacuumcooling.eu

- Same design for 40+ years
- Improve energy efficiency
- Improve time efficiency
- Give our customers more value for money ROI
- Open to new avenues to markets where previously not able to operate a vacuum cooler



Climate Change

Effects climate change has on farming in developing countries

Shocking facts

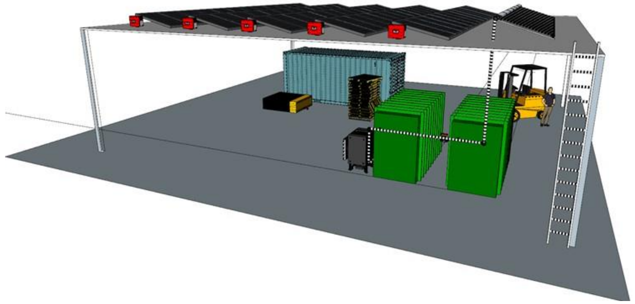
- Climate change increasing field heat
- Post harvest loss increases
- Lack of cold chain
- Up to 50% loss case studies
- Water stress
- Population increasing
- Hunger increases
- Profits reduced

2018

Commercial Vacuum Cooling

Continue with core business activities
Eco Range

- **Humanitarian**
- **Social Enterprise**
- **Small hold farmer groups/co-operatives**
- **Aid Projects**



Eco-Range Off Grid Cooling equipment

- Pilot partner

Funding/ Investment

ICL
www.vacuumcooling.eu

UNIVERSITY OF EXETER

THANK YOU

Postharvest business development support

- Training on best practices for postharvest handling, cooling, cold storage, cold chain logistics from farm to market
- Use of returnable plastic crates (requires systems for cleaning, rental, returns)
- Investments in missing infrastructure (cold storage and processing facilities, power/energy, roads)
- Linking producers to markets (reefer van or insulated trailer transport, alternative markets, meeting quality standards)

Rwanda retail market in Kigali

Urban fresh produce delivery

Kitinoja 2018

Postharvest Education Foundation

Clean cooling systems development requires:

- Appropriate cooling, cold storage and cold chain technologies
- Vetted business models for small, medium and large scale enterprises
- Access to reasonably priced equipment, tools, supplies
- Trained technicians for maintenance and repairs
- Enabling support – finance options, basic infrastructure
- Incentives such as duty free imports, low interest rates, corporate tax breaks
- Educational support – training opportunities and rural extension systems

COOLING TO SHARE

Professor Toby Peters, University of Birmingham

#CoolWorldCongress
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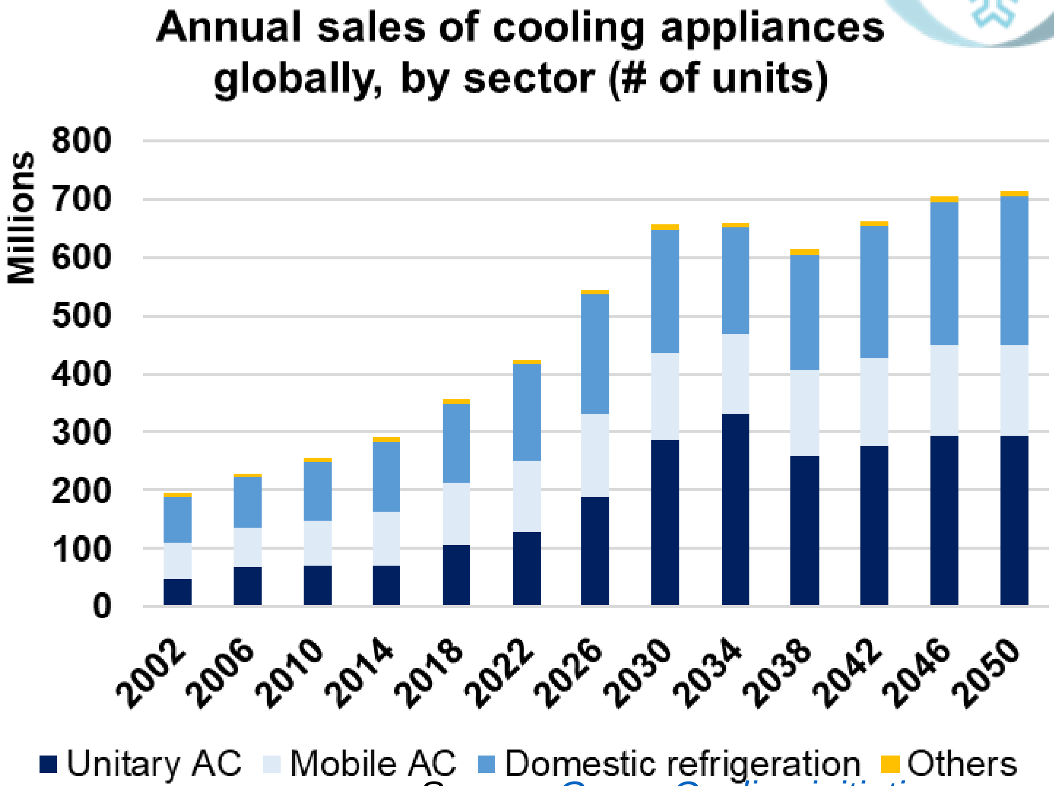
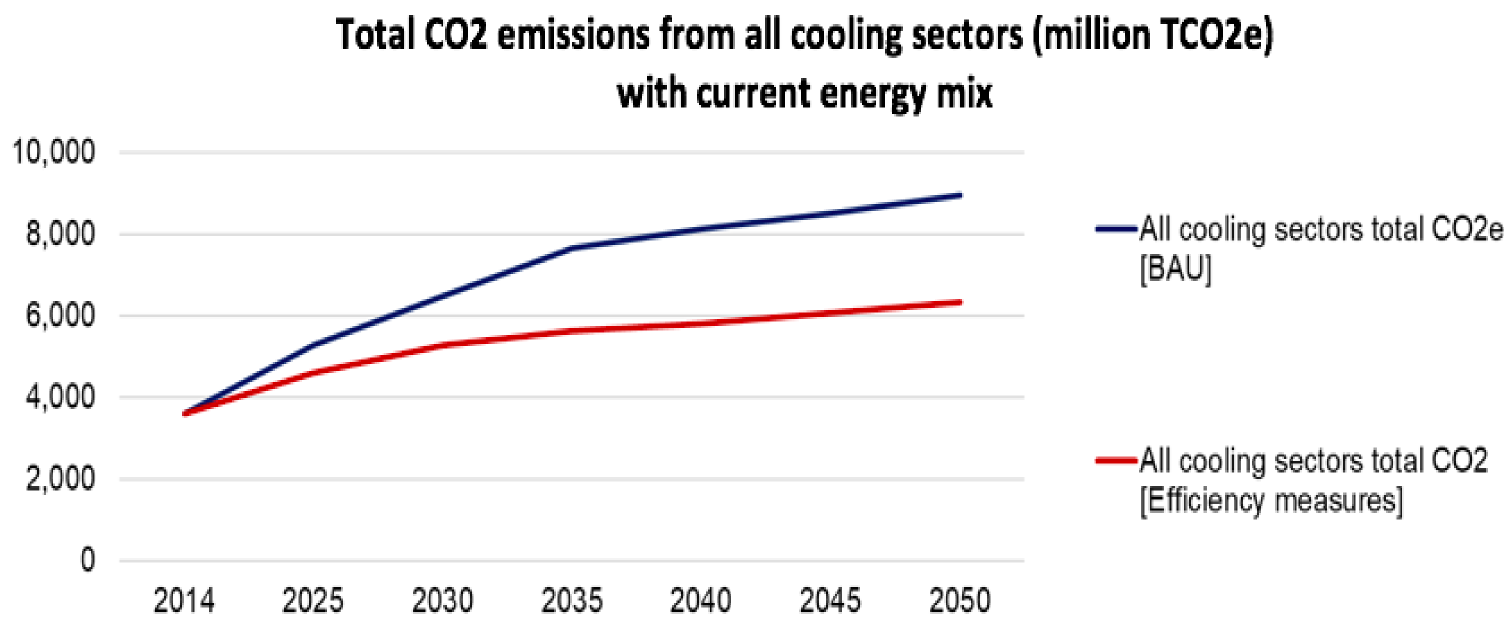
Cooling - A Growing Market



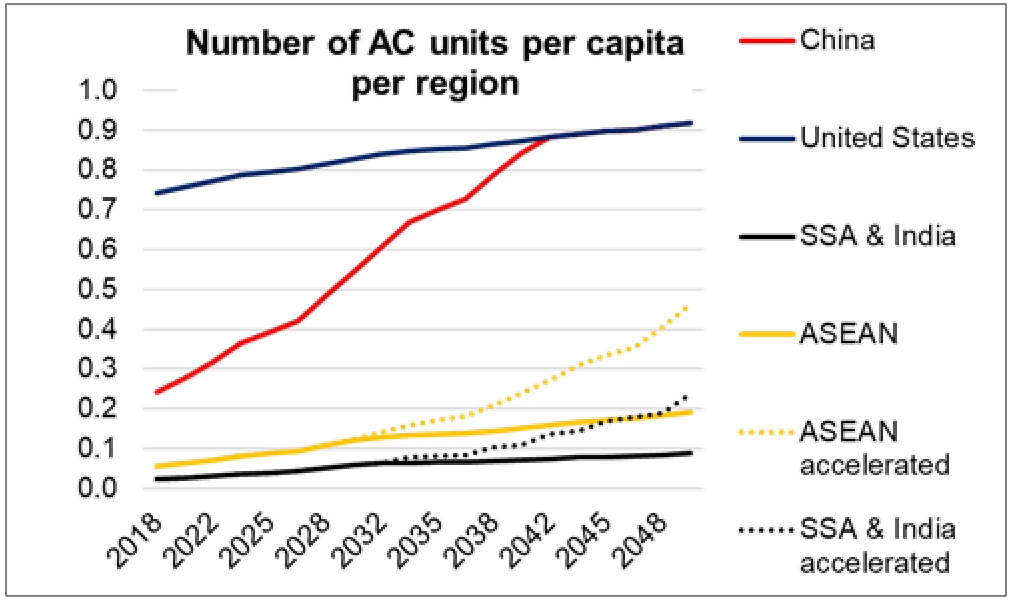
Source: [Green Cooling initiative]

