



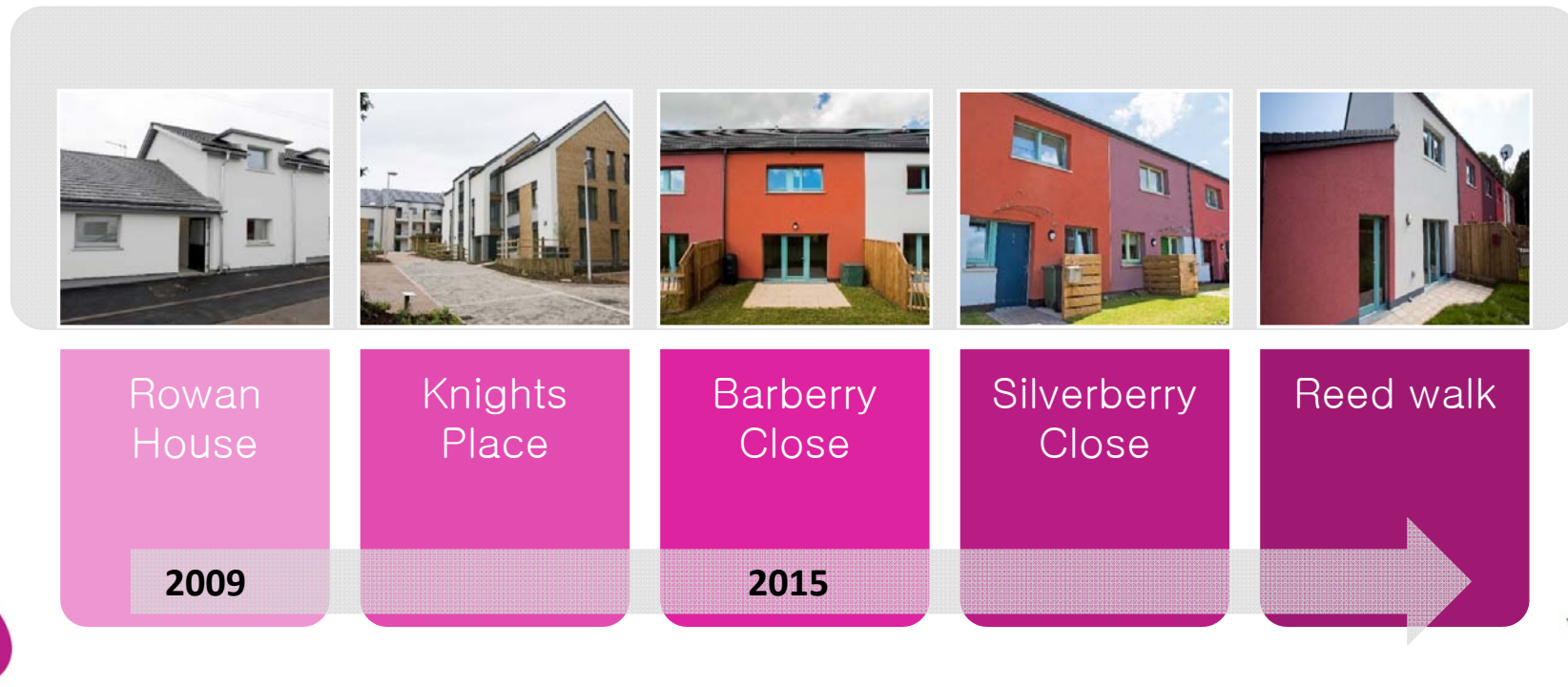
# ARE YOUR BUILDINGS LOW ENERGY, CLIMATE-READY & HEALTHY? DEVELOPING THE EXETER CITY COUNCIL WAY



