THE BIG 5 International Building & Construction Show

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DEEP FOUNDATIONS INSTITUTE DFI®

5 - 8 DECEMBER 2022
DUBAI WORLD TRADE CENTRE

Reducing carbon emission in geotechnical construction

Nicol Chang

SESSION NAME/DATE/TITLE


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS


WORLD GREEN BUILDING COUNCIL
SUSTAINABLE DEVELOPMENT GOALS
Green buildings can improve people's health & wellbeing
Green buildings can use renewable energy, becoming cheaper to run
Building green infrastructure creates jobs & boosts the economy
Green building design can spur innovation & contribute to climate resilient infrastructure
Green buildings are the fabric of sustainable communities & cities
Green buildings use 'circular' principles, where resources aren't wasted
Green buildings produce fewer emissions, helping to combat climate change
Green buildings can improve biodiversity, save water resources & help to protect forests
Through building green we create strong, global partnerships
3 GOOD HEALTH AND WELL-BEING
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
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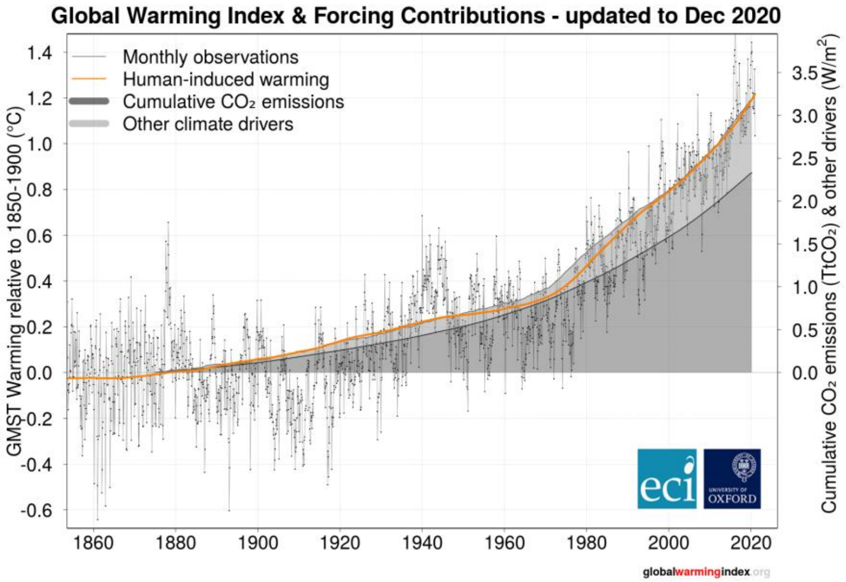
17 PARTNERSHIPS FOR THE GOALS

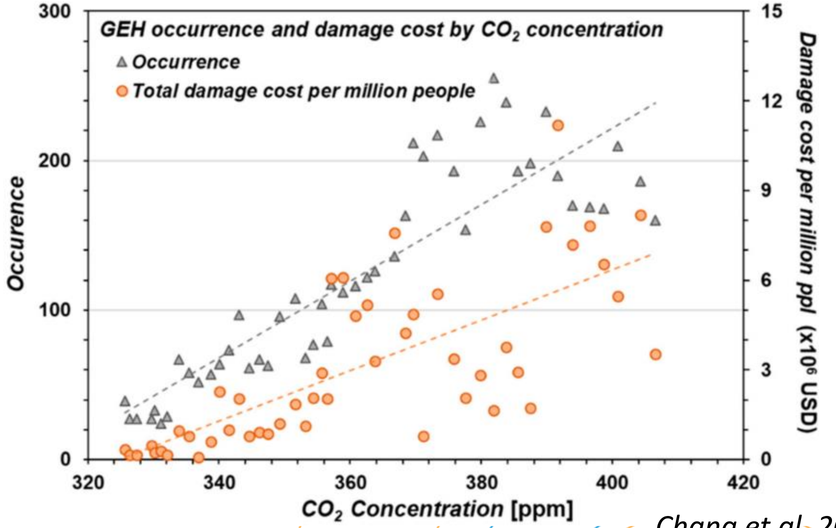
Global warming, CO_2 emission and geohazards