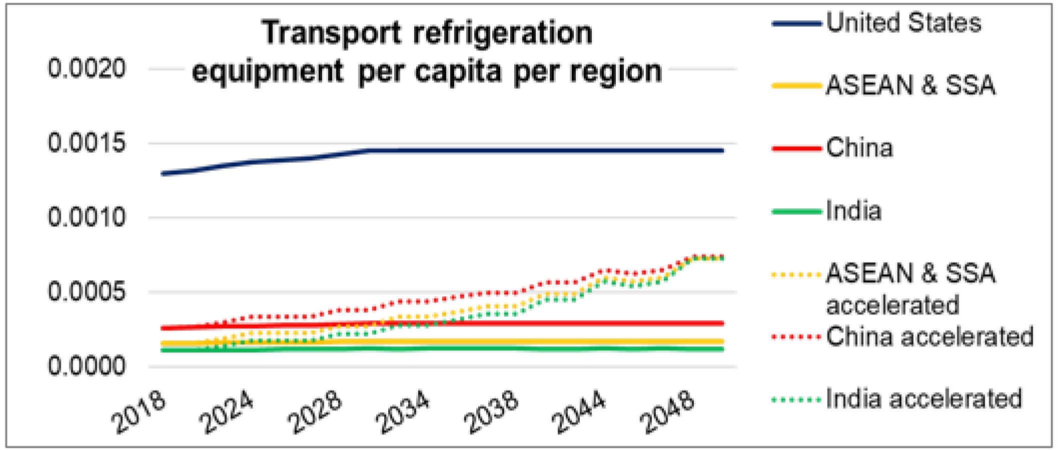
Annual sales of cooling equipment are worth $140bn in 2018 (globally).
Will grow to over $260bn by 2050

Cooling – CO2 impact

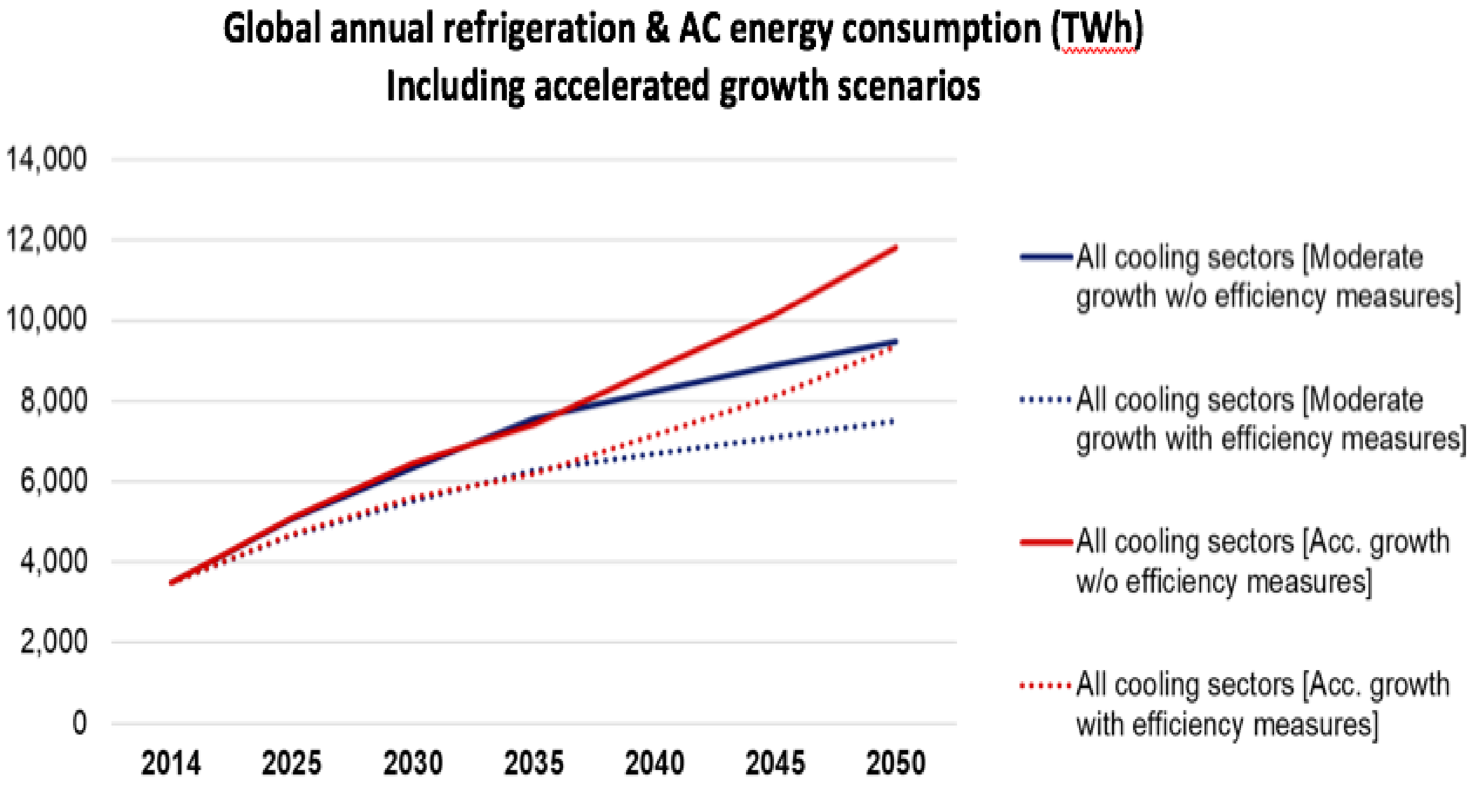


Cooling Penetration

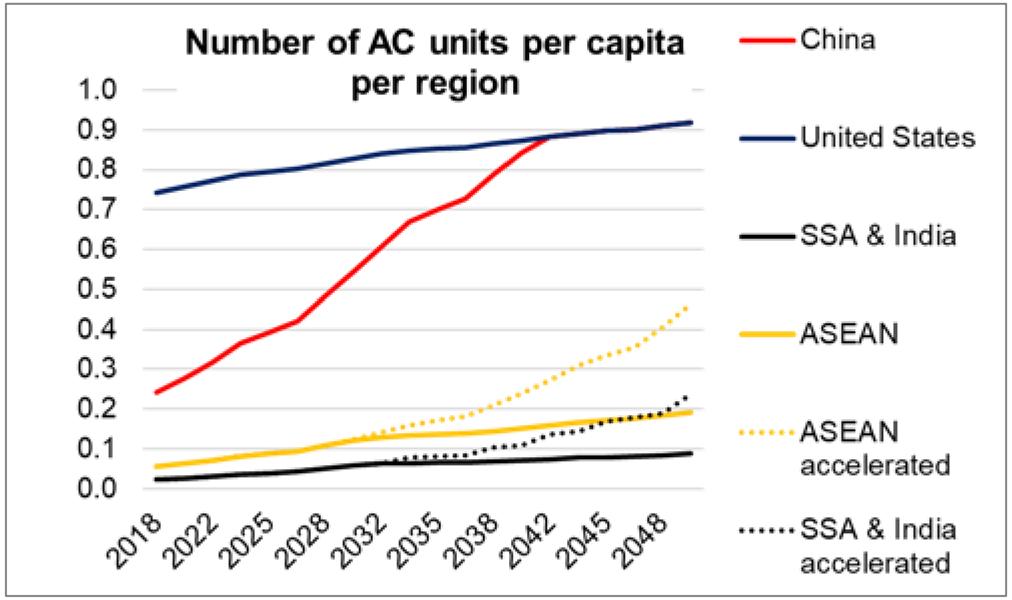


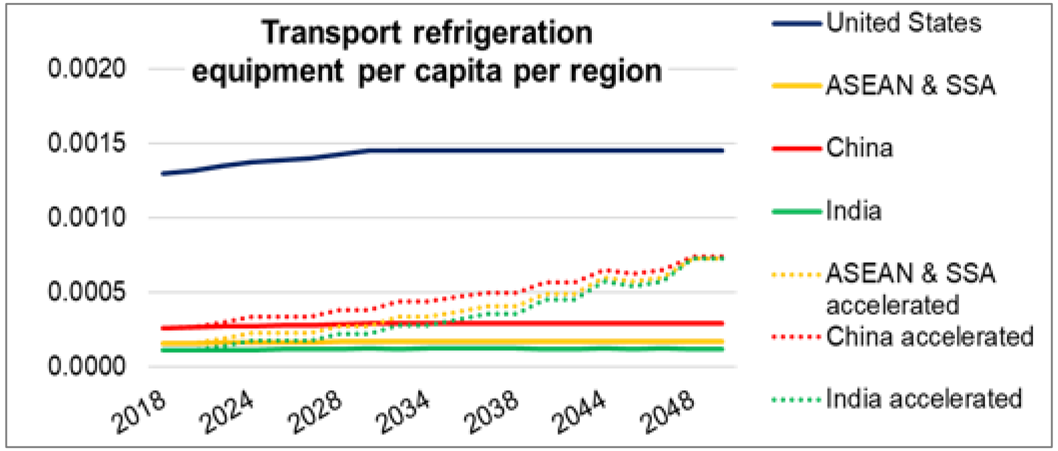


Cooling Energy demand



Cooling Penetration





The Ladder of Opportunities

Given demand, need for both urgent intervention as well as long-term sustainable strategies, we need a roadmap and pathways based on a ladder of opportunities.

