Doubling Energy Productivity in Cities By 2030 – through Energy Efficient Innovations

Australian National University, Feb 22 2016

Presentation by Dr Michael Smith (ANU)
Country | Low energy target |
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California | By 2020, all new residential buildings have to be net zero energy. By 2030, all new commercial buildings have to be net zero energy. |
Denmark | By 2020, all new buildings use 75% less energy than currently enshrined in code for new buildings. Interim steps: 50% less by 2015, 25% less by 2010 (base year=2006) |
Finland | 30–40% better than standard buildings by 2010; passive house standards by 2015 |
France | By 2012, all new buildings are low-energy buildings; by 2020, new buildings to be energy positive |
Germany | By 2020, buildings should be operating without fossil fuel |
Hungary | New buildings to be zero-emissions buildings by 2020, and for large investments by 2012 |
Ireland | 60% less energy than current standards by 2010, net zero energy buildings by 2013 |
Netherlands | 25% less energy than current standards by 2010, 50% less energy than current standards by 2015, energy neutral by 2020 |
England | New commercial buildings to be zero-carbon from 2019 |

**COAG National Energy Productivity Roadmap**

- **Industry**
  - Help business self-manage energy costs
  - Recognise business leadership and support voluntary action
  - Research business benchmarks and success factors
  - Reduce barriers to financing

- **LIGHT VEHICLE ENERGY EFFICIENCY**
  - Cars
    - Improve light vehicle efficiency
    - Drive innovation in transport and infrastructure systems

- **COMMERCIAL BUILDING ENERGY EFFICIENCY**
  - Commercial Buildings
    - Expand commercial buildings ratings and disclosure
    - Advance the National Construction Code
    - Improve energy productivity in government

- **RESIDENTIAL BUILDING ENERGY EFFICIENCY**
  - Residential
    - Make choice easier
    - Deliver a new Equipment Energy Efficiency (E3) prioritisation plan
    - Support best practice services for vulnerable consumers
    - Improve residential building energy ratings and disclosure
    - Improve compliance with building energy efficiency regulation

- **ENERGY COST SAVINGS**

- **NEW AND INNOVATIVE PRODUCTS AND SERVICES**
  - **Energy Market Reforms**
    - Emerging technologies in the electricity system
    - Transition to cost reflective energy pricing
    - Competitive smart meter rollout
    - Develop an Energy Use Data Model for better planning
    - Deliver a Gas Supply Strategy

- **MARKET BENEFITS**
  - **Innovation**
    - Support innovation and commercialisation
    - Promote best performers
    - Collaborate internationally
A project of the Australian Alliance to Save Energy

http://www.2xep.org.au/
California’s Energy Productivity 1.7 times Australia’s.

- California’s electricity grid services twice Australia's population & an economy 50% larger, but only generates slightly more daily electricity than Australia.

- The per capita carbon footprint of California's electricity sector is also ½ that of Australia's.
The ‘energy’ service delivery system – many options now exist.

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

- **Wholesale energy price**
  - Other inputs, eg chemicals, water

- **Retail energy price**

- **Consumer cost of service delivered**
Annual electricity use for some activities in an Australian home: existing stock; best available now; and possible future

- **Building + equipment**
  - Many households are also installing on-site and local renewable energy generation and smart management systems – and next, storage

Kilowatt-hours per year

<table>
<thead>
<tr>
<th>Activity</th>
<th>STOCK</th>
<th>BEST NOW</th>
<th>POSSIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating and cooling</td>
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<tr>
<td>Refrigeration</td>
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<td>Hot water</td>
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<td>Lighting</td>
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<td>TV/AV/IT</td>
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<td>Cooking</td>
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<tr>
<td>Clothes washing</td>
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</tbody>
</table>
Innovations Enable A Step Change in EP: Energy/Transport/Building Sectors

- Buildings – 50–80% more efficient
- Innovations in High Density Living and Compact Transport Options (https://www.ted.com/talks/kent_larson_brilliant_designs_to_fit_more_people_in_every_city?language=en)
- Smart control innovations for LED lighting cut energy by a further 50%
- Transport demand management innovation
- Electric vehicle (2,3,4 wheeler) innovations
What is the energy and resource efficiency technical potential of systems? Is it possible to deliver the same or better services whilst using 70–80% less energy? If so, How? What policy measures are needed?
How many years of current emissions would use up the IPCC’s carbon budgets for different levels of warming?

- **3°C**
  - 33% chance of remaining below
  - 50% chance of remaining below
  - 66% chance of remaining below

- **2°C**
  - 33% chance of remaining below
  - 50% chance of remaining below
  - 66% chance of remaining below

- **1.5°C**
  - 33% chance of remaining below
  - 50% chance of remaining below
  - 66% chance of remaining below

The Carbon Brief

Path to 100% renewables

**World Electricity supply and demand**

- **Annual demand**
- **Wind + PV**
- **PV (15% growth rate)**
- **Wind (10% growth rate)**

TWh per year

- 2016
- 2020
- 2024
- 2028
- 2032
- 2036
- 2040

50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1. Peak in emissions: IEA strategy to raise climate ambition

**Global energy-related GHG emissions**

- INDC Scenario
- Bridge Scenario

**Savings by measure, 2030**

- Fossil-fuel subsidy reform: 10%
- Upstream methane reductions: 15%
- Renewables investment: 17%
- Reducing inefficient coal: 9%
- Energy efficiency: 49%