Talks Geotechnical & Engineering

THE BIG 5

Greenhouse gases consist of CO_2, CH_4, N_2O





Chang et al, 2019

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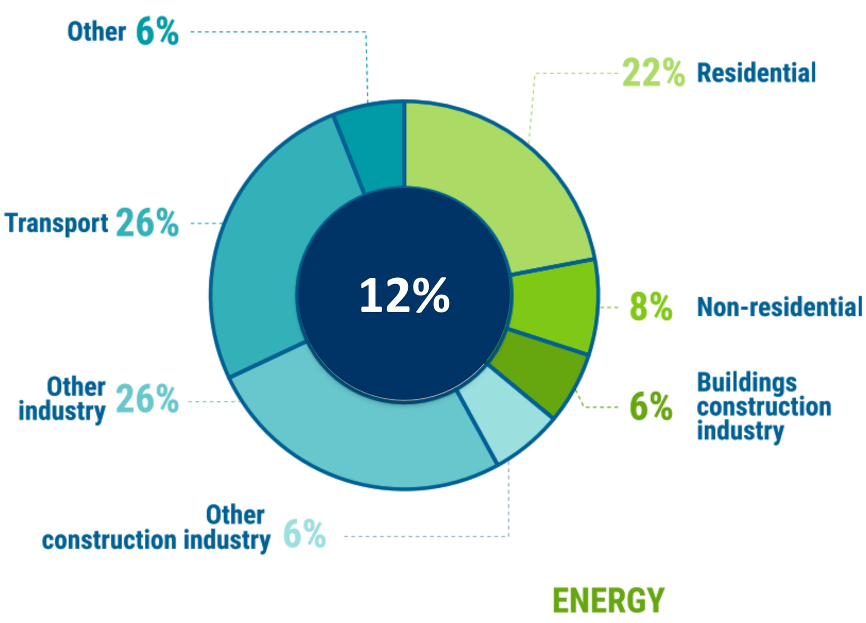
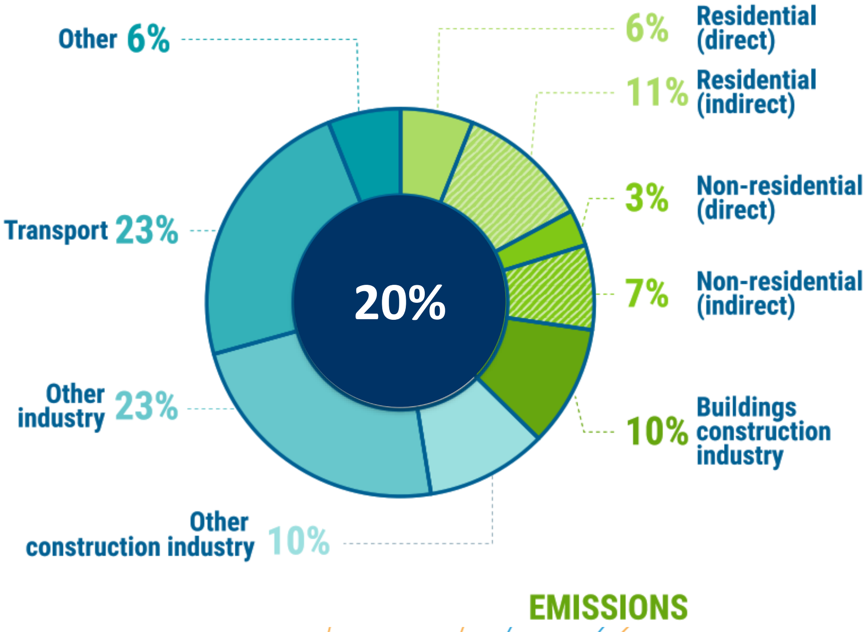
Contribution from construction industry

IEA 2021, Tracking Clean Energy Progress 2021





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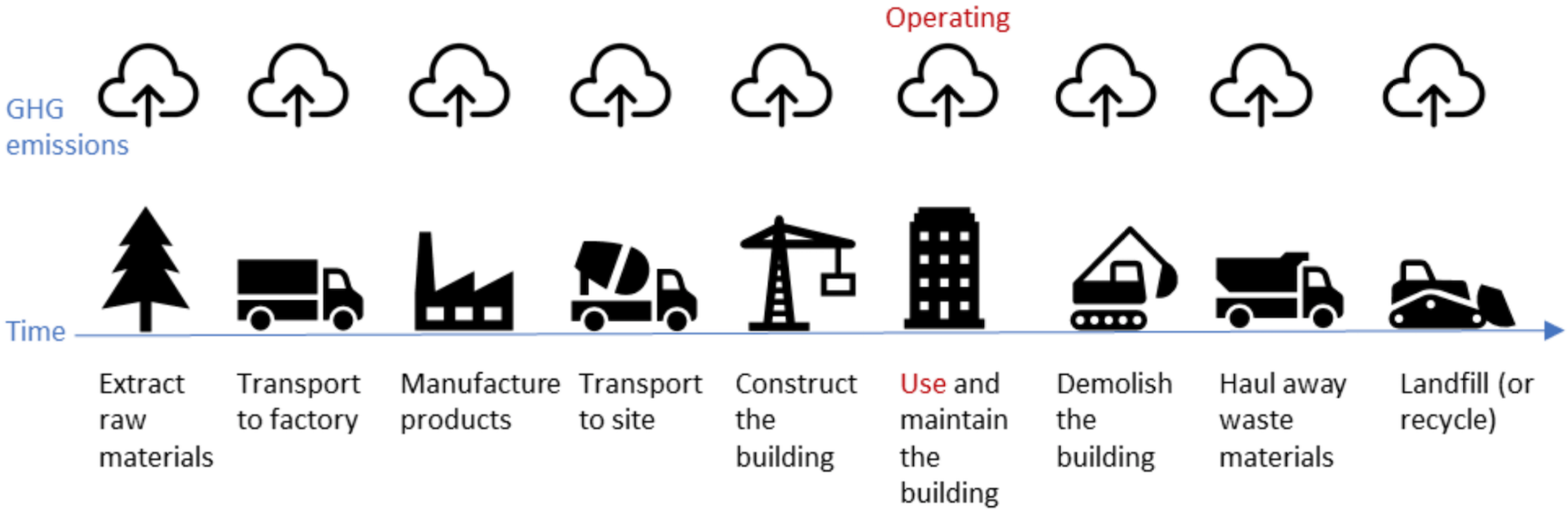
Emissions throughout construction process