"must have" **– ensure basic needs are met for all people whilst living within our natural limits and mitigating future risks to our planet**

Now!

Ensuring lowest GWP and highest energy efficiency of current technologies – maintenance, best in class adoption

Active steps to reduce demand for cooling

Mitigate need (building design, passive cooling, food packaging)

Behavioural changes

Think thermally, rather than default to electricity – turn waste heat and cold into a value

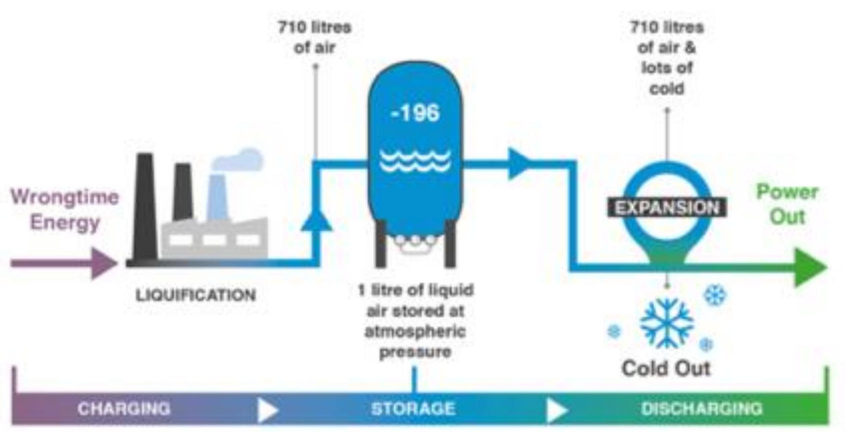
Think system and how to harness waste energy to meet cooling needs

Develop!

Needs-driven leapfrog new technologies

"future proofing" **–improving quality of life for all whilst equally creating abundance from our natural resources.**

Harnessing "Waste Cold"



Cold Economy - Systems Approach

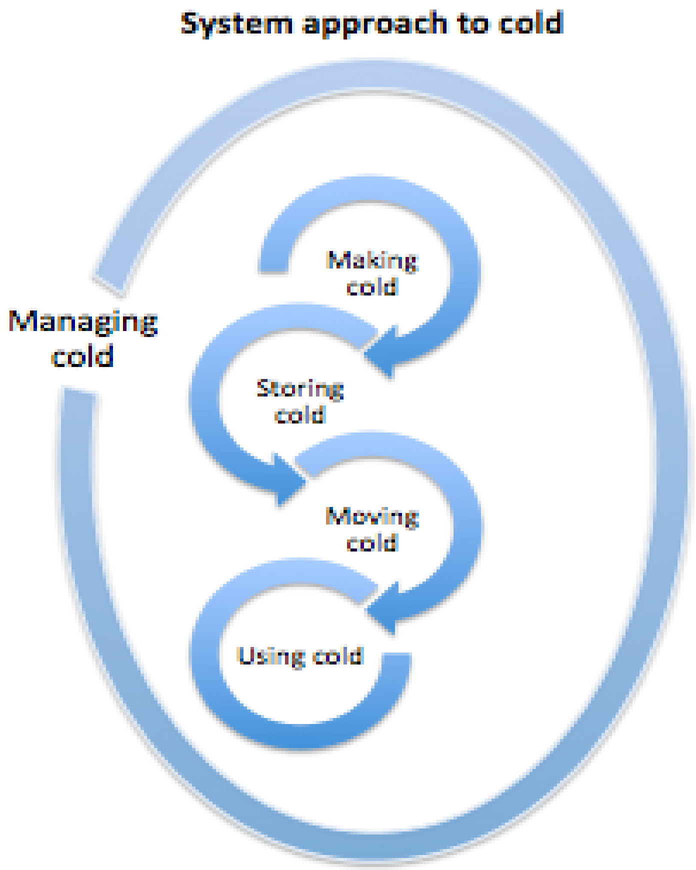
Making cold
Harness waste/unused resources e.g.: ‘wrong time’ renewable energy (e.g. wind), waste cold (e.g. LNG) ambient heat & cold (e.g. ground source)

Storing cold
Thermal energy storage to warehouse

Moving cold
New energy vectors and material to shift cold

Using cold
Reduce cold loads
Increase efficiency and reduce GWP of conventional technologies
New technologies to harness new stores and vectors

Managing cold
Monitoring, controls and management

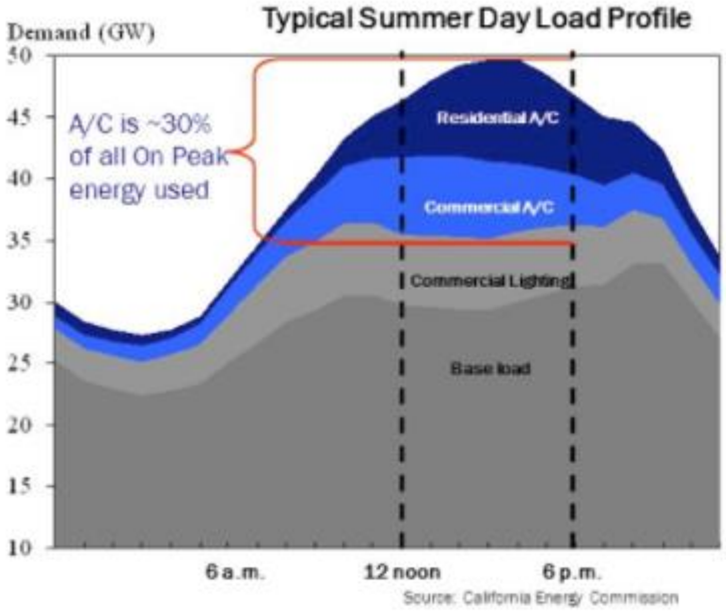


Need to reset the energy strategy

Need to reset the energy strategy

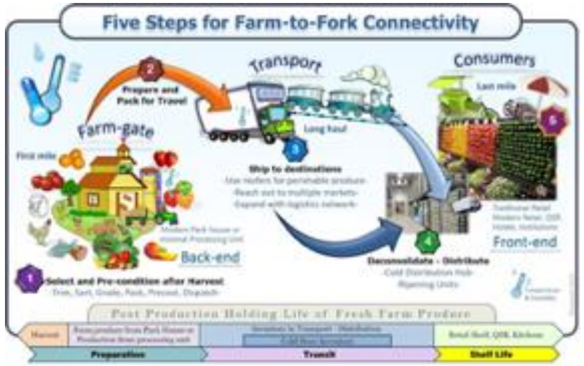
The key question is *'what is the service we require, and back-casting how can we provide it in the least damaging way'*, rather than *'how much electricity do I need to generate?'*

System, not just the technology



Cold Economy - Systems Approach

Cold Chain (food, pharmaceuticals)

