Food-Water-Energy

Waste Not, Want Not

Dr Tim Fox

Head of Energy and Environment
Institution of Mechanical Engineers
@TimFox_IMechE

Introduction

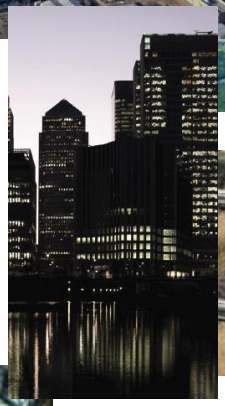
- Overview
  - Increasing demand
  - Food security
  - Wastage opportunity
  - Perishable product loss
  - Sustainable cold chains
  - What needs to done?
  - Conclusions

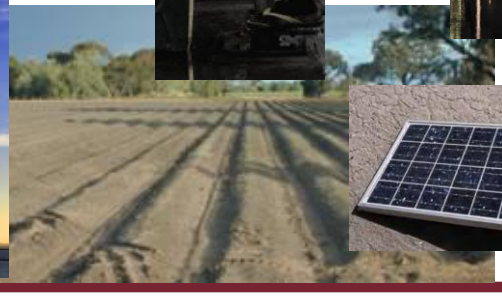
Increased global demand

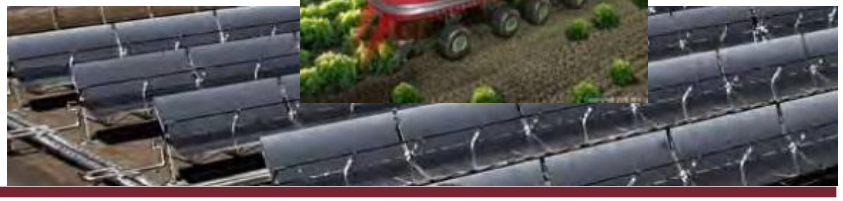
- Basic needs
  - Food – double agricultural demand by 2050
  - Water – global consumption up 30% by 2030
  - Shelter – 75% of people urban by 2050 (3 billion more)
- Supported by
  - Energy – 40% demand increase by 2035 (90% non-OECD)
- Changing tastes
  - Most populous region becoming more affluent, fuelling unprecedented demand for goods and dietary changes
- Stresses from climate change & geopolitical tensions
  - Extreme weather, droughts, floods, sea level rise
  - Finite resources and finite usable land

Food-Water-Energy

A defining challenge for the 21st century







Food security

- About more than having enough nutritious food
- Access, human development and stability
  - Individual and Community: key enabler for route out of poverty and mechanism to increase human well-being
  - National: well-being of citizens and stability of state
  - International: reduction of geopolitical tensions
- Sustainable food security
  - Enhances water and energy security, reduces land-use tensions as well as environmental degradation and risk

Food wastage opportunity

Increased production and/or wastage control?

- Total tonnage of around 4 billion (bn) produced today
- Estimated 30-50% is wastage (1.2 – 2 bn tonnes)
- Basic maths:
  - Feeding 6 bn people on 2 – 2.8 bn tonnes
  - Feed 9 - 10 bn on a little more than 4 bn tonnes

Opportunity – reduce and help feed future population

- Connect farmers to market options: increases farmer incomes, enables economic development
- Radically reduces pressure on water, energy, land-use

Food wastage – where?

- Loss – developing and emerging economies
  - Poor harvesting techniques, inadequately engineered storage and transportation infrastructure
- Waste – mature developed economies
  - Retailer practices encouraging over purchasing
  - Supermarket crop rejections at supply chain source
  - Consumer behaviour in the home and marketplace
  - Hospitality industry procurement practices

Perishable priority – why?

- Population growth and demographic change
  - Asia and sub-Saharan Africa projected to experience biggest growth in absolute numbers
  - Increased urbanisation demanding more and longer rural-urban supply chains
  - Dietary preference changes to food based on perishable produce with increasing affluence
  - Increased demand for convenience foods; largely based on perishable produce
- Global warming
  - Tropical and sub-tropical regions already warm; anticipated to experience most severe climate change
  - Productivity yields projected to reduce so critical to ensure as much produce as possible reaches market

India and Tanzania

- Inadequate cold chain infrastructure
  - India & Tanzania loose up to 50% of perishables (fruit, vegetables, fish & meat) between field – market
  - 97% Tanzanian meat not refrigerated and 16-25% dairy lost (seasonal)
  - Indian and Tanzanian framers often receive just 30 – 20% of potential produce value
  - Indian total food losses equivalent to ≈ US$7.5 billion lost revenue annually