Type of CO_2 emission in construction

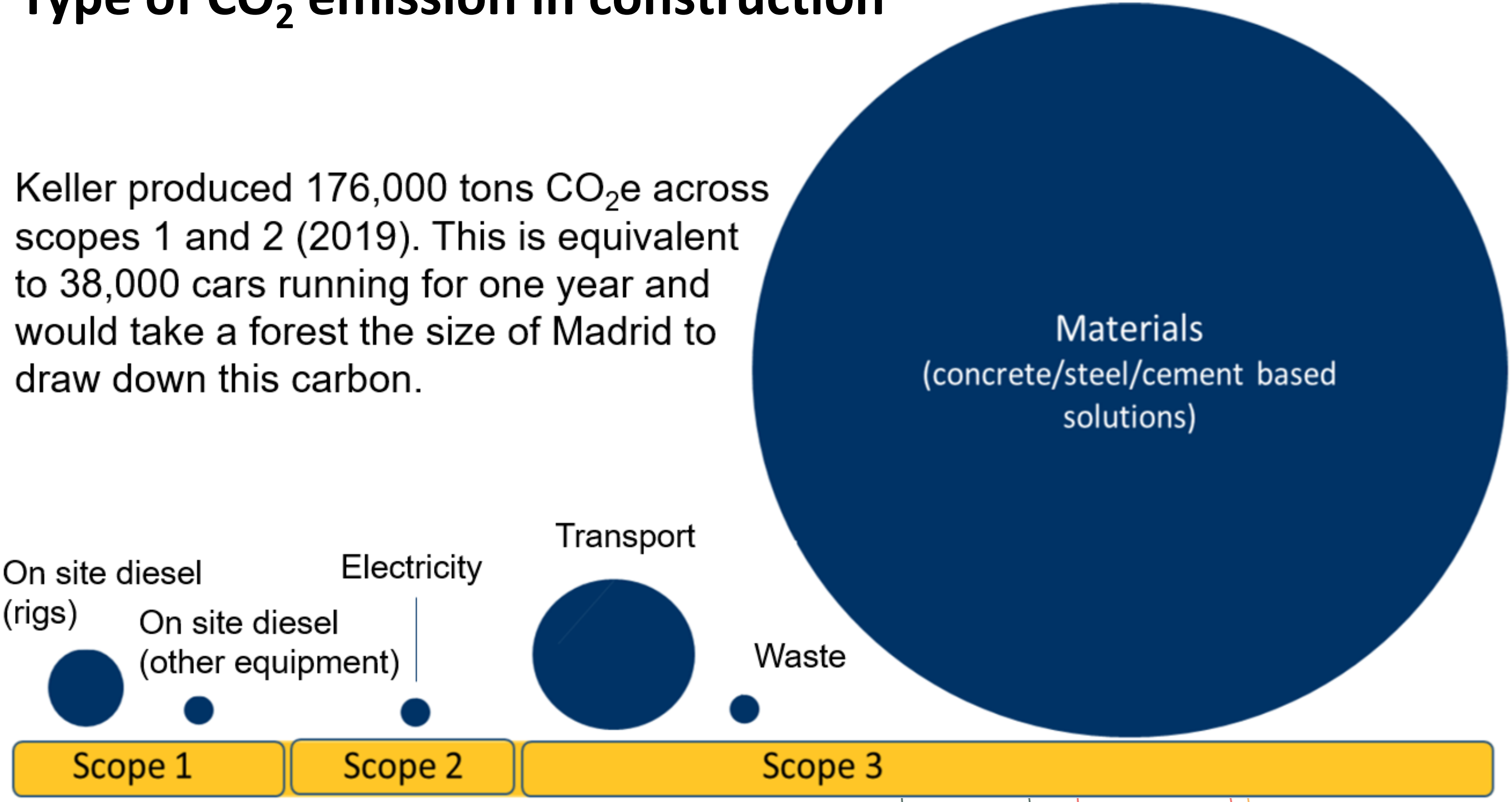
Scope 1: Direct emissions (fuel on site)

Scope 2: Indirect emissions (electricity supplied by grid)

Scope 3: Other indirect emissions (embodied in materials and transportation)

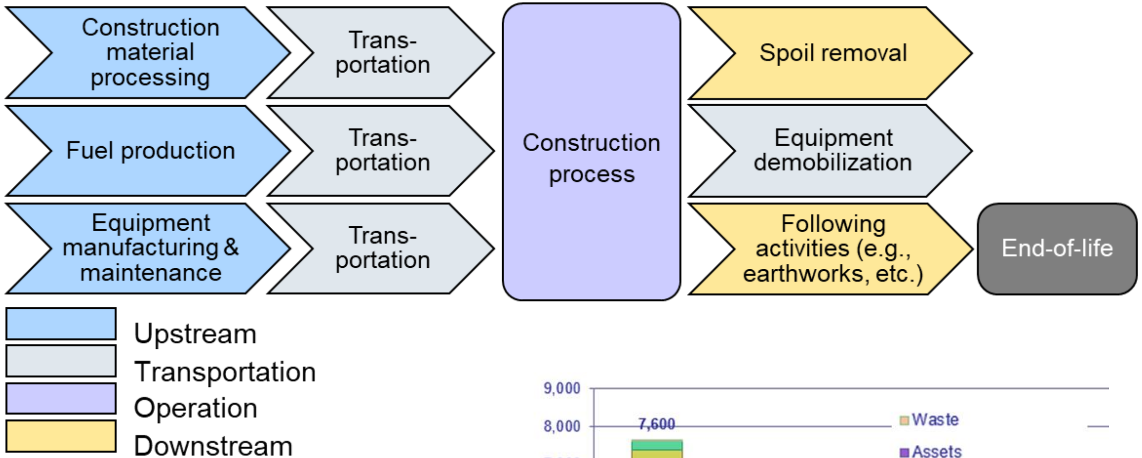
Type of CO_2 emission in construction

Keller produced 176,000 tons CO_2e across scopes 1 and 2 (2019). This is equivalent to 38,000 cars running for one year and would take a forest the size of Madrid to draw down this carbon.