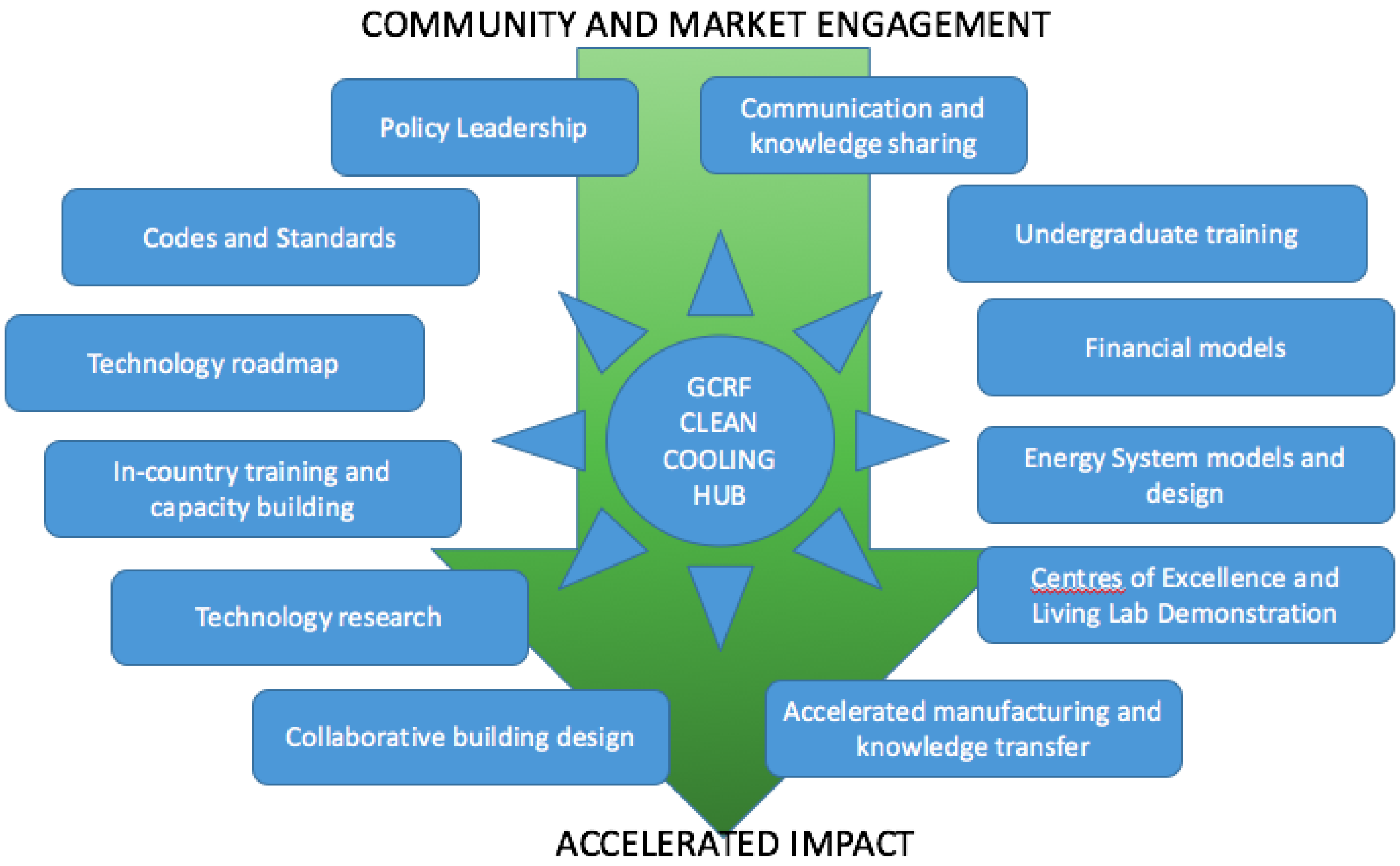


Mobility

Buildings & Cities

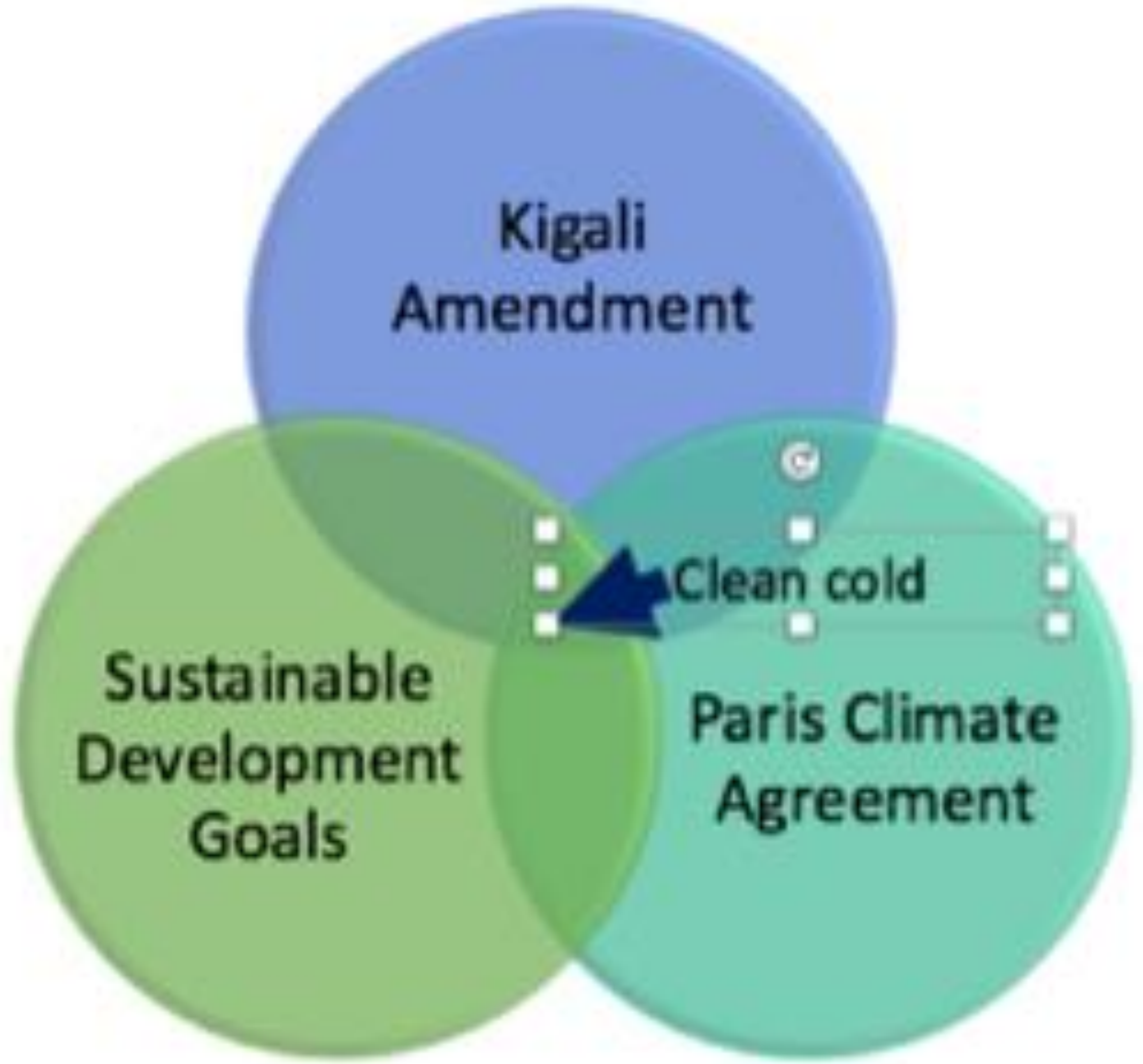
Data

Global science – local solutions
1. International Clean Cold Consortium



Global science – local solutions
2. Clean Cooling Centres of Excellence

Clean cooling ....



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THINK THERMALLY FOR DEMAND – SIDE MANAGEMENT

Ian Tansley, Surechill

SURE CHILL | COOLING TECHNOLOGY

Ian Tansley
Inventor & Co-Founder
ian.tansley@surechill.com

THINK THERMALLY FOR DEMAND-SIDE MANAGEMENT

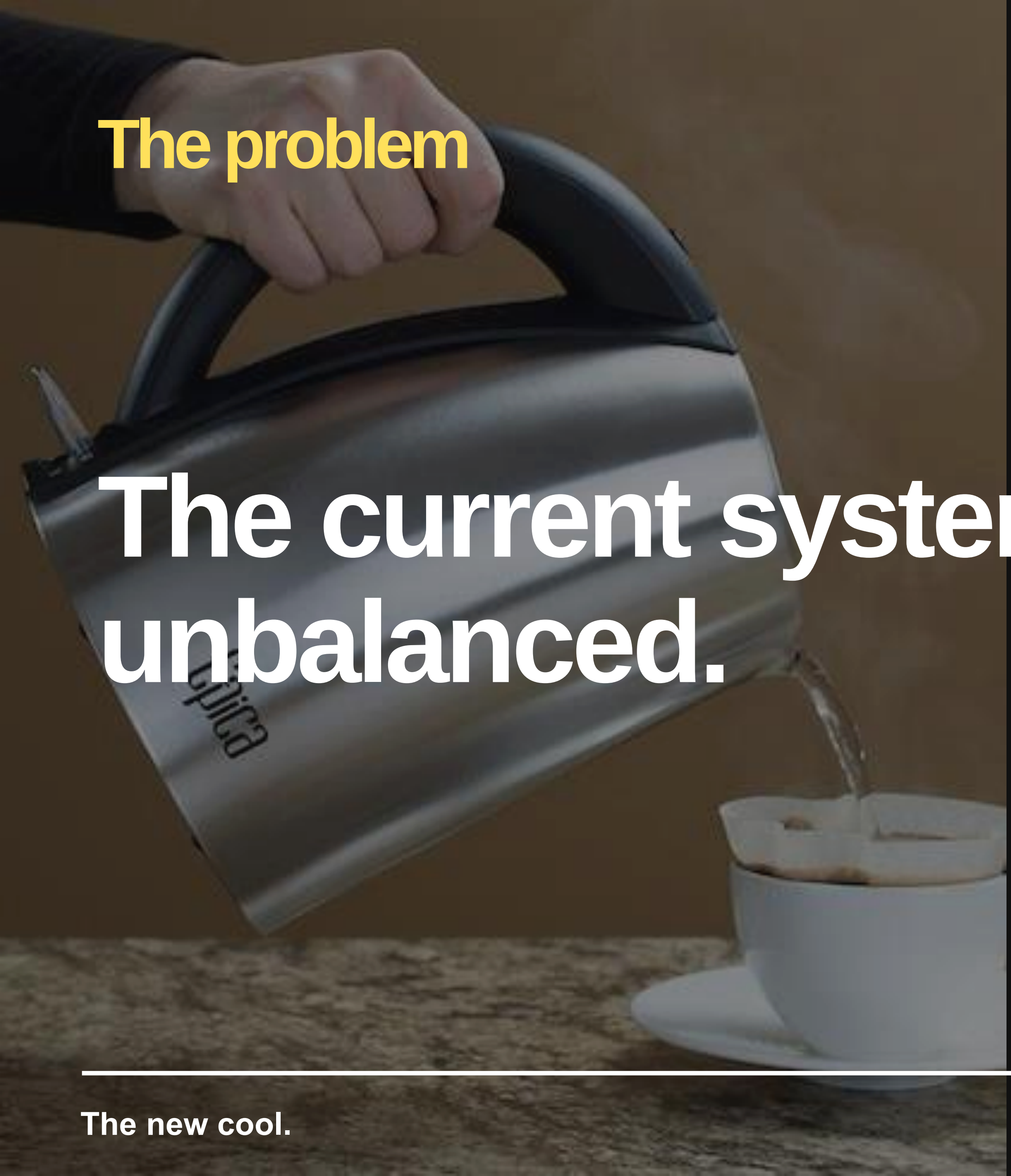
Our partners

unicef

World Health Organization

Bill & Melinda Gates foundation

Shell Foundation




The problem

The current system is unbalanced.