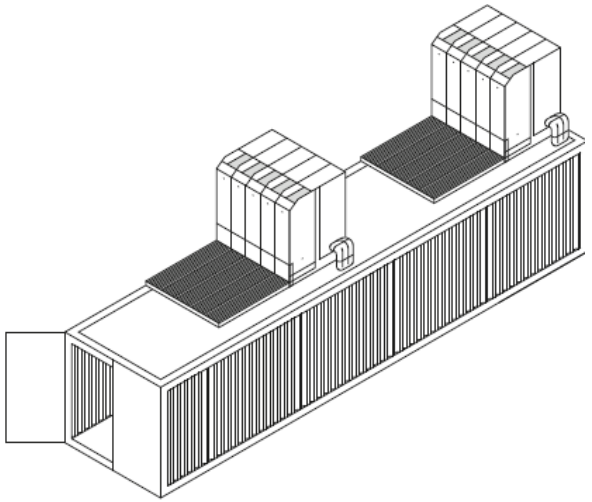
Energy security

- The primary challenge
  - Nearly all cold chain technologies require reliable, continuous and affordable source of electricity (pre-cooling/chilling/freezing & storage) or diesel (transport)
  - 400 million people in India are not connected to grid and 350 million of those are located in rural villages
  - Less than 14% of Tanzanians have access to electricity and in rural areas the figure reduces to 2%
  - Farmers resort to diesel generator sets; energy security issue – often expensive and in short supply
  - Energy security will become more challenging as global competition increases and diesel subsidies withdrawn

Renewable energy for cold

- Direct use of renewable energy
  - Refrigeration based on absorption process driven by solar thermal (e.g. SunChill, Solar-Polar)

- Small scale power use
  - Solar (e.g. SunDanzer, Promethean)
  - Biogas (e.g. UGARF)



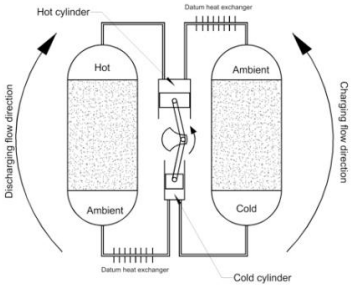
Reliable power: energy storage

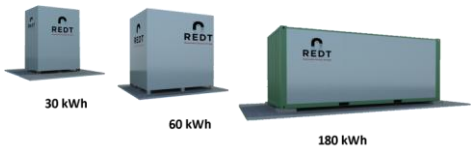
- Needs to be suitable for local context

  - Pumped Heat Electrical Storage
    - 2 containers of local mineral & reversible gas machine; engine & heat pump
    - Low-cost, modular, closed, 2-5MW units

  - Flow Batteries
    - Extension of conventional battery thinking
    - Decadal lifetimes, little maintenance, no safety issues, scalable 5kW to 250+kW

  - Cryogenic energy storage
    - Liquid air of nitrogen formed by chilling air, stored, expands to drive turbine when exposed to ambient temperature





A Tank of Cold - power & cold

- Enables scaleable holistic systems level approach
  - Not only reliable electricity, but also direct cooling
  - Avoids traditional refrigerants and uses benign feedstock (air) and working fluid (liquid air)
  - Established mechanical engineering with embedded global supply chain in place
  - Enables provision of 'fuel' for transport refrigeration units – step 3

Challenges for engineers?

- Focus on delivering appropriate energy storage technology for use in off-grid and micro-grid applications
- Offer alternative technologies that deliver 'power and cooling' for both rural and urban areas
- Tackle issues of equipment and plant scaling to enable a range of facilities to be delivered
- Take a systems level view connecting renewable energy sources, excess cryogenic capacity and waste cold to deliver a sustainable 'cold economy'
- Ensure solutions are affordable, safe, reliable, easy to build, operate and maintain and suitable to local technical skills

What needs to be done?

- Governments – stimulate deployment
  - Create attractive enabling environments; policy initiatives, regulatory frameworks, finance support, barrier removal
  - Build on existing aspirations for electricity access and energy security
- NGOs and donor aid community – champion change
  - Work with local communities and private sector to raise awareness, local capability building, finance deployments
- Finance and business community – ultimate key
  - Recognise financial structure; capital vs operating costs
  - Development banks; provide long term infrastructure debt financing with terms appropriate to local cash flow reality
  - Seed money for pilots and full-scale demonstration

Conclusions

- Pressing need to connect farmers with higher value markets and increased incomes through cold chains

- Challenge for engineers is to do so in a way that minimises food wastage, is energy secure, sustainable and avoids harmful emissions

- Unique opportunity exists to increase energy security and leapfrog the resource-hungry unsustainable 'business-as-usual' model of cold chain deployment

- Beyond the engineering, empowering communities to implement cold chain infrastructure through access to appropriate finance is THE most crucial need.

Thank you

Twitter: @TimFox_IMechE