**apse** APSE Renewables and Climate Change Advisory Group

1. Introduction
2. Environmental Factors
3. Commercial Case
4. EXEseed Developments
5. Questions

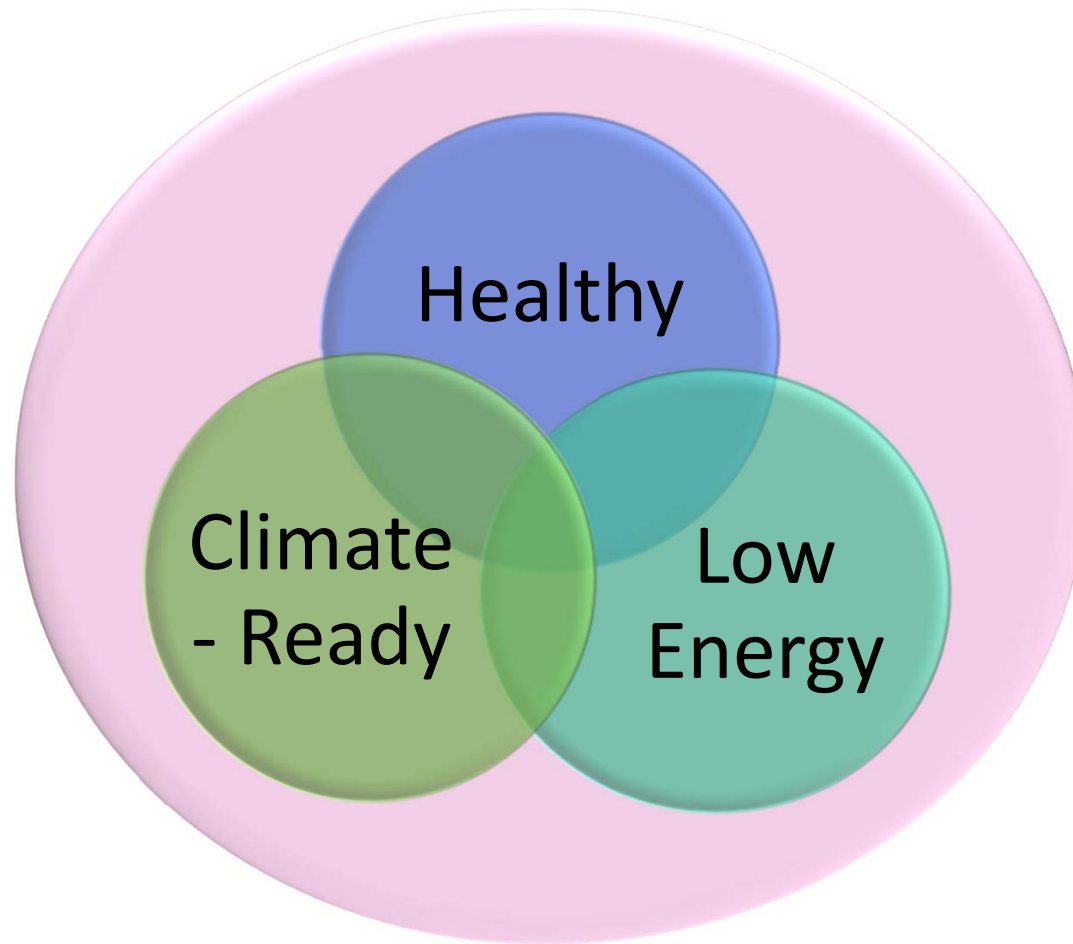
## Development Track Record to Date



## What is in ECC's pipeline?



# ENVIRONMENTAL FACTORS



## What is Passivhaus?

- a rigorous **energy** standard
- a rigorous **comfort** standard
- a rigorous **quality** standard

# What is Passivhaus?

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- limit of 15kWh/sqm/year for heating and cooling
- limit of 120kWh/sqm/year for total primary energy
- limit that occupied hours cannot exceed 25°C for more than 10% of annual occupied hours



# What is Passivhaus?

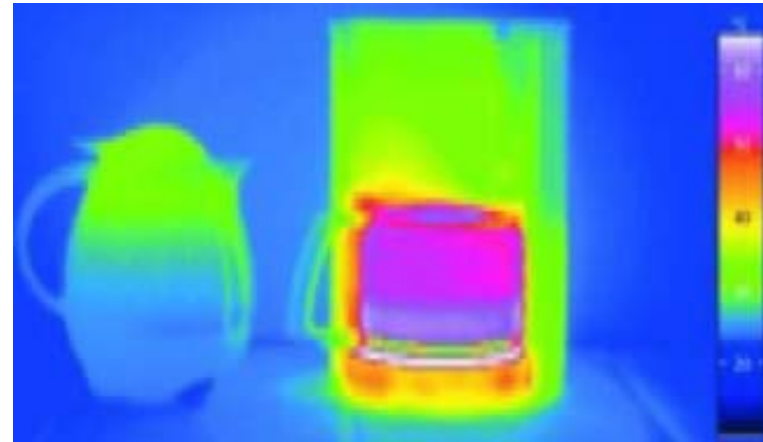
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- developed in Germany between 1988 and 1990 by Wolfgang Feist, a building physicist
- in response to concern that buildings were not performing as predicted
- Passivhaus Institute was founded in 1996 to promote and control the standard through certification





# What is Passivhaus?



# How do you achieve Passivhaus?

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- design the orientation and form of the building to optimise solar gain and improve day lighting
- improve the building fabric - eliminate thermal bridging, increase insulation, airtightness and window specification
- use MVHR to ensure sufficient ventilation, whilst avoiding unnecessary heat loss in winter

# How do you achieve Passivhaus?

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- Be an informed client
- Select and appoint an experienced and qualified professional consultancy team
- Select and appoint an experienced contractor
- Use PHPP to demonstrate design achieves standard
- Monitor construction carefully
- Supply PHPP modelling, evidence from air test, and proof of supply of key products to Certifier
- Certifier assesses compliance and issues certificate

# Why Passivhaus?

**It works!**



*“I love the fact that the flat is warm all the time and whenever I come in from outside it is always nice and warm unlike any other building I have been in”*

*“I have never felt uncomfortably hot or cold a single day since moving in”*



# Why does Passivhaus work?

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- it does not rely on complicated technology
- simply ***good design*** and ***good construction***
- underpinned by ***rigorous certification***



# Why does Passivhaus work?

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- based on sound building physics and on the evidence of what ***actually works***
- based on ***reducing energy, by design***, instead of offsetting carbon, by add-on
- encourages integrated design, and a rigorous discipline, that delivers ***buildings that work***

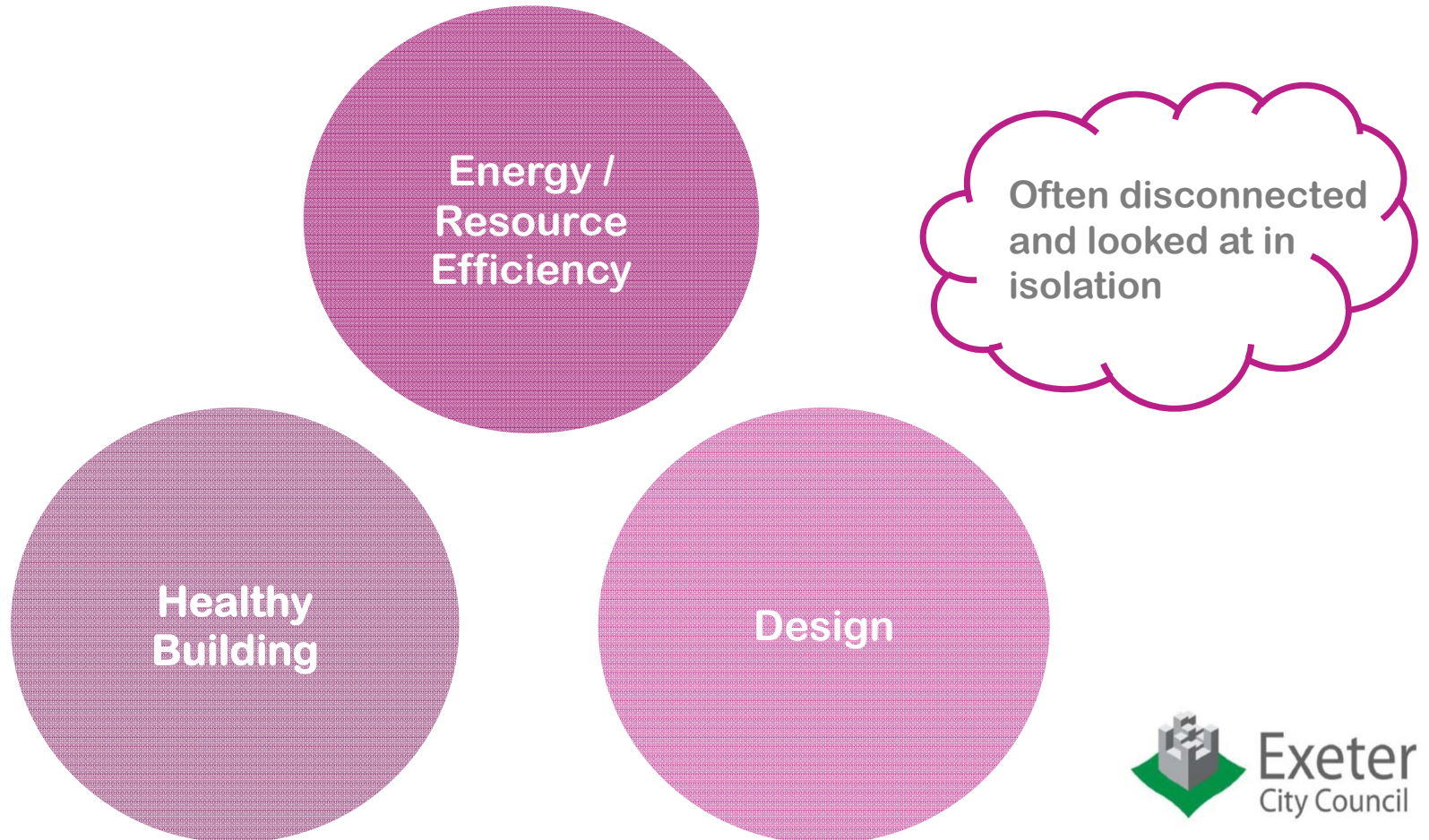
## Dispelling Passivhaus Myths...