200MW

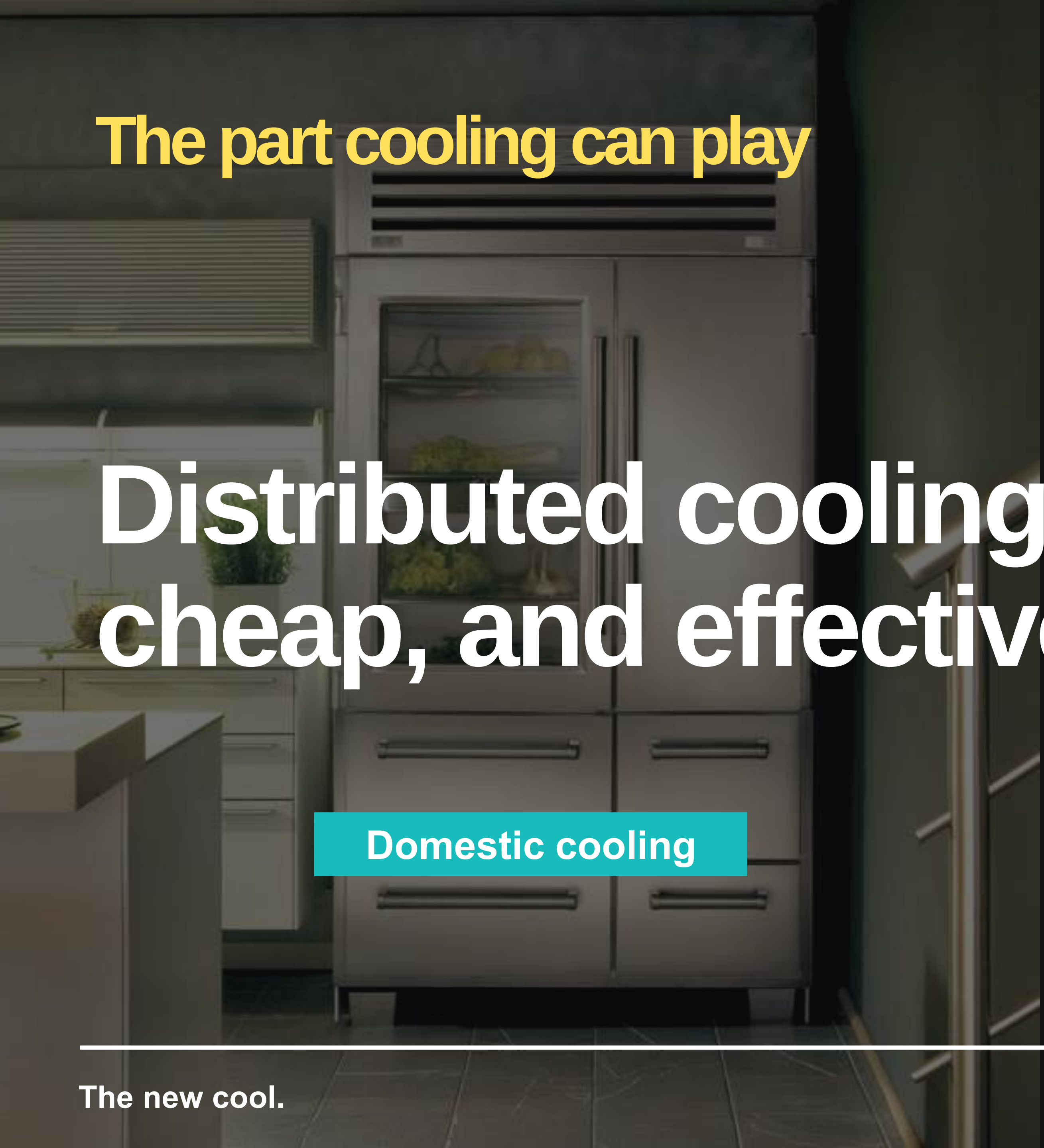
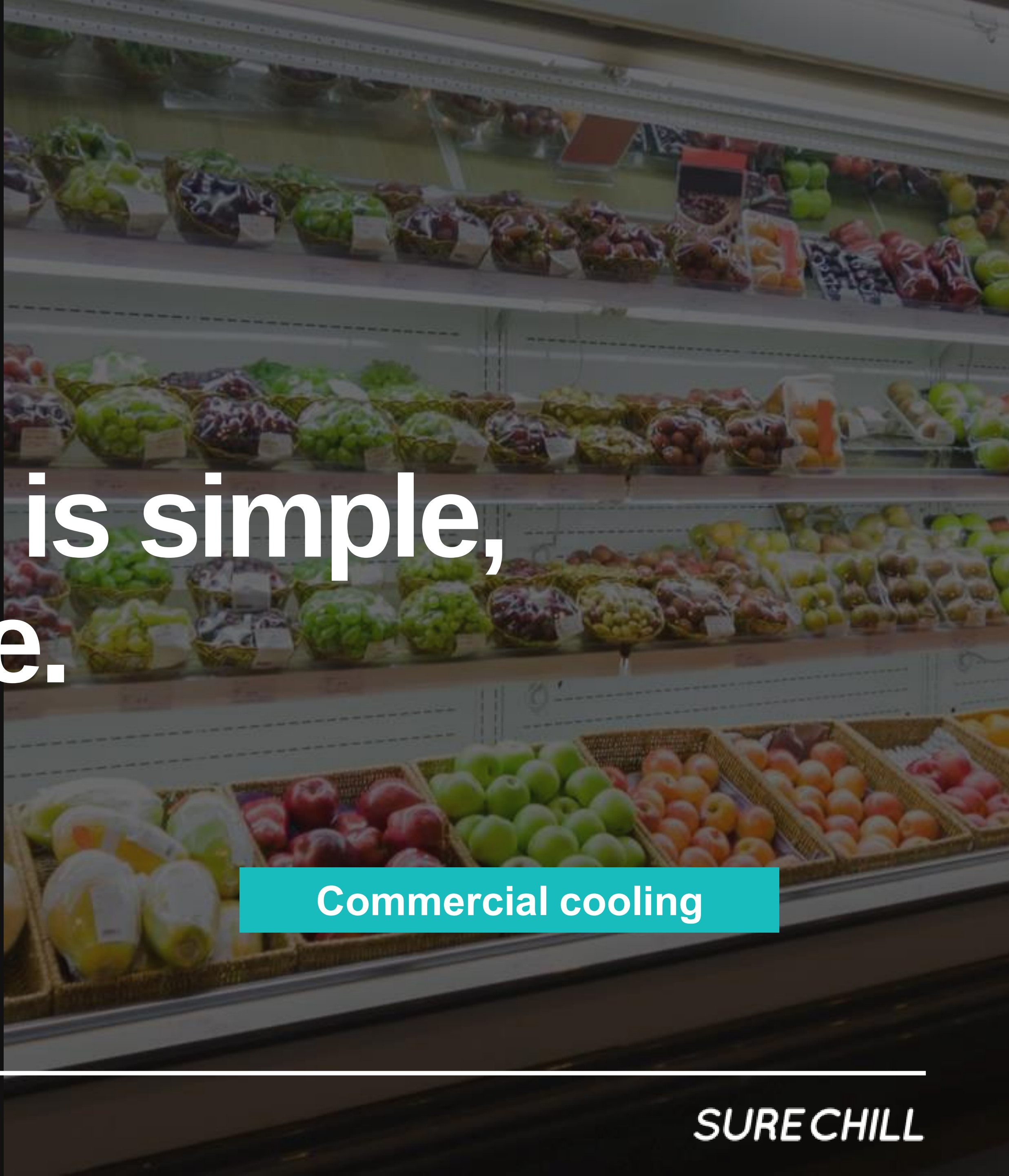
The huge drain kettles put on the UK grid at 7pm every day.

The current solutions

The solutions are limited, inefficient, and often remote.

200miles

from an urban area, means much power is lost during transfer.