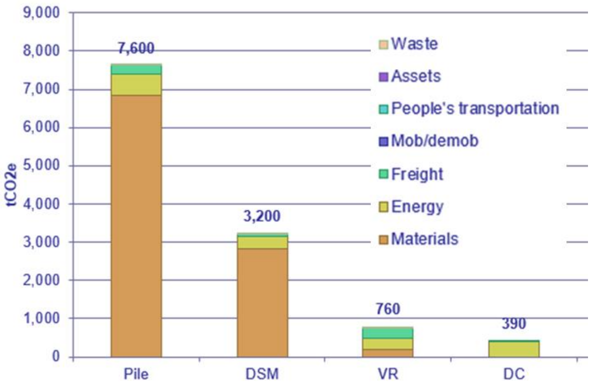
EFFC-DFI Carbon calculator

carbone 4
V2.2 www.carbone4.com



The implemented databases:

- EFFC-DFI recommended values
- Defra and Uni of Bath (UK)
- EPA (US)
- Bilan Carbone (France)



Techniques covered:

- Bored piles
- Displacement piles
- Micro piles
- Diaphragm and slurry walls
- Sheet pile walls
- Grouting
- Soil Mixing
- Pile walls
- Anchors
- Soil Nails
- Jet Grouting
- Stone Columns
- Vibro Compaction
- Dynamic compaction
- Vertical Drains

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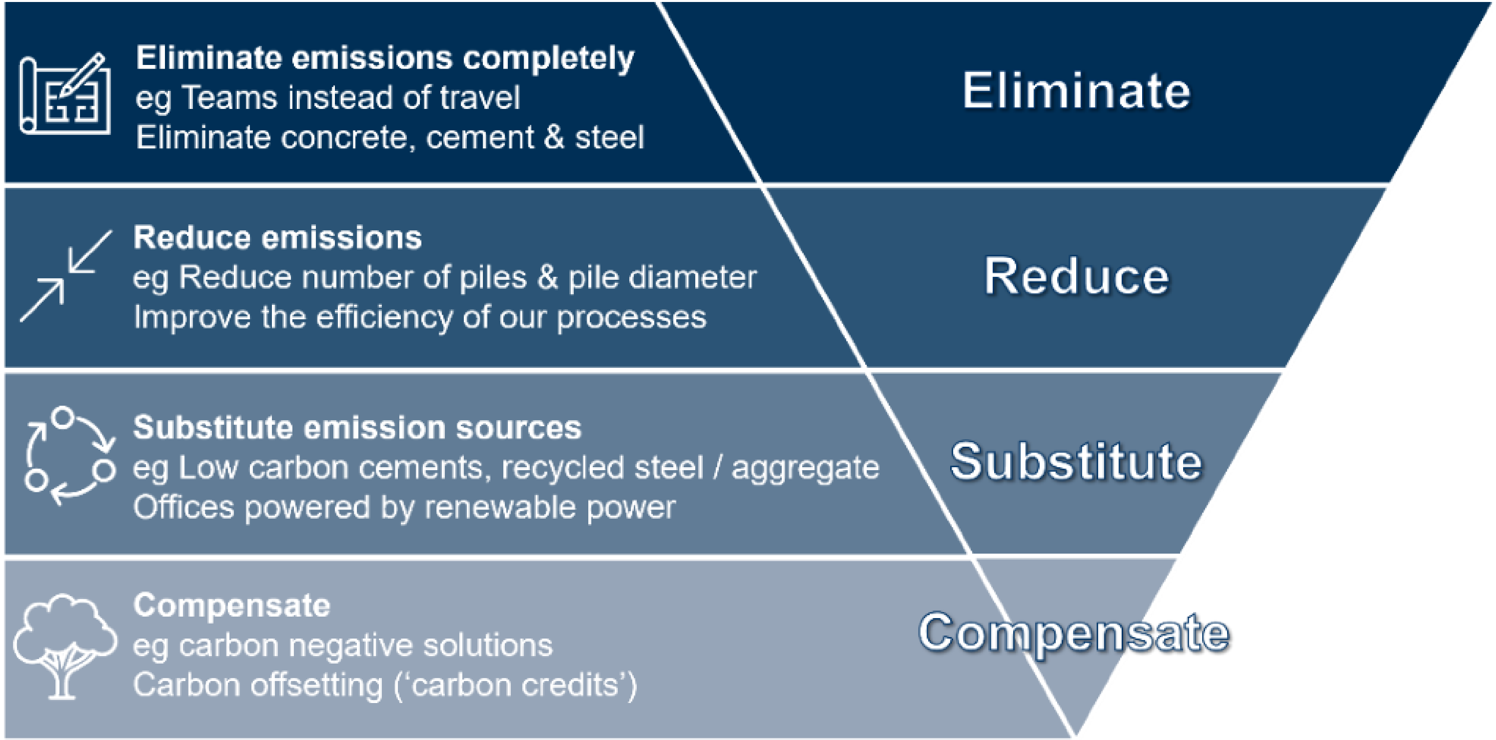
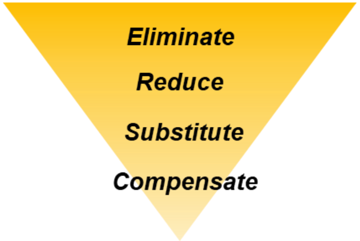
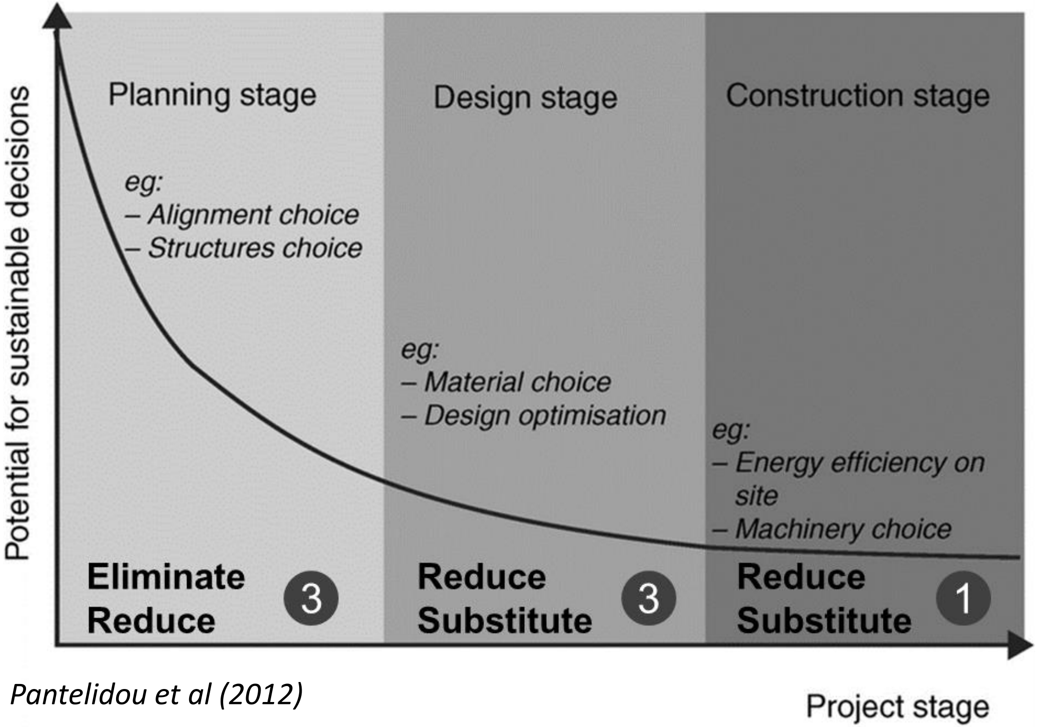
Hierarchy of carbon reduction