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- You can open the window
- It is not just a German standard
- It doesn't dictate construction method
- It is not just a domestic standard
- It doesn't exclude other standards e.g. BREEAM
- It does not need to be more expensive

## Building Biology

*'Holistic study of interrelationships between humans and their environment'*



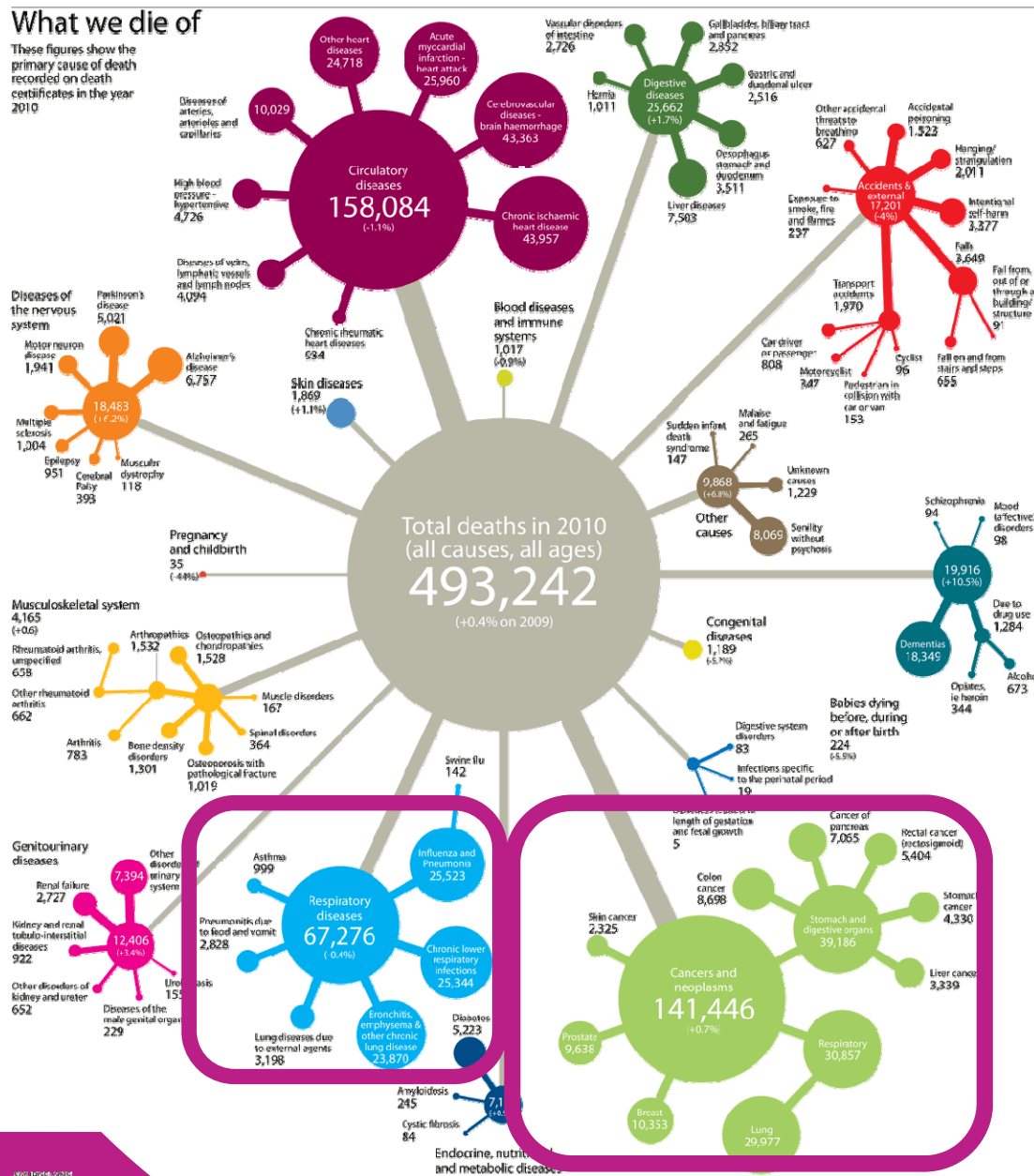




*Since the mid 1970s in the UK, the incidence of Alzheimer's disease has increased by 50% and is expected to increase by 20% in the next 10 years. Europeans will be affected by 10% in 2014.*  
(EAACI, 2011)

