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Our efficient, smart, flexible, distributed and diverse energy future

Presentation at APEC Energy
Ministers' Meeting 13 October 2015

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Extreme energy efficiency transforms our thinking
about reality: world record holding human
powered vehicle – 137.9 km/h

<http://gosporttimes.com/2015/09/20/crazy-fast-human-powered-vehicle-sets-new-world-speed-record/>

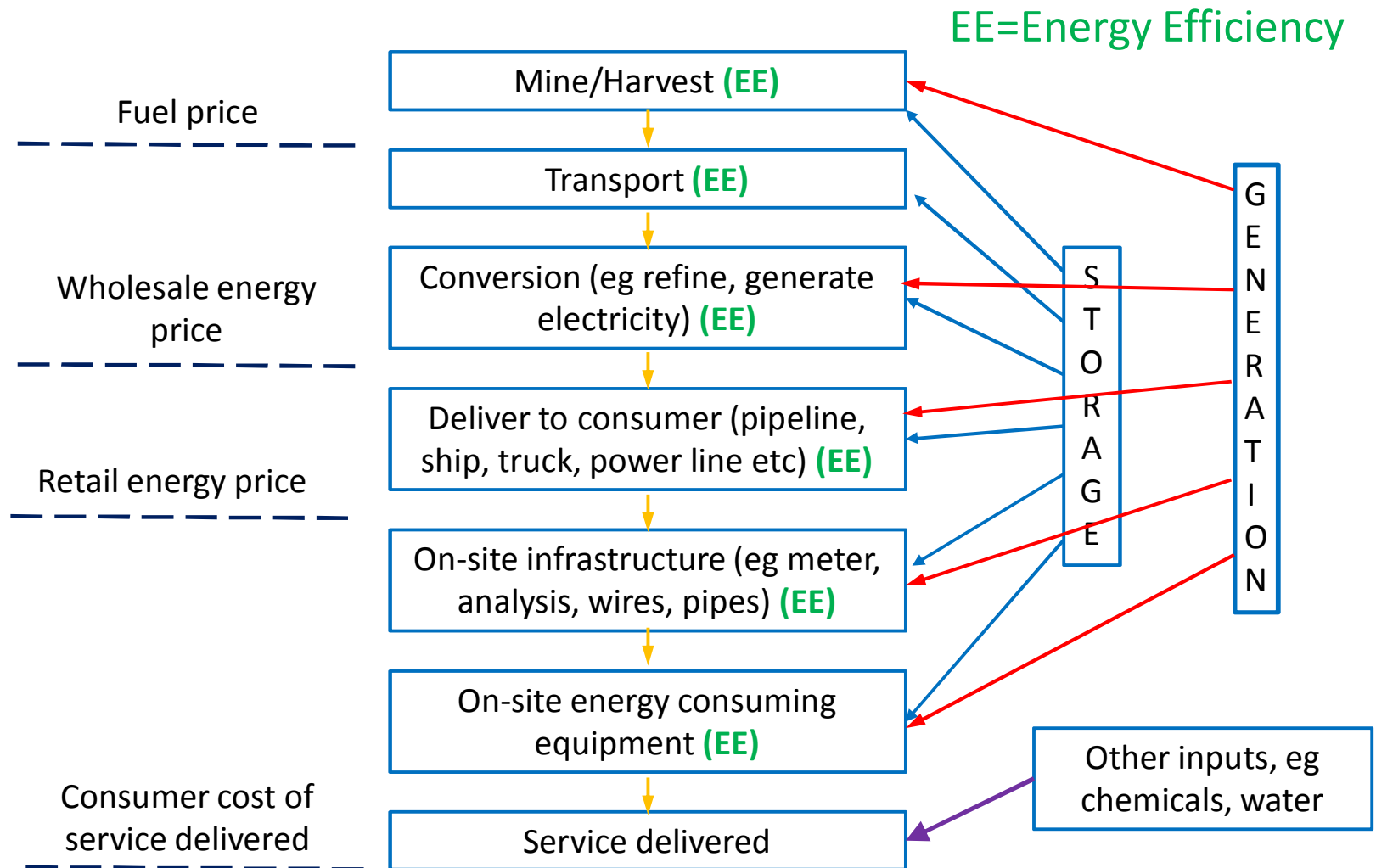
Change in energy reflects broader disruptive changes in technology and society such as:

- 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
 - Urbanisation
 - Growth of services economy
 - Globalisation
-
- Energy, resources industries are among the last to face culturally disruptive change and major 'substitution' risk

Key Energy Drivers

- 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.