The part cooling can play

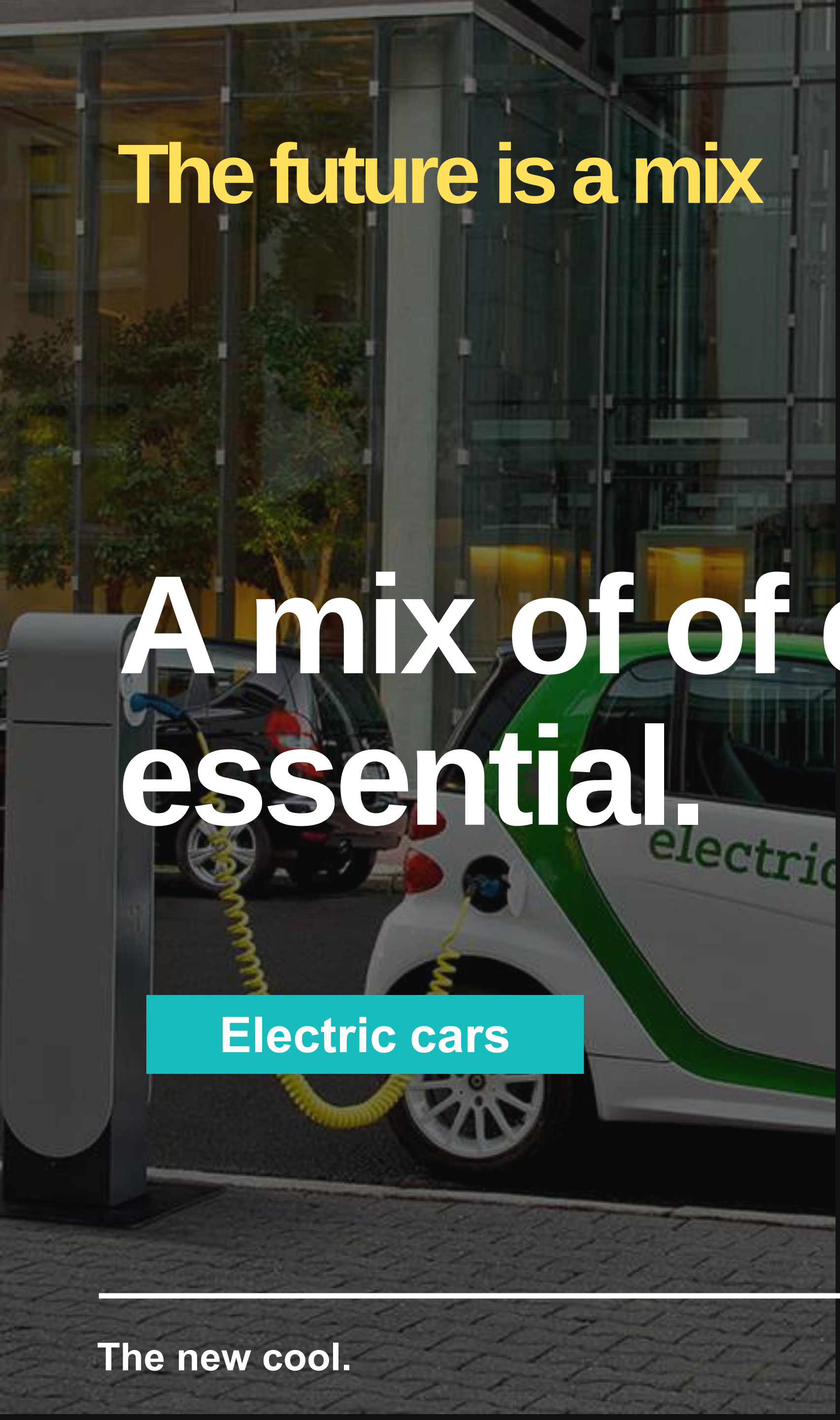
Distributed cooling is simple, cheap, and effective.

Domestic cooling

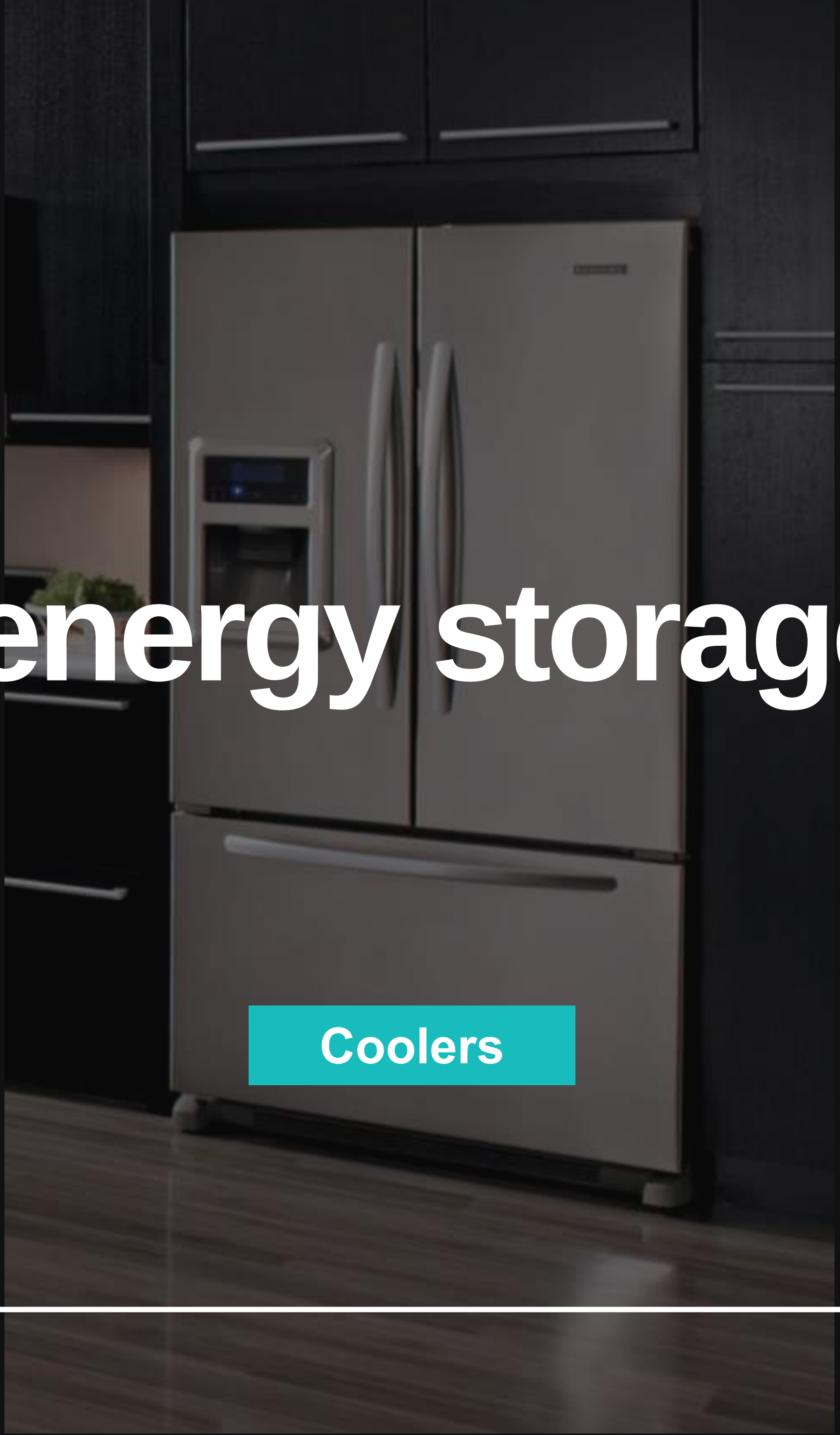
Commercial cooling

The future is a mix

A mix of of energy storage is essential.



Electric cars



Coolers

Hydrogen storage

Let’s work on this together.

Ian Tansley,
CTO, Sure Chill
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@sure_chill

FROM WASTE TO HIGH-VALUE COOLING – AN INTEGRATED APPROACH TO ENERGY

Jan Grimbrandt, Boson Energy

#CoolWorldCongress
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From waste to high-value cooling – an integrated approach to energy

Jan Grimbrandt
CEO and Founder

JGR@bosonenergy.com

Also here in Birmingham:

Aditya Sharma
Senior VP Asia

ASH@bosonenergy.com

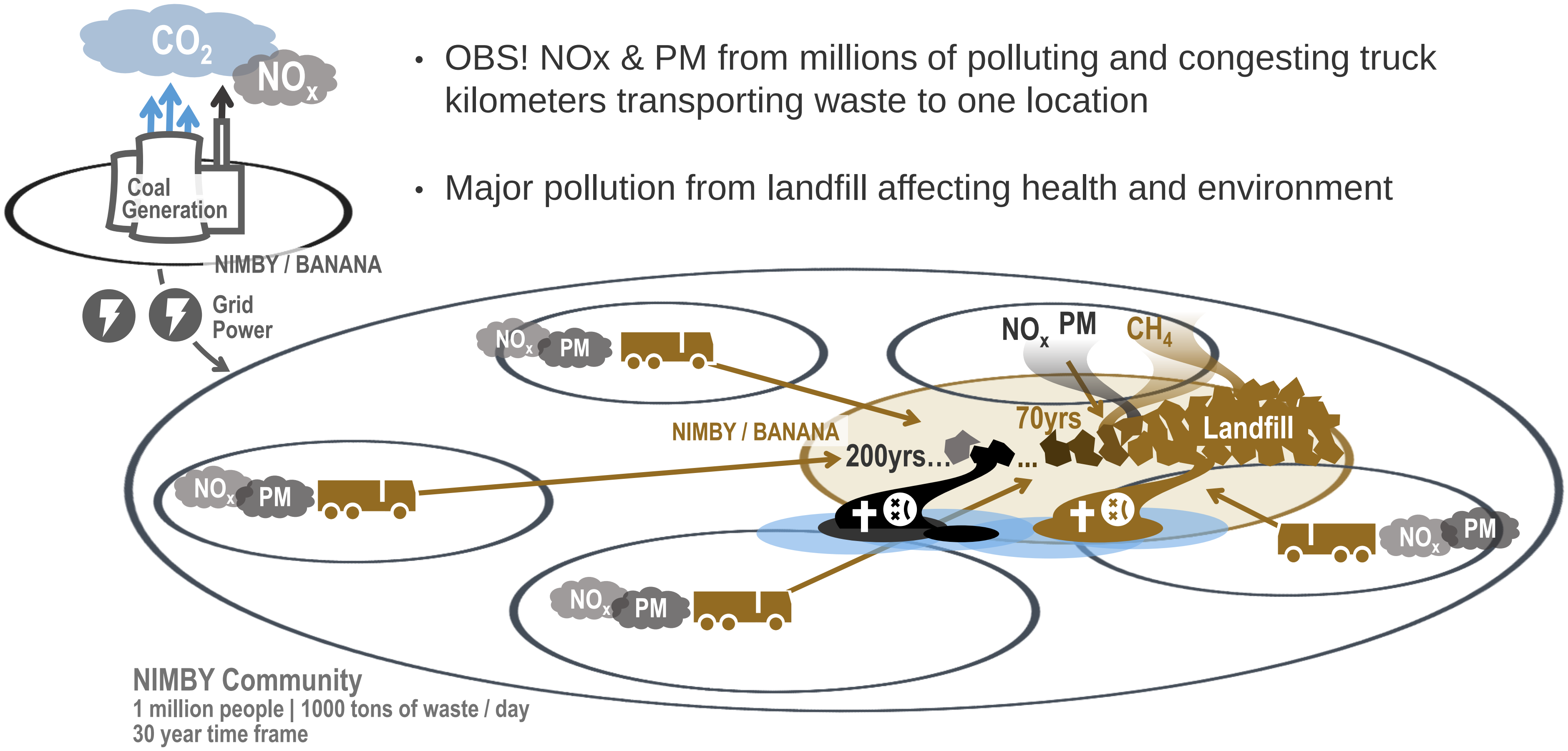
Waste is an exploding global problem driven by prosperity.