### What we die of

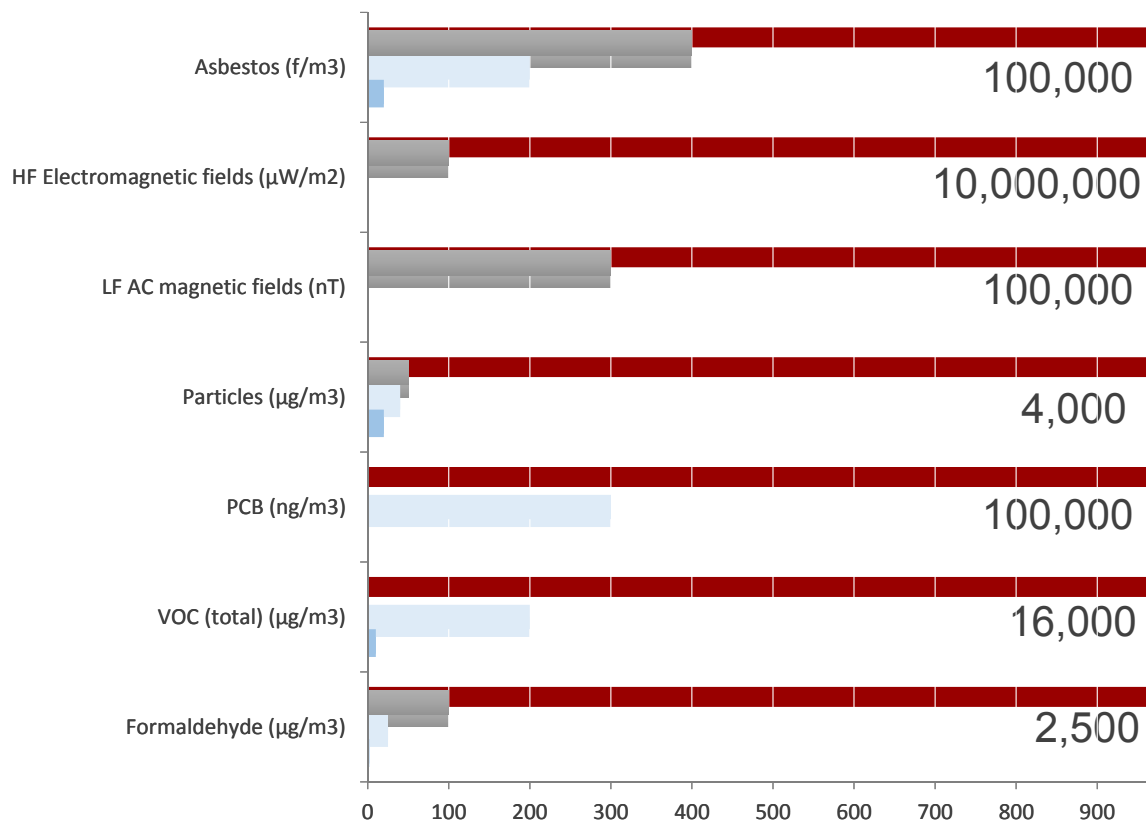
These figures show the primary cause of death recorded on death certificates in the year 2010



**Healthy Design**  
Does it matter?

# Healthy Buildings

Recommended limits for a range of substances classified as either 'carcinogenic (1)' or 'possibly carcinogenic (2a)' by the WHO.



## Healthy Design – Why bother?

On average we spend about **90% of our time indoors** and 30% of our time in bedrooms

At these exposure times **even low concentrations** of harmful substances **affect our health** in the long term and can cause chronic diseases. More vulnerable inhabitants like children and elderly persons are particularly exposed to this risk

**Bau Biology is about managing this risk** and reducing it where possible

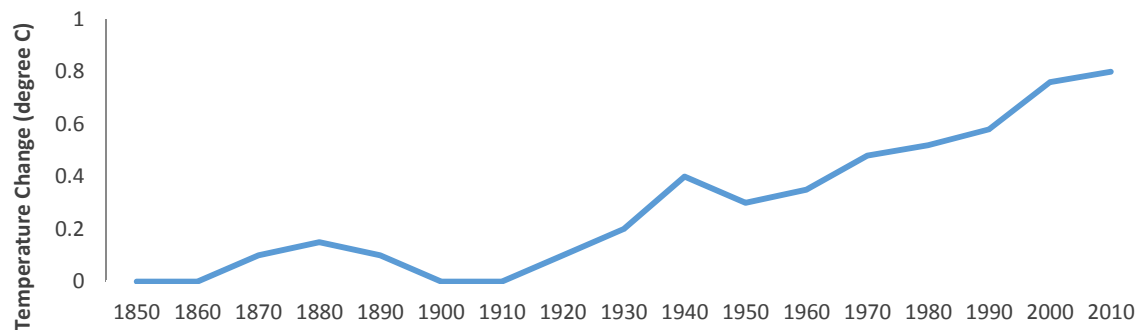


## Climate Change

What is predicted for the UK?

- Since 1960's the average temperature in UK has risen
- Average summer temperature increase of 4-6 degree by 2100
- Increase in UV radiation
- Events of extreme rainfall and flooding have become more frequent and this trend is predicted to increase