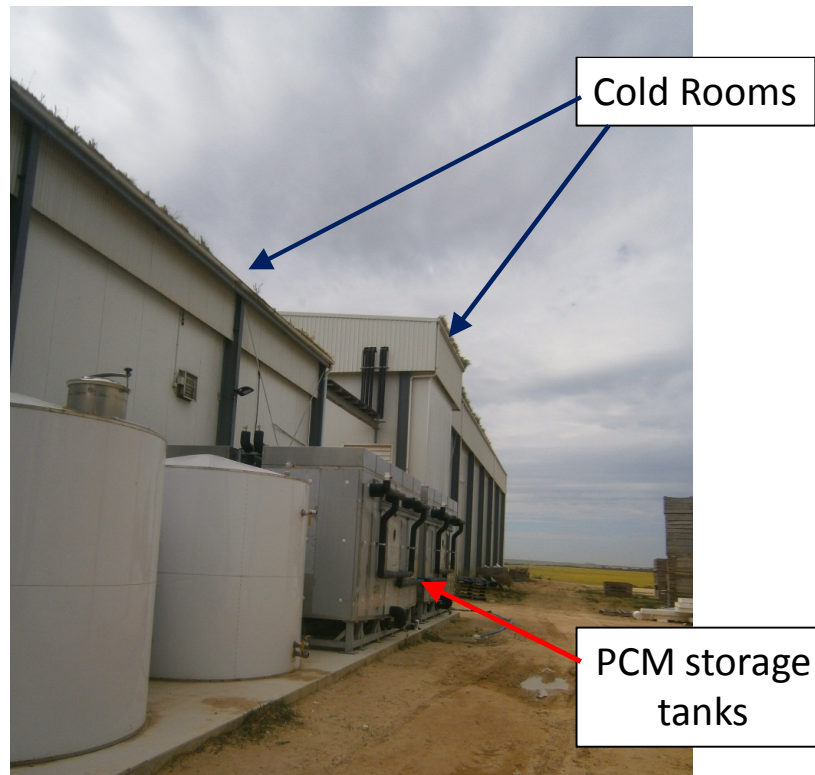


Diverse energy service solutions are emerging. Centralised systems still have a role, but distributed ones are gaining. Combinations of solutions often work best, and there will be ongoing transition

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

Example – Cold Storage:

University of South Australia / Glaciem demonstration project



- 120 kWe Refrigeration system
- 1.4 MWhrs e thermal storage (1% floor area)
- 200 kWp of solar PV planned
- 20% IRR for both storage and PV

Potential Integrated Energy Solution

On-site energy efficiency:

- Building: heat reflective paint, insulation, air locks
- High efficiency chillers, smart controls

On-site energy storage:

- Thermal ('coolth' using phase change materials - PCMs)
- Electricity

On-site energy production:

- Rooftop solar PV
- Use waste chiller heat to dehumidify, cool, heat (eg cleaning water)

Integrated energy management

- Optimise operating cost
- Optimise exports and imports of electricity
- Maybe go 'off-grid' or micro-grid?
- Maybe cooperate with other local generation, storage and energy users?