Potential for sustainable decisions





Pantelidou et al (2012)

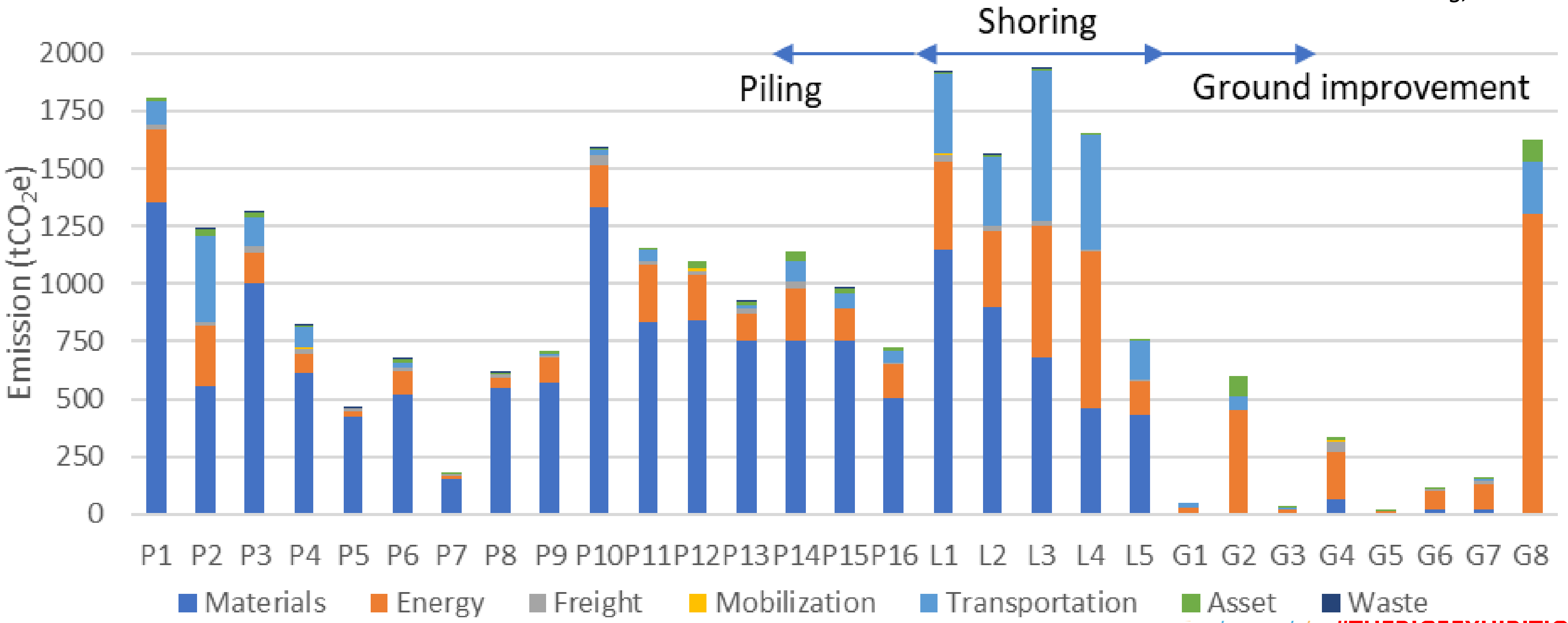
Planning stage
- Site choice
- Structure & foundation type (Piling vs GI)

Design stage
- Value engineering
- Green mix, recycled steel/aggregate (beware of transportation)

Construction stage
- Energy efficiency on site
- Replacing generators with solar
- Equipment efficiency (engine efficiency class, equipment using alternative fuel)