**Change in Average Temperature Since 1850**



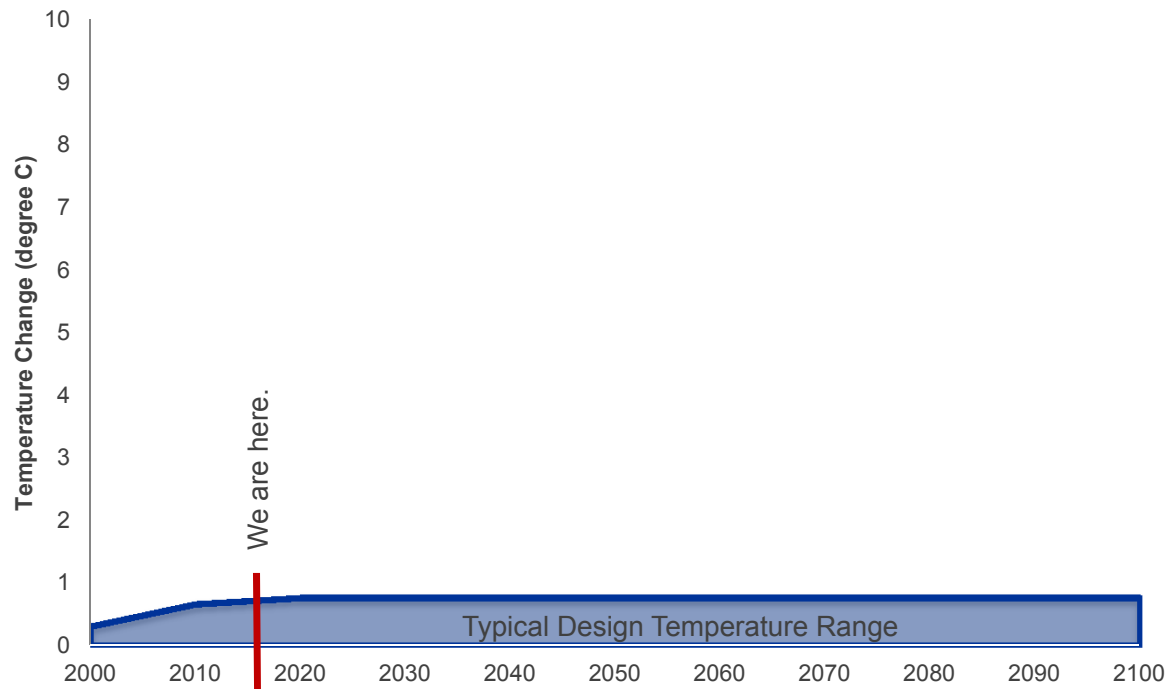
## Overheating

What about climate change?

Building designers typically use weather data that is based on past experience to predict the future performance of a building.

The building is then designed to maintain optimum comfort and (*ideally*) to use minimal energy over the lifetime of the building.

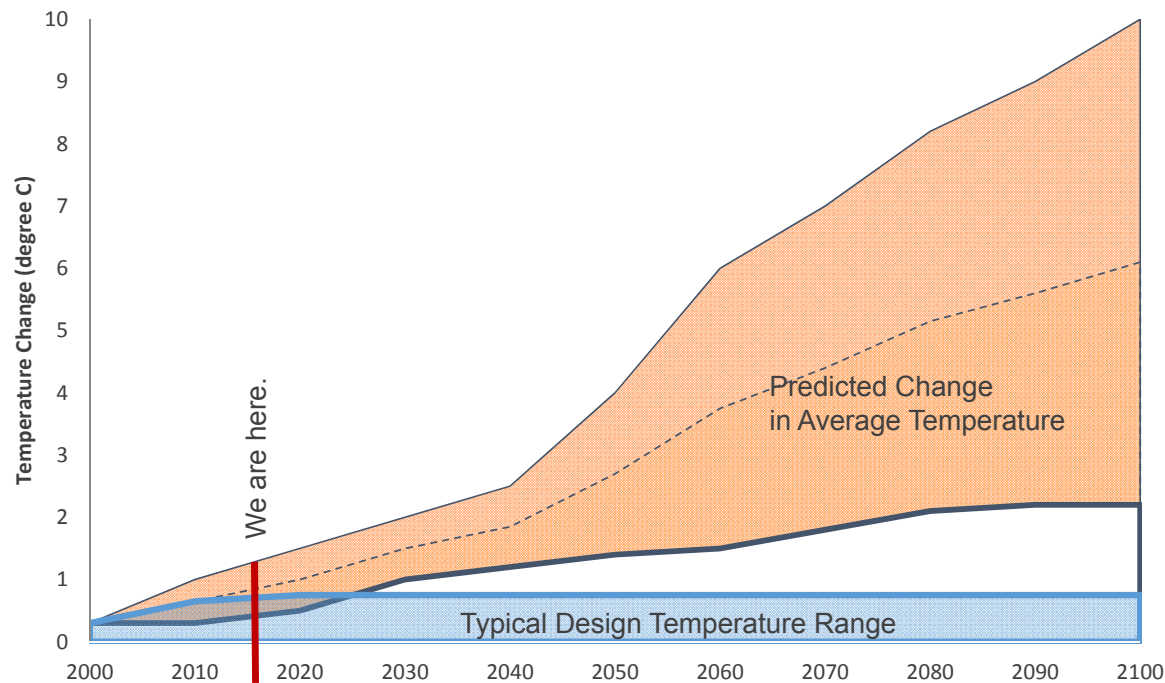
Ignoring the evidence that the climate is changing.



## Overheating

What about climate change?

Building designers typically use weather data that is based on past experience to predict the future performance of a building.



ECC uses probabilistic future weather data from Exeter University's *Prometheus Project* which were derived from the latest climate projections for the UK (UKCP09).

The projections are probabilistic in nature instead of deterministic so as to allow users to assess the level of risk.