However, prosperity is probably the best thing that can be given to a family for health, education, food quality and so much more.

No energy harnessed from waste – 9.85m tons of waste over 30 years

Today, most cities or islands in Asia and Africa send waste to landfill + burn coal for energy

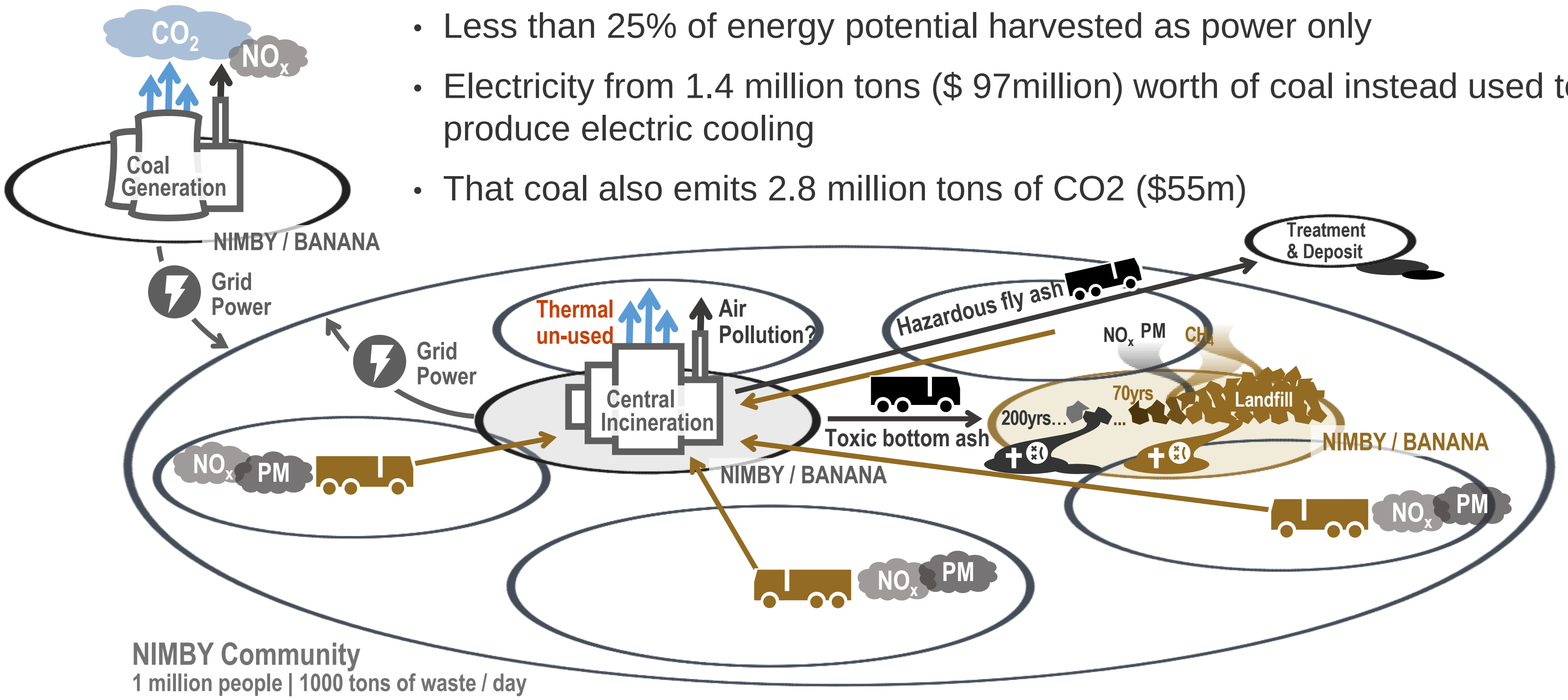
- 4.1 million tons ($ 290 million) worth of coal used to replace the wasted energy for *power and cooling*
- That coal also emits 8.2 million tons of CO2 ($165 million at $ 20/ton)
- OBS! NOx & PM from millions of polluting and congesting truck kilometers transporting waste to one location
- Major pollution from landfill affecting health and environment



Only power harnessed while thermal energy lost (>40% of potential lost)

Alternatively, the waste is incinerated and the toxic ash sent to landfill – only concentrating and moving the waste problem to future generations

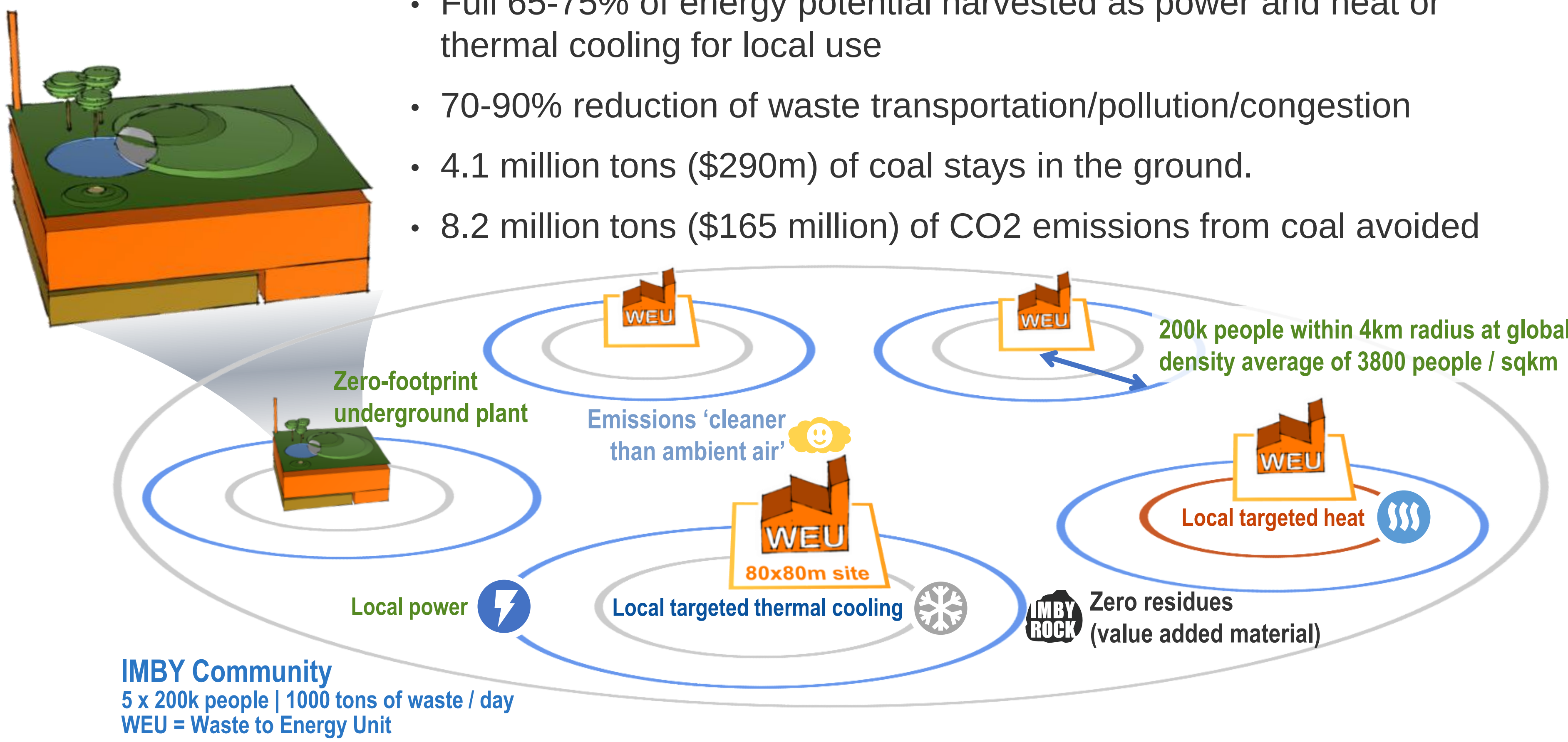
- 9.85 million tons of waste means 1.2 million tons of toxic ash for (treatment?) and deposit (473 Olympic size swimming pools)
- Same NOx and PM from millions of polluting and congesting truck kilometers transporting waste and toxic ash
- Less than 25% of energy potential harvested as power only
- Electricity from 1.4 million tons ($ 97million) worth of coal instead used to produce electric cooling
- That coal also emits 2.8 million tons of CO2 ($55m)



Both power AND thermal energy fully harnessed (65-75% of total)

IMBY solution with full responsibility towards future generation and both in terms of clean and efficient waste treatment AND sustainable energy diversification

- 9.85 million tons of waste diverted from landfill
- 0.6 million tons of clean ready-to-use IMBY Rock™ for art and local infrastructure – NO residues for treatment or deposit
- Full 65-75% of energy potential harvested as power and heat or thermal cooling for local use
- 70-90% reduction of waste transportation/pollution/congestion
- 4.1 million tons ($290m) of coal stays in the ground.
- 8.2 million tons ($165 million) of CO2 emissions from coal avoided



Follow BOSON ENERGY on Twitter and Linkedin!