Aluminium smelting: strategies and research projects to cut energy use

- Big picture options to cut aluminium energy use per unit service:
 - ‘virtual’ solutions replace physical ones
 - Design of products for optimal material use
 - High strength alloys, 3-D printing use less material
 - Switch to other materials, eg carbon fibre
 - Use recycled aluminium
- R&D, eg ARPA-E projects (US government R&D program)
 - **Alcoa:** heat exchanger (using molten glass or salt) built-into pot casing improves insulation, provides flexibility in electricity demand (using heat storage); improved electrodes – **50% saving target**
 - **Gas Technology Institute:** use reusable solvents (chemical dissolution) at near room temperature; could be located near bauxite mines – **44% cost reduction target**
 - **Infinium:** new electrochemical cell, much better insulated and high value by-product (pure oxygen); drop-in retrofit – **50% net saving target**
- Shift to renewable electricity

Aluminium
smelting uses
3.3% of global
electricity

Industrial steam

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

* Can use renewable electricity

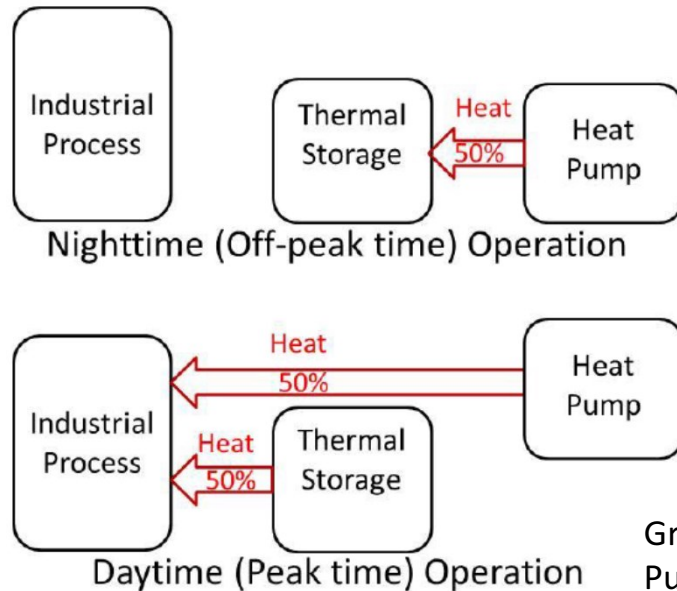


Fig. 2.3.2 Overview of system (KOBELCO: SGH series)