## Background



**Bus Station  
Regeneration**



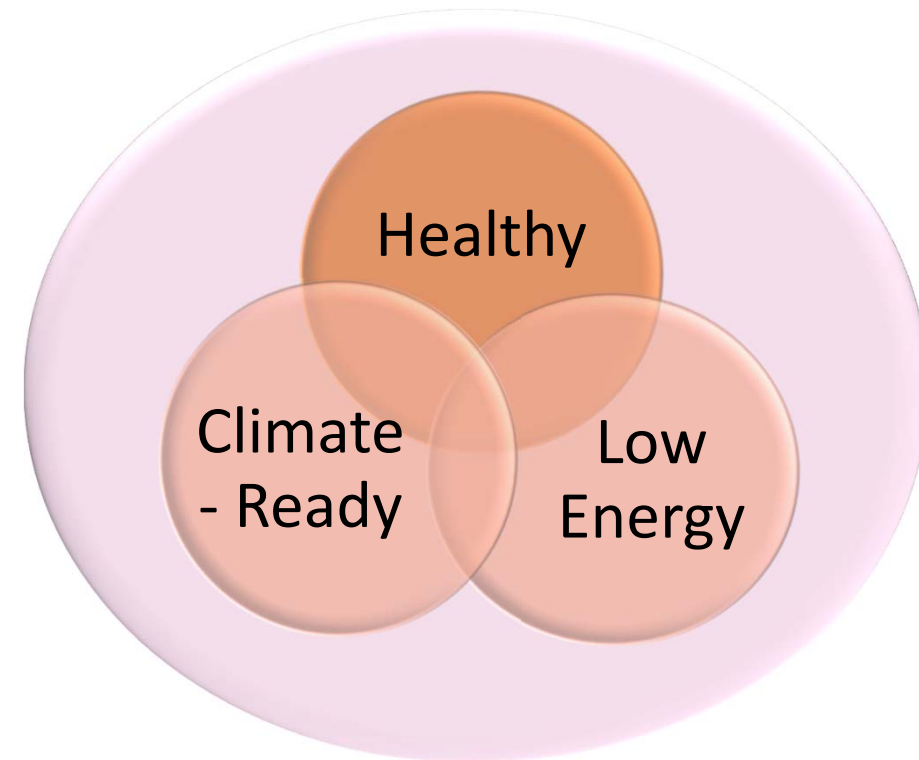
**TSB Report**



**Replacement for  
Pyramids**

## Specification

Element	Provision
<b>Main Pool 25m, 8 lane pool</b>	2.0m, movable floor across half the area
<b>Teaching Pool 20m, 4 lane pool</b>	0.0 – 1.2m deep, movable floor
<b>Confidence Water</b>	60 sq m
<b>Spectator Seating</b>	100 seats
<b>Gym</b>	150 station, 750 sq m
<b>Exercise Studio</b>	30 + 20 person, separate spinning studio
<b>Health Suite</b>	Spa offering, 350 sq m
<b>Flexible Meeting Room – Crèche, Seminar, etc.</b>	35 sq m
<b>Café</b>	50 seats, with servery and food preparation room (no kitchen)
<b>Soft Play</b>	Double height in part





## The Passivhaus Pool Concept

A passivhaus building envelope will significantly reduce heating energy losses in pool building and results in the following benefits:

- Higher surface temperatures
- Minimum thermal bridging avoiding condensation risk
- Increased thermal comfort



## Other Passivhaus opportunities and benefits:

Higher relative humidity throughout the year ( $\approx 64\%$ )



- Reduced evaporation rates from pool water and reduced required ventilation rates (1ac/hr with no circulation)



- High quality PH ventilation system and controls will further reduce ventilation heat losses



- Reduced electrical energy demand for ventilation
- More economic ventilation / ducting (e.g. glazed facade elements don't need to be ventilated to protect from condensation)



# Passivhaus Leisure Centre

## Key design elements:

- High performance passivhaus building fabric
- High performance windows & doors
- High levels of airtightness
- Internal zoning
- Compact building form
- Optimum solar orientation  
(40% south facing glazing  
for wet areas)





# Passivhaus Leisure Centre – Energy Saving

## The Great Unknown – Energy Cost

- Future energy costs fluctuating
- Arup Forecast: A reduction of energy cost by 70%



**Conventional build predicted energy costs £57/m<sup>2</sup>/pa**  
**Passivhaus predicted energy costs £20/m<sup>2</sup>/pa**

# Passivhaus Leisure Centre – Energy Saving

## PASSIVHAUS FACTS AND FIGURES

The energy savings generated within one year would be sufficient to:

cover the total annual energy consumptions of 350 (4 person) average UK households



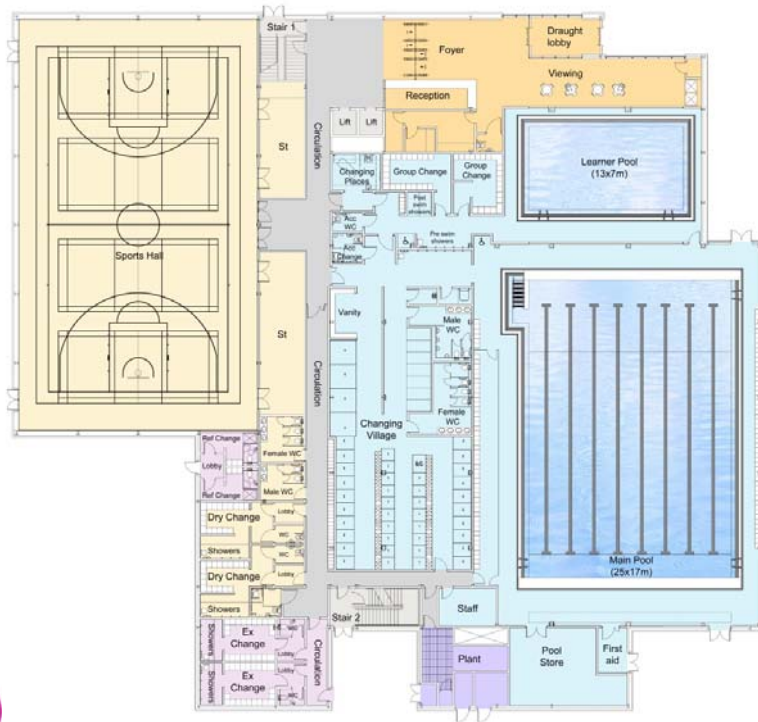
make 140 million cups of tea



The carbon reductions from adopting Passivhaus on the Exeter Active project for a single year (when compared to a standard modern UK leisure facility) are equivalent to:

## Passivhaus Effect

Typical Leisure centre



Example Leisure Centre of 4,500m<sup>2</sup>

- Energy cost £250k/ annum
- Passivhaus cost £90k/ annum
- **Saving** £160k/ annum



## Bau Biology – The 25 Principles

5 categories:

1. Site

2. Environmental Impact

Energy

Water

3. Materials

4. Design

Light

5. Indoor climate

Air quality

Acoustics



## ECC Environmental Factor = SBM 2015

### Comfort criteria:

- Offices 23 – 26 deg C
- Swimming pool 30 – 34 deg C
- Dry Sports 14 – 16 deg C
- Changing rooms 24 – 25 deg C

### Daylight criteria (daylight factors):

- Offices: Average 5%, minimum 2%
- Swimming pool Average 5%, minimum 2%
- Dry Sports Average 5%, minimum 3.5%
- Changing rooms Average 3%, minimum 1.5%

### Water quality

- WHO ('World Health Organisation') drinking water quality
- comply with DIN 19643

### Radiation

- offices and creche to SBM 2015 part A category 'no concerns'

### Air quality

- offices and crèche to SBM 2015 Part B 'no concerns'





## Water quality – UK situation

During a 45 minutes swimming lesson a child swallows about a pint of pool water.

The UK is the only country in Europe that does not comply with the German DIN standards or an equivalent high standard.

UK pools are estimated to have 10 to 20 times higher parasitic infection rates when compared against other EU countries (EuroSurveillance V12, May 2007).

UK treatment standards PWTAG: 1.5mg/l of nitrogen trichloride are acceptable, under German DIN only a maximum of 0.2mg/l are allowed.