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Also here in Birmingham:

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Feedback

Stephen Gill, Institute of Refrigeration

DAY 1 SUMMARY, THOUGHTS AND CLOSE

Professor Richard Williams, Heriot-Watt University

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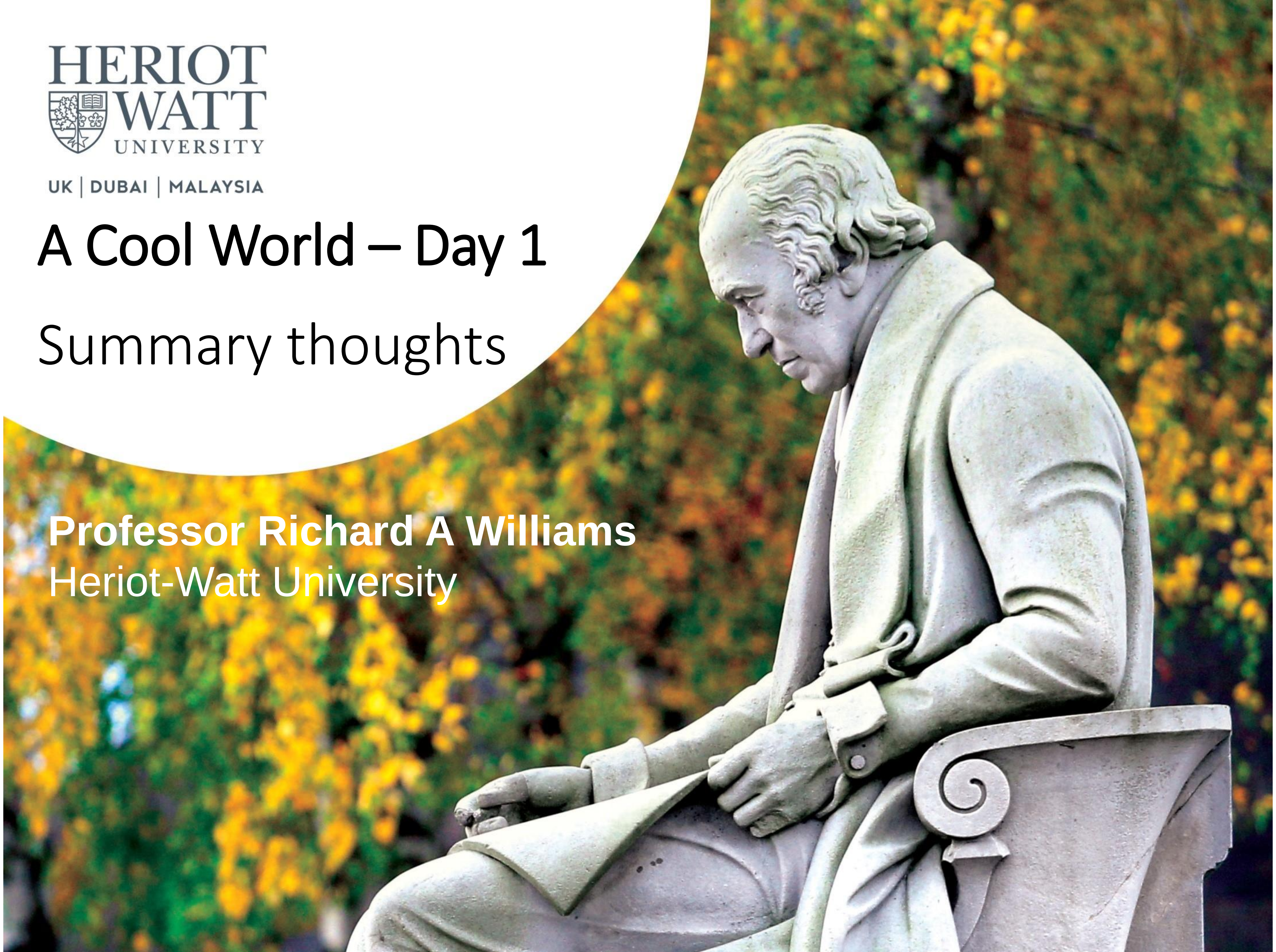
A Cool World – Day 1

Summary thoughts

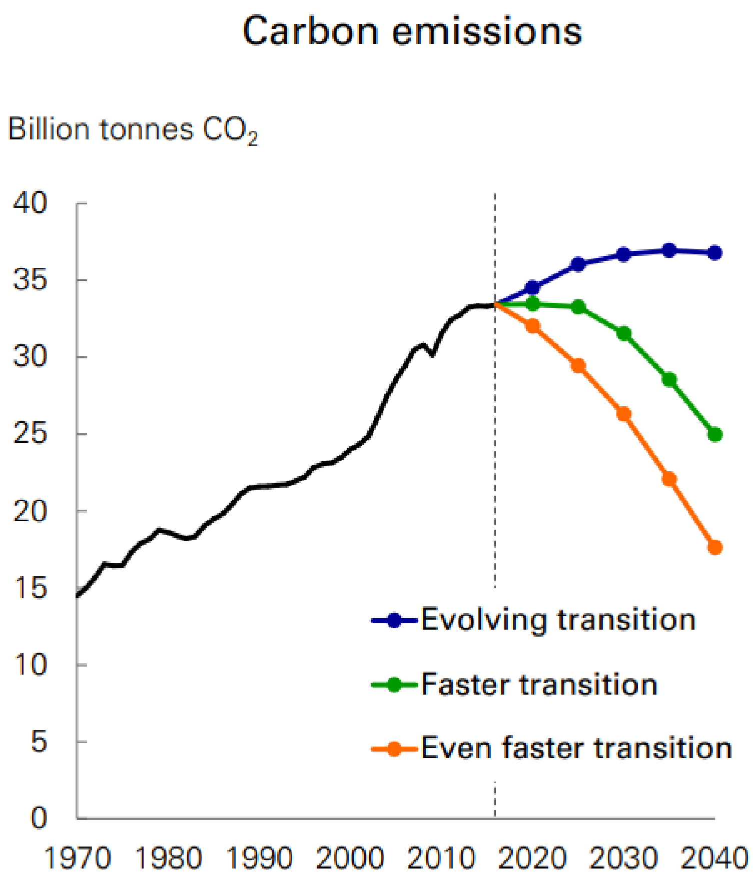
Professor Richard A Williams
Heriot-Watt University

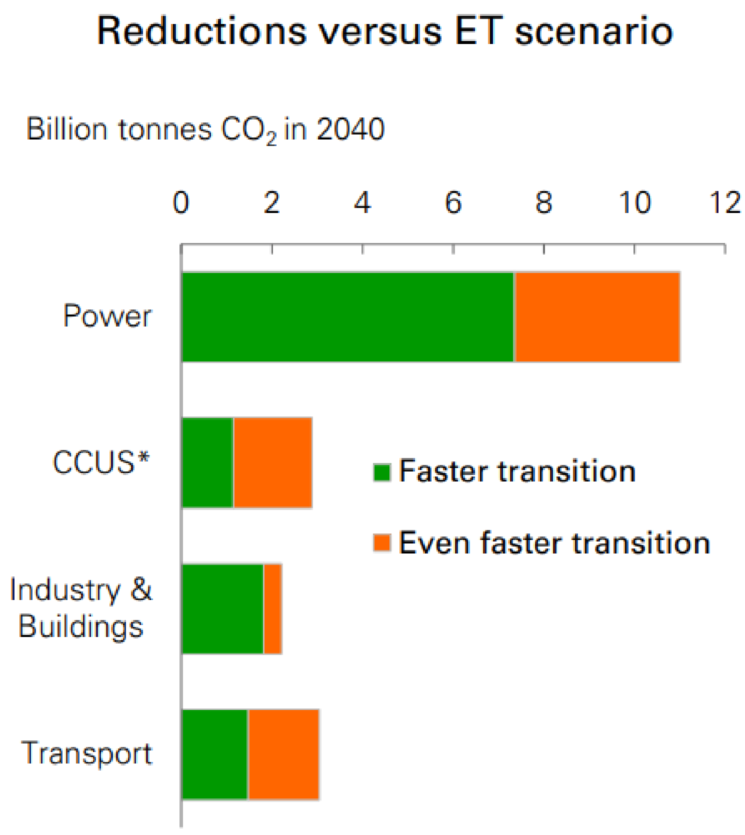


1. Energy transition requires “radical innovation” in technology and systems

Carbon

Carbon emissions continue to grow in the ET scenario...





*Carbon capture use and storage

A global call to innovate to close the gap…

"While important progress has been made in cost reduction and deployment of clean energy technologies, the pace of innovation and the scale of transformation and dissemination remains significantly short of what is needed" 30th November 2015 at COP21

2. Accelerating innovation in clean cooling offers major societal benefits for future sustainable lifestyles – *one of the few examples of revolution since COP21*

3. Aim for ‘radical innovation’ solutions - *not just incremental fixes*

Innovation is:

- *“an invention or discovery that has been put into use resulting in significant benefits”*

A **radical innovation** is:

- *“one that offers a radical beneficial impact on society, and it does this since the invention itself is often extraordinary”*

N.B. Of course incremental solutions that are deployed widely can also be transformative, but are likely to be insufficient

4. Recognise the characteristics of radical cooling innovations – *and plan accordingly*

- Initially unbelievable?!
- Often involves simple concepts
- Daring and ambitious
- High risk - *low chance of success, requires resilient team work*
- Hard to fund - *disrupt existing markets or have no existing market*
- Scales slowly - *market growth rates, manufacturability, talent bottlenecks, needs to connected to adopting communities*

5. Challenges drive change – *let us determine to engage to solve the global cold challenge!*

"When you are face to face with a difficulty you are up against a discovery"

LORD KELVIN