CO_2 emissions from geotechnical projects

Chang, 2021



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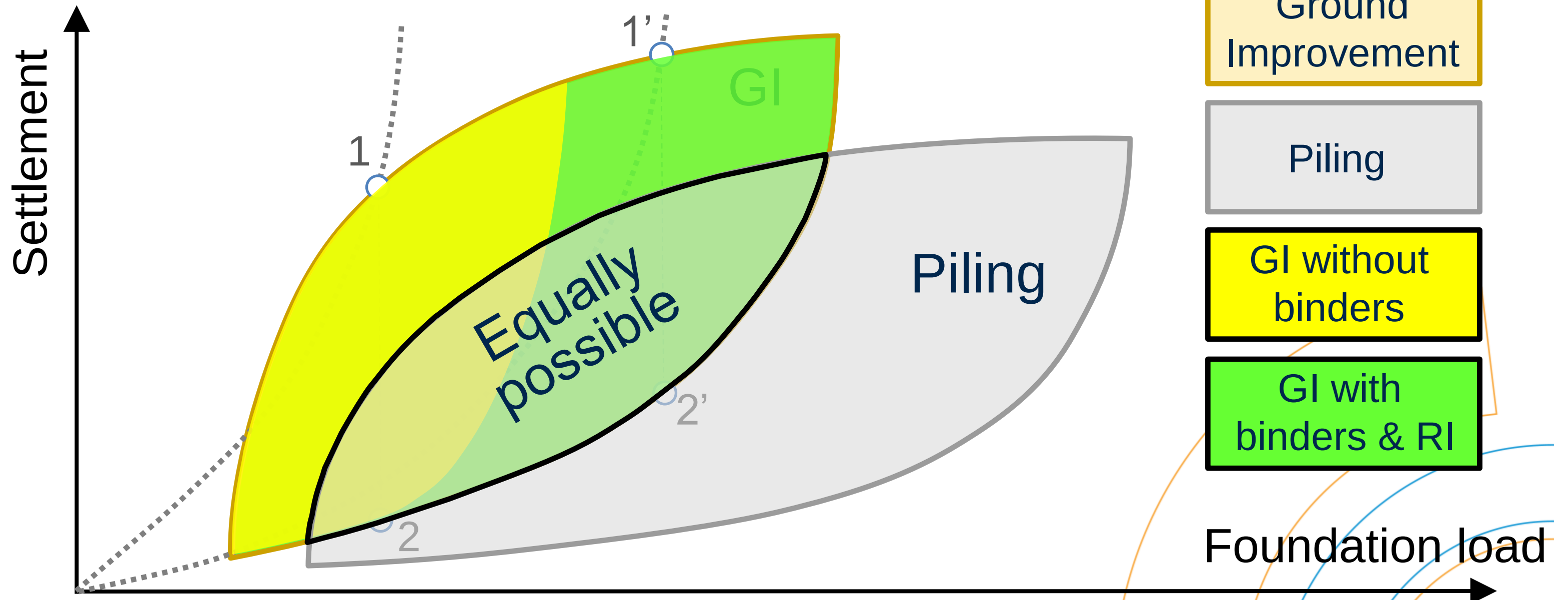
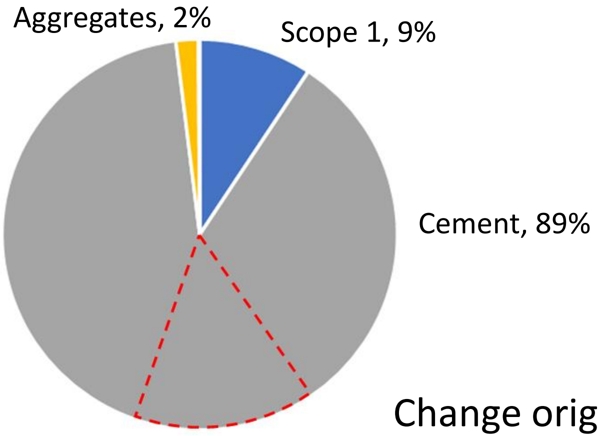
When can we use ground improvement?

Topolnicki, 2018



Case study 1: Logistics park

- Logistics park on soft soils
- ~45000 rigid inclusions to 32m depth
- Total 1108 kgCO_2 per RI installed



Change original concrete mix to include fly ash (by product of burning coal)

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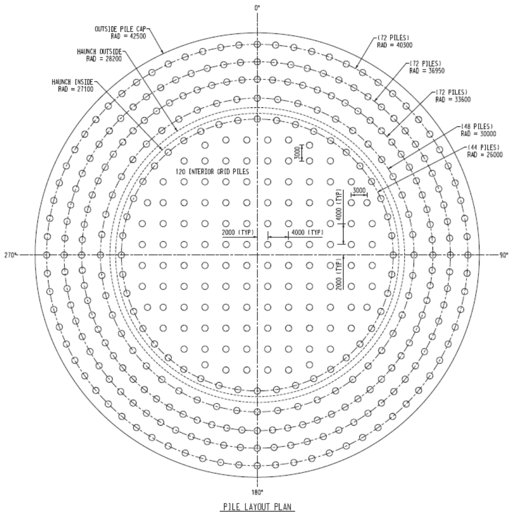
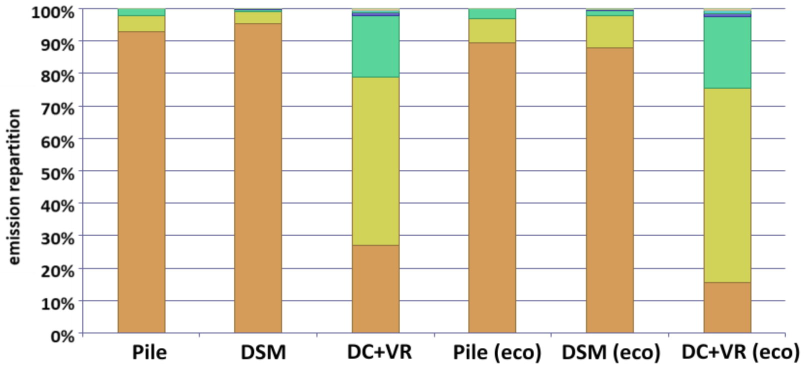
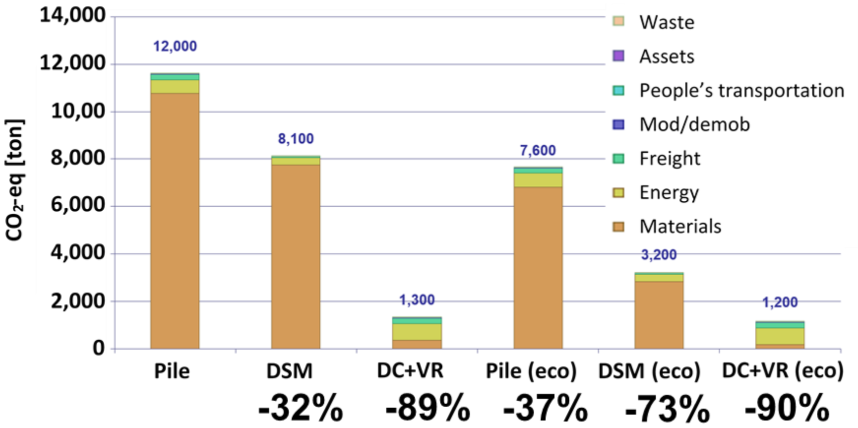
Case study 2: Tank foundation