And yet the German Environment Agency states that public pools are not safe for children under 2 years.

... where does that leave the UK ?



## Common practice – water treatment

### Chlorination of pool water

- The chlorine smell of swimming pools is due to a chlorine reaction product called nitrogen trichloride.
- This gas is heavier than air and thus creates a layer of higher concentration immediately above the pool water where it is inhaled by bathers.
- Nitrogen trichloride has been linked to occupational diseases and to causing asthma (2006, pool chlorine hypothesis).
- A study of 624 swimming pool workers found a significant correlation between upper respiratory symptoms and their total exposure to nitrogen trichloride and specific symptoms of asthma.
- In another study two hours exposure to nitrogen trichloride above a swimming pool was found to weaken the protective nature of the surface of the lungs (hyperpermeability) which could allow allergens to cross this barrier.



### Children and asthma (UK)

- One in 11 children has asthma.
- The UK has among the highest prevalence rates of asthma symptoms in children worldwide.
- in 2013 on average there were 69 emergency hospital admission per day, or one every 21 minutes.

### The costs of asthma

- The NHS spends around £1 billion a year treating and caring for people with asthma.
- In 2008/09 up to 1.1 million working days were lost due to breathing or lung problems.

## Common practice - Filtration

- Most common filtration strategy for public pools is sand filtration.
- To assist the filtration 'flocculants' are automatically added to the water prior to it passing through the filters.
- Poly aluminium chloride is most commonly used and it forms a 'floc' that helps trap fine particles, microbes and pollutants in the water.
- But, Aluminium chloride has been established as a neurotoxin.
- Neurotoxins are poisonous and destructive to nerve tissue and long term exposure can cause widespread central nervous system damage such as intellectual disability, persistent memory impairments, epilepsy, and dementia.
- Sand filtration requires relatively high levels of chlorination.



## Alternative water treatment / filtration strategies

### Ultrafiltration

Ultrafiltration is a membrane filtration system where excess pool water is forced by high pressure through a semipermeable membrane which filters out molecular size particles and bacteria.

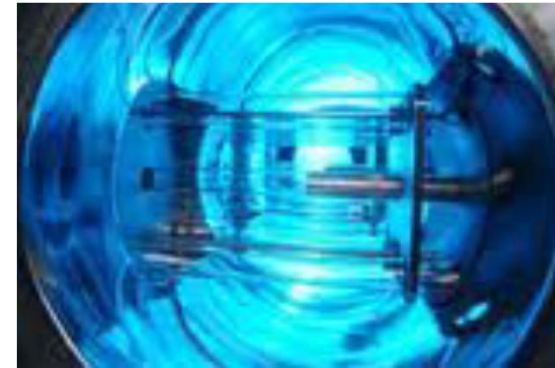
- No chemicals required (aside from cleaning)
- Constant product quality regardless of feed quality
- Compact plant size
- Capable of exceeding regulatory standards of water quality, achieving 90-100% pathogen removal



## Alternative water treatment / filtration strategies

### UV Treatment

Ultraviolet (UV) light induces the formation of covalent linkages on DNA and thereby prevents microbes from reproducing. Without reproduction, the microbes become far less dangerous. Studies have shown that UV doses are effective at killing bacteria like Giardia and crypts and have been successfully used in public pool buildings in combination with other filtering/treatment technologies.





# Climate Ready Leisure Centre

- 3<sup>rd</sup> party verification – The Centre for Energy and Environment at Exeter University
- Climate change adaptations:
  - Design (orientation, overhangs, zoning)
  - Cooling strategies (spectator seating /gym/ studios)
    - Night cooling
    - Comfort cooling
    - G – value glazing
    - Brise soleil
  - Water attenuation
- Comfort 2018 – 2080 (62 year modelling)



# Cost Effective Leisure Centre

- Passivhaus Premium?

Uplift	Source
10 – 23%	Aecom
15%	PH I
0 – 15%	Passivhouse + Magazine

- Base Cost Caution – apple v. apple
- ECC Residential £ 1,145/m<sup>2</sup> (BCIS 4<sup>th</sup> Q 2015 £618 - £ 1,330/m<sup>2</sup>)
- ECC Leisure 10% premium (£1.8m)
  - Passivhaus
  - Climate Ready
  - Building Biology
- Life Cycle Costs





# Cost Effective Leisure Centre

## Cost Drivers

Cost Increase	Cost Decrease
Better quality components	Compact forms
Air tightness products	Simpler systems
Ventilation system	Simpler controls
Attention to detail	

- Early stages of design development is where the cost uplift can be limited with cost effective design decisions such as orientation, compact form etc.

**The cost uplift is influenced by key drivers, which must be focused upon and optimised from the outset of design development.**







## Cost Effectiveness

- Passivhaus can be delivered cost effectively and within typical benchmark costs when the following is considered;
  1. Clear understanding of budget constraints and comparable base cost.
  2. Design approach which optimises cost effectiveness from the outset of design stages.
  3. Careful consideration of procurement strategy, contract form and market engagement.

