Energy Efficiency: the invisible ‘poor cousin’ of energy supply that offers much better value

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1. Peak in emissions: 
IEA strategy to raise climate ambition

Global energy-related GHG emissions

Savings by measure, 2030

Five measures – shown in a “Bridge Scenario” – achieve a peak in emissions around 2020, using only proven technologies & without harming economic growth

From IEA Energy and Climate Change presentation, London June 15 2015
Plenty of EE scope: 88% waste! In both developed AND developing countries.
Energy efficiency offers many benefits beyond cost savings: in particular productivity, amenity, equity, resilience

But most policy analysis and decision-making ignores most of these benefits!

from International Energy Agency 2014 Capturing the Multiple Benefits of Energy Efficiency
Change in energy reflects broader disruptive changes in technology and society, that increasingly drive improving energy efficiency and lower energy intensity

- Examples:
  - Electronics and intelligent technologies
  - Internet, ‘virtual’ solutions, dematerialisation
  - Green chemistry and alternatives to process heat
  - New materials – nanotech, graphene etc
  - Computerised design, control, monitoring
  - Modular, decentralised technologies, 3-D printing etc
  - Growth of (lower energy intensity) services economy
Do I even need a building?

Virtual solutions are transforming our need for buildings (and transport and products!)

(Popular Science Aug 2011 By Clay Dillow Posted 07.05.2011 at 11:00 am)
High energy efficiency and low embodied energy (and CO2 emission) design techniques and materials are becoming available and improving.

Engineered timber structural elements
http://www.hobbithouseinc.com/personal/woodpics/_g_IJK.htm

Fibre reinforced concrete and geopolymers, extenders etc
http://www.sciencedirect.com/science/journal/09500618/44

High strength steel from car industry
http://nextbigfuture.com/2012/08/nanosteel-has-new-high-strength-light.html

Silica aerogel – daylight and insulation
25 mm aerogel=R1.5; double glazed low-e argon filled glazing=R0.5

Wood ‘foam’ Source: Fraunhofer WKI
Key Disruptive Energy Factors

- Our ‘need’ for energy flows from ‘needs’ for services like nutrition or economic output and the materials, products, services and business models used to satisfy them.

- Recent innovation dramatically increases options to satisfy ‘needs’ – *substitution* by radically different alternatives.

- These involve *integrated* use of combinations of:
  - Innovative reframing of what our needs are (eg virtual solutions)
  - Diverse business models, markets and technology supply chains
  - More efficient energy and resource use
  - Smart management of demand
  - Storage of energy in many forms (heat, coolth, electricity, chemical, gravitational potential, movement)
  - Distributed and diversified energy production or conversion
The ‘energy’ service delivery system – many options of very different kinds now exist and compete in different markets.

- Fuel price
- Wholesale energy price
- Retail energy price
- Consumer cost of service delivered

**Energy Efficiency (EE)**

- Mine/Harvest (EE)
- Transport (EE)
- Conversion (eg refine, generate electricity) (EE)
- Deliver to consumer (pipeline, ship, truck, power line etc) (EE)
- On-site infrastructure (eg meter, analysis, wires, pipes) (EE)
- On-site energy consuming equipment (EE)
- Service delivered

Other inputs, eg chemicals, water
Diverse, efficient energy service solutions are emerging. Centralised systems still have a role, but distributed ones are gaining. Combinations of solutions often work best, and there will be ongoing transition

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>CENTRALISED</th>
<th>DISTRIBUTED</th>
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<tbody>
<tr>
<td>Economies of scale</td>
<td>Through larger size</td>
<td>Through mass production</td>
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<tr>
<td>Flexibility of roll-out</td>
<td>Limited</td>
<td>Large</td>
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<tr>
<td>Capital required, risk, subsidies</td>
<td>Large lumps, long-term, subsidies on-going</td>
<td>Small lumps, early cash flow, subsidies up-front</td>
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<tr>
<td>Innovation and ‘learning from experience’</td>
<td>Slow</td>
<td>Fast, from diverse markets and technologies</td>
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<tr>
<td>Planning, construction timeframes</td>
<td>Long, limited flexibility</td>
<td>Short, responsive</td>
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<tr>
<td>Resource suitability</td>
<td>Fossil fuels, dams</td>
<td>Renewable energy, diverse water sources, end-use technologies</td>
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<tr>
<td>Resilience to failures, changing conditions</td>
<td>Limited</td>
<td>Diversity, modularity help</td>
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<tr>
<td>Environmental, social impacts</td>
<td>Local, regional, global</td>
<td>Local, linked to beneficiaries</td>
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<tr>
<td>Overall system efficiency</td>
<td>Significant losses in conversion, distribution</td>
<td>Variable – near point of use, so consumer pays</td>
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Industrial steam

- Avoid use of steam: centrifuge, microfiltration, depressurisation*
- Advanced high temperature heat pump (up to 165°C)*
- Modular hot water or steam generator*
- Renewable heat sources
- Storage (heat or electricity)

* Can use renewable electricity

Residential: Technology transformation
(Based on Pears presentation to Sydney A2SE Workshop, April 2014)

Annual electricity use for some activities in an Australian home: existing stock; best available now; and possible future

Many households are also installing on-site and local renewable energy generation and smart management systems – and next, storage
Office Building Operating Energy improvement: power of a simple tool and rating

NABERS whole building star ratings for Melbourne office building vs electricity use per square metre (for an all-electric building) (using reverse calculator from www.nabers.gov.au)

![Graph showing NABERS Star Ratings vs kWh/year/m²]

- 'Typical' building stock
- Approx 2011 Building Code
- Best Buildings
- Zero (or Beyond Zero) emission buildings combine high efficiency and renewable energy
Where to: the new ‘black’

- Extreme energy efficiency
- Outstanding performance
- Renewable electricity
- ‘smart’
- Excellent design