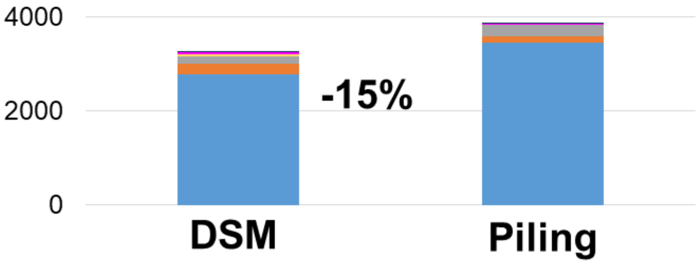
- Original design was piles
- Keller proposed two alternative techniques: DSM and DC+VR (satisfying project requirements)
- Eco solutions:
  - Piling 70% OPC replaced by GGBS, 40% rebar recycled steel
  - DSM: 70% of OPC is replaced by GGBS.
  - VR: 50% of aggregates is recycled or recovered

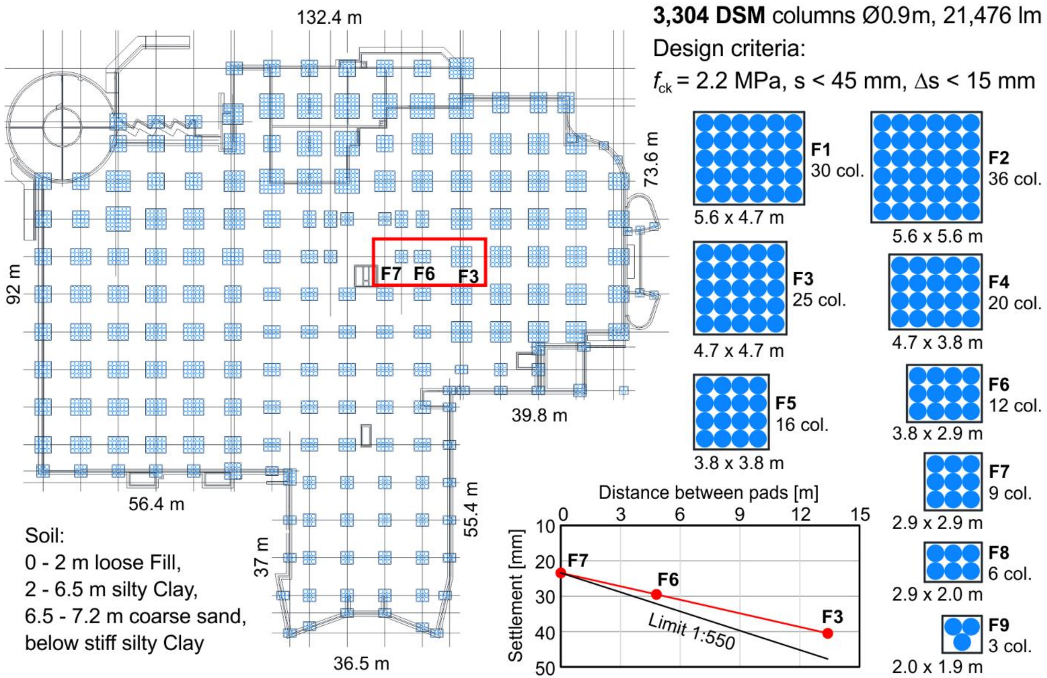




Case study 3: Shopping mall

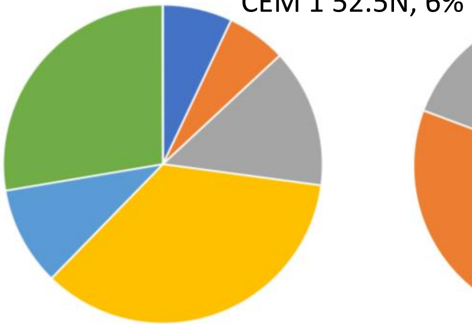
- 187no columns, loads up to 16500kN
- Original design was ~1100 CFA piles, 80cm dia, 12m long.
- Alternative design ~3300 DSM col, 90cm dia, 5.5m long.
- Quantities
  - +31% total length
  - -27% foundation volume
  - -42% reinforcement
  - -45% cost saving



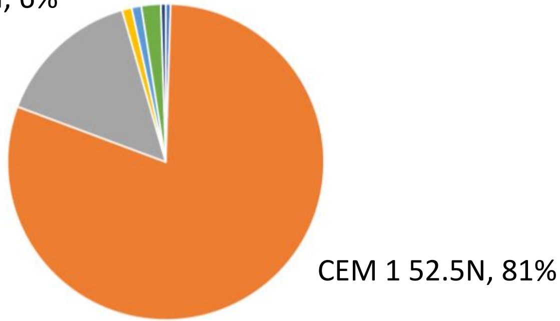


Case study 4: Dwall project

- Original design 1.2m thick diaphragm wall, C40/50 concrete.
- Value engineering to 1.0m thick dwall with C50/60 concrete.
- Use more carbon intensive concrete mix to achieve
  - 7.5% saving on concrete volume,
  - 4.4% saving on steel reinforcement
  - 270t reduction on CO2e
  - £1.2m saving on project cost