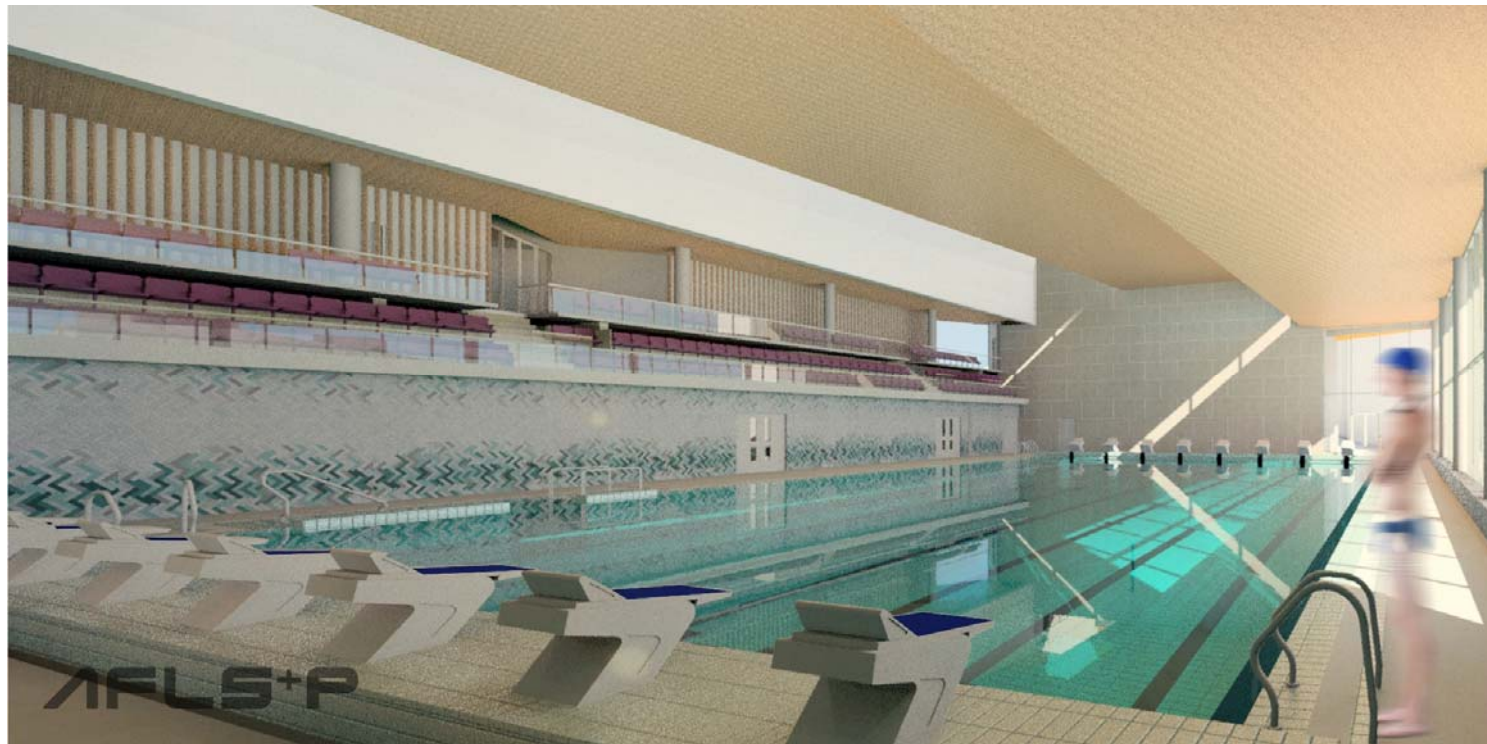
Consider utilising a bespoke Contractors Framework







# Competition Pool











# Conclusion

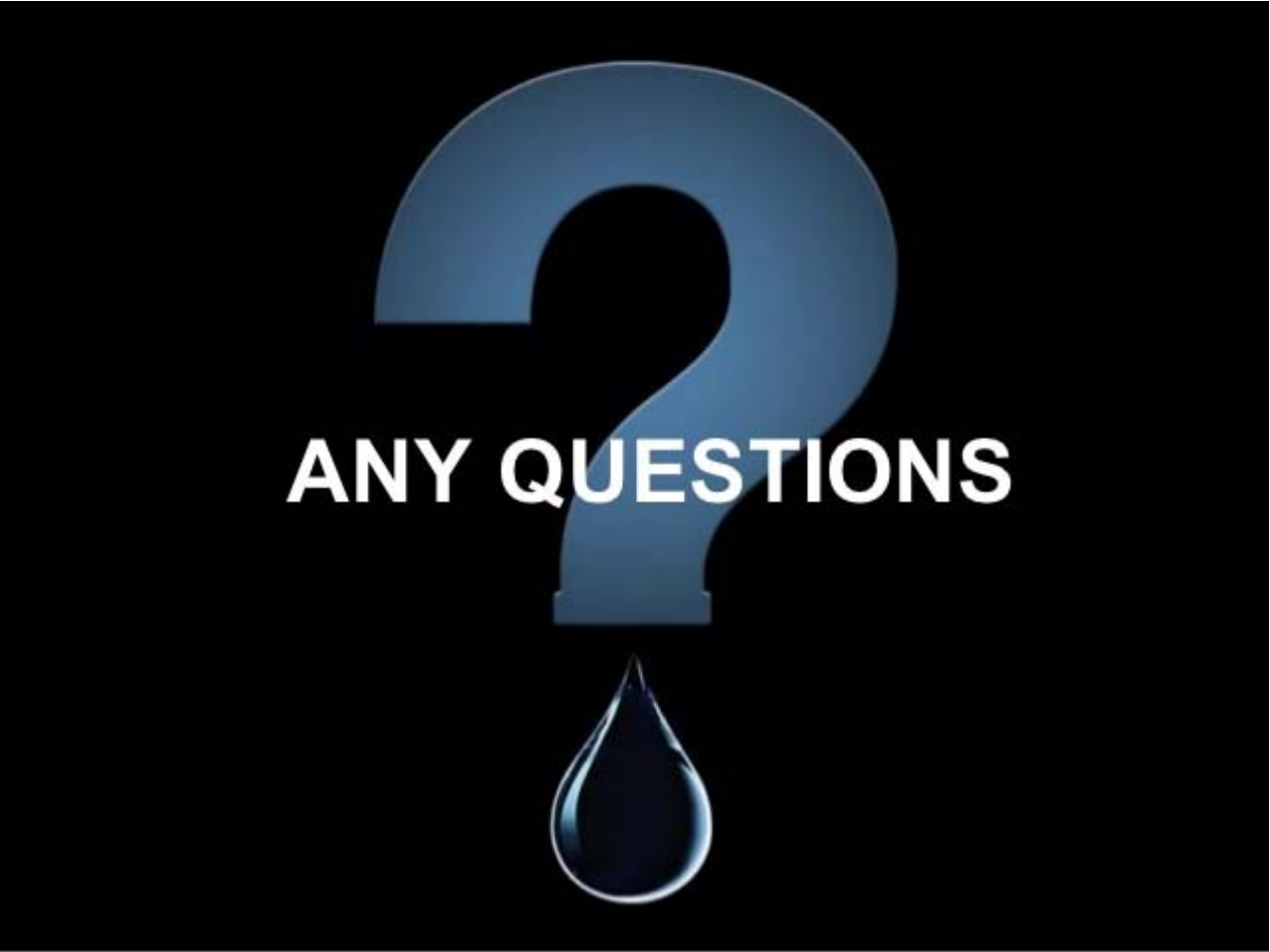
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Sustainable Energy Efficient Developments

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