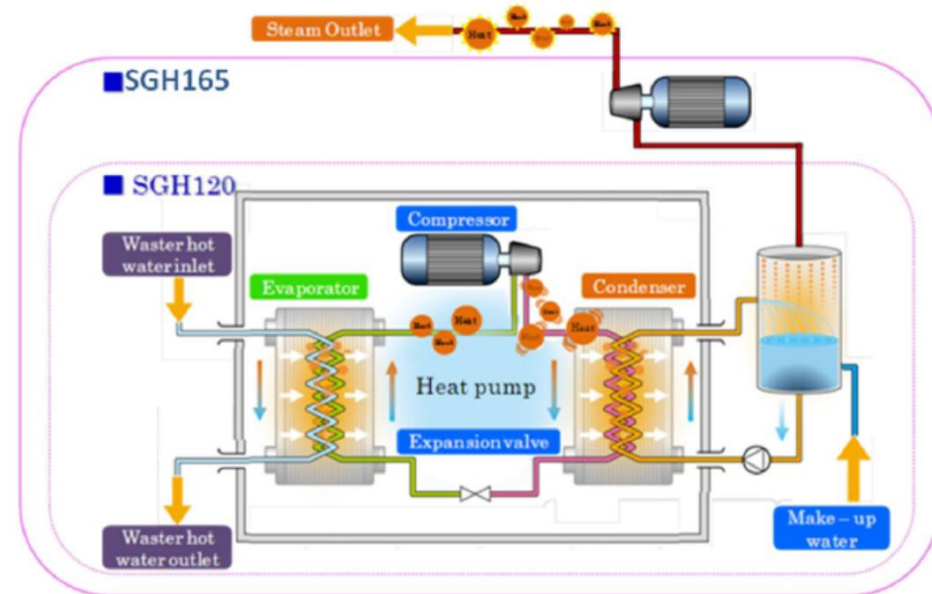
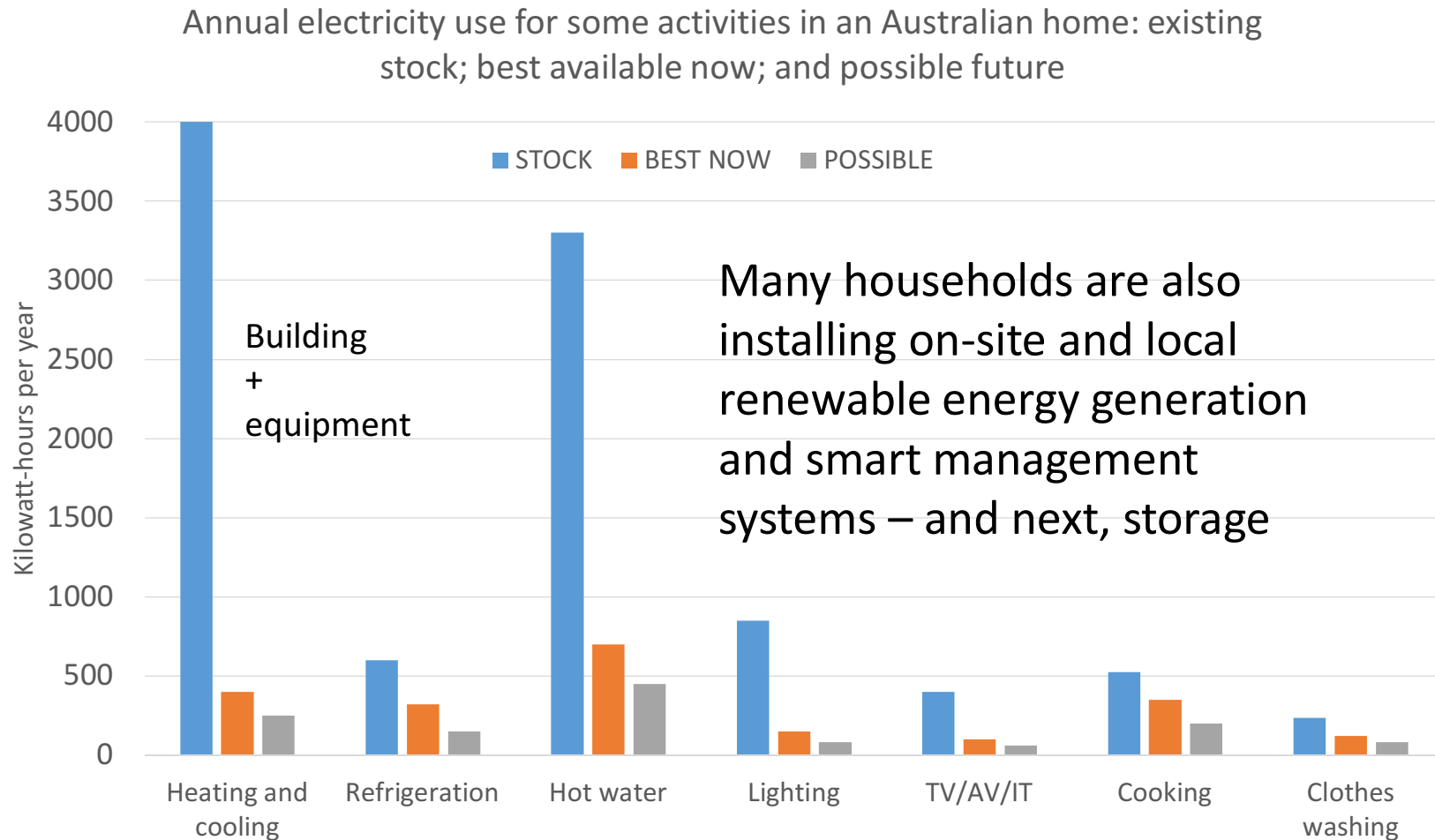


Fig. 2.3.1 System flow (KOBELCO: SGH series)