Mix: % by volume



Mix: % by CO_2e

A pathway to achieving carbon reduction

1. Measure!

- What to measure?
- How to measure?
- Estimate carbon footprint & hotspots
- Determine the baseline

2. Identify ways forward

- Right people in the room
- Get all the ideas, big & small
- Bring in other stakeholders
- Documentation

3. Trial initiatives

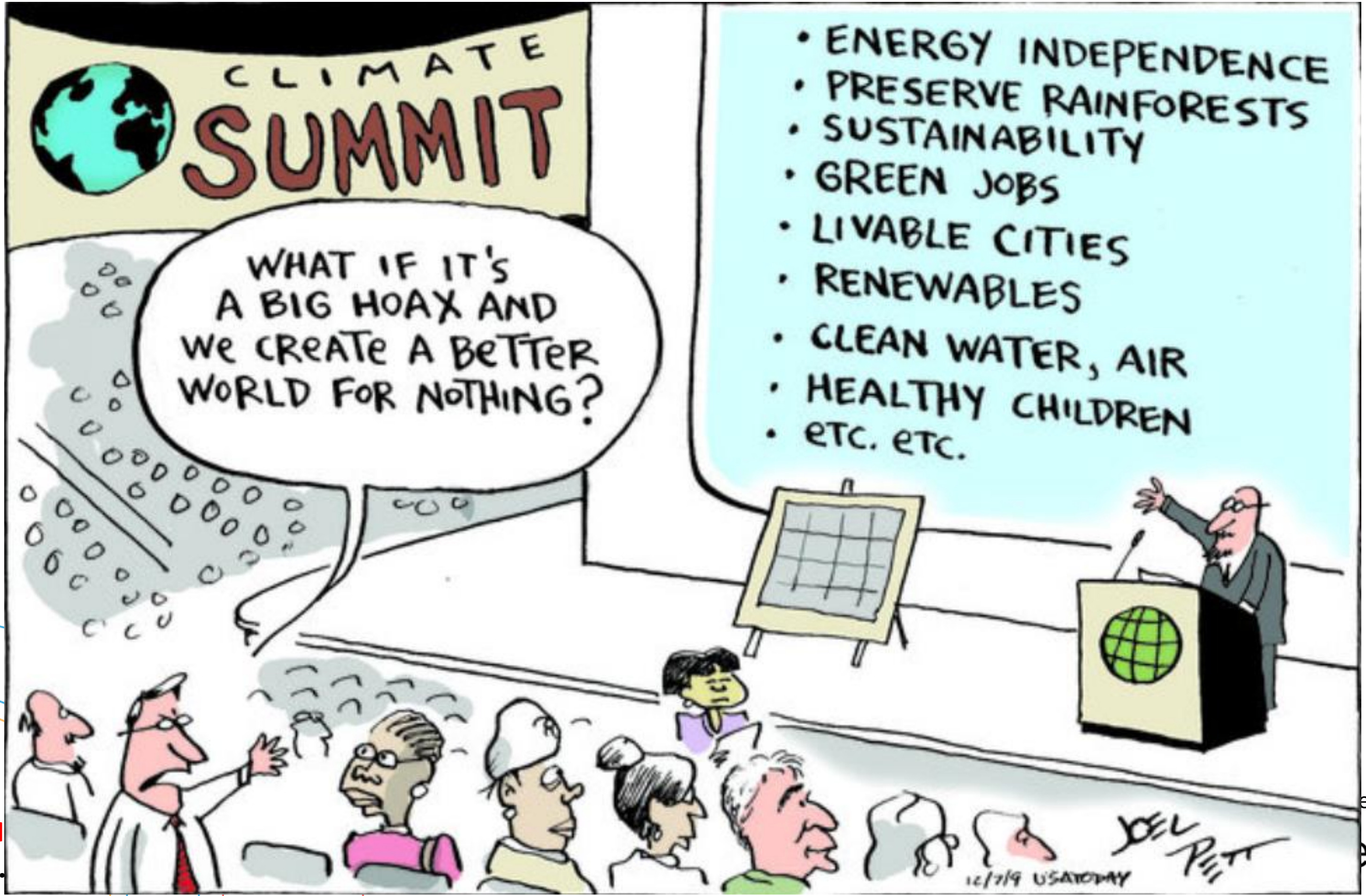
- Collaborate with partners
- Prioritise initiatives
- Implement actions
- Understand challenges
- Look at scalability
- Create action plans

4. Targets

- Leading targets
- Feasibility / scalability of targets
- Informs lagging targets for Scope 1 & 3

The take home…

- Construction industry generates ~20% of global CO_2 emissions (throughout the construction process)
- Highest potential for sustainable decisions during project planning stage
- Biggest impact when focused on scope 3 (materials) emissions
- Ground improvement solutions have lower carbon footprint (compared to cement and steel based solution)
- There is an overlap where ground improvement is equally applicable as piling solutions
- Consider the overall savings (geo-solutions, civil works, transportation etc) when making decisions


CLIMATE SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
JOEL PETT
12/7/9 USATODAY

THANK YOU

THINK SAFE

THINK GREEN

Talks Concrete

Talks Facilities Management

Talks Geotechnical & Engineering

Talks HVAC R

Talks Offsite & Modular

Talks Project Management

Talks Solar

Talks Stone Design

Talks Technology

Talks Urban Design & Landscape