*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
Energy efficiency can delay “lock-in” of CO₂ emissions permitted under a 2 °C trajectory – which is set to happen in 2017 – until 2022, buying five extra years.
Socolow and Pacala’s Stabilisation Wedges

<table>
<thead>
<tr>
<th>Wedge Number</th>
<th>Description</th>
<th>Underestimated the potential of energy efficiency to contribute to cutting emissions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Efficient Vehicles – Double Fuel Efficiency</td>
<td>(10) Wind – 2 million MW (50 times current)</td>
</tr>
<tr>
<td>2</td>
<td>Reduced Use of Vehicles – By Half</td>
<td>(11) PV – 2000 GW (700 times current)</td>
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<tr>
<td>4</td>
<td>Efficient Base-load Coal Plants – Double Conversion Efficiency to 60%</td>
<td>(13) Biomass for fuel – 100 times current Brazil and US cropland</td>
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<tr>
<td>5</td>
<td>Replace inefficient coal plants with gas plants (four X the current production of gas-based power)</td>
<td>(14) Reduced deforestation, plus reforestation, afforestation, and new plantations</td>
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<tr>
<td>6-8</td>
<td>Carbon Capture and Storage (3 wedges)</td>
<td>(15) Conservation Tillage</td>
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<tr>
<td>9</td>
<td>Nuclear Power – Double Current Global Output</td>
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<tr>
<td>Additional Stabilisation Wedges – End Use Energy Efficiency by 2030</td>
<td>Areas of Large Potential for Rapid Greenhouse Gas Reductions</td>
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<tr>
<td><strong>#2</strong> – Industry - Upgrade Motor Driven Technologies to cut global electricity use by 10%.</td>
<td><strong>#9</strong> Energy/Water Efficiency Opportunities – Reduce urban water leakage, improve urban water efficiency</td>
<td></td>
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<td><strong>#3</strong> - Investment In Co-generation - avoids the need for 10% of new generation by 2030 saving $950 billion per annum by 2030. (IEA,2011)</td>
<td><strong>#10</strong> Circular Economy - Product Stewardship, Materials Efficiency and Recycling.</td>
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<td><strong>#4</strong> – Energy Efficient Street Lighting – Shift to efficient lighting could save up to $650 Billion</td>
<td><strong>#11</strong> Product Design Standards - to be more energy/water efficient</td>
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<td><strong>#5</strong> – Transition to More Efficient Transport Options: ~40% trips in OECD cities are &lt;5 km.</td>
<td><strong>#12</strong> Reduce Global Food Waste in half.</td>
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<td><strong>#6</strong> - Fuel Efficient Freight Transport Options including modal shifts. IEA and OECD show potential to halve transport fuels by 2030.</td>
<td><strong>#13</strong> Behaviour Change (ie diet, energy, travel)</td>
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<td><strong>#7</strong> - Reducing Urban Heat Island Effect - Increasing urban albedo + investing in green urban development</td>
<td><strong>#14</strong> Reducing Black Carbon – from moving to cleaner energy sources for households and transport.</td>
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Did you Know That Doubling Energy & Resource Efficiency of Cities = > $15 Trillion Increase to GDP of cities by 2030 above BAU?

- Energy efficiency could cumulatively add ~US$18 Trillion to GDP by 2035 above BAU & cut energy supply capital investment requirements & fuel costs by US$7 Trillion each. (IEA World Energy Outlook, 2012)

- Water productivity measures, that also save energy and cut emissions, to add $2–4 Trillion cumulatively to GDP Growth by 2030: Reducing urban water leakage globally could add US$165 Billion to GDP per annum by 2030 whilst water efficiency globally adds ~ US$120 Billion per annum to global GDP by 2030.


Energy Productivity is the total value of economic output generated by the energy we use.

Aims to measure **multiple dividends** derived from effective application of energy resources.

It’s about **getting more**, as well as using less.

\[
\text{Energy Productivity} = \frac{\text{Gross Value Added (Real $)}}{\text{Units of primary energy (GJ)}}
\]

Energy efficiency focuses on delivering same level of service or output using less energy. Important element of energy productivity.
Energy Productivity investments also enhance traditional measures of productivity in a myriad of ways. For instance,

- **Labour Productivity (LP)** – Newer, more energy and resource efficient equipment often provides labour productivity co-benefits. Also energy efficient “green buildings”, which have better quality lighting, air and reduced indoor air pollution increases LP. Improving energy productivity can also lead to jobs growth and greater labour participation which also boost LP.

- **Capital Productivity (CP)** – Investment in energy productivity can improve capital productivity by providing a quicker return on investment (through the operational energy cost savings), improving capital asset values and thus the contribution of capital assets to the value of the business.

- **Multi-Factor Productivity (MFP)** – Improving energy productivity directly correlates closely with improving MFP.

OUTSIDE VIEWS

- Mental Function & Memory: 10-25% better
- Call Processing: 6-12% faster
- Hospital Stays: 8.5% shorter

DAYLIGHT

- Students achieve 5-14% higher test scores and learn 20-26% faster
- Workers are 18% more productive
- 15-40% increase in retail sales

SYSTEMS

- Productivity increases by 23% from better lighting
- 11% from better ventilation
- 3% from individual temperature control
How cities can create partnerships with the private sector and civil society to work together to lead a new wave of innovation to achieve low carbon efficient sustainable cities.

http://www.naturaledgeproject.net/NAON_ch17.aspx#one
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NET NEW PRODUCTS AND SERVICES

MORE EFFICIENT ENERGY MARKETS

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