Graphics from IEA HPP Annex 35 Application of Industrial Heat Pumps, Task 3 (2013)

Residential: Technology transformation

(Based on Pears presentation to Sydney A2SE Workshop, April 2014)

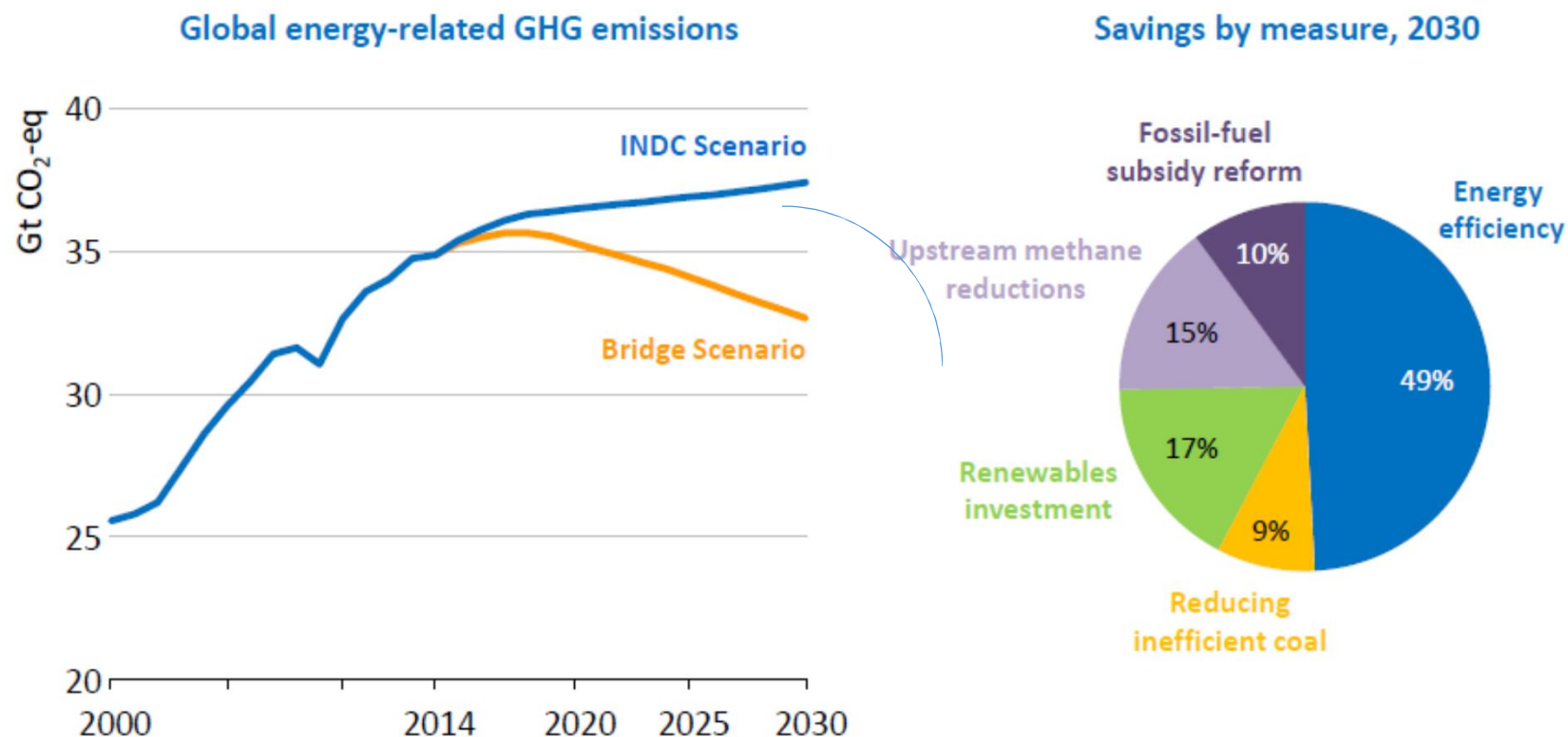


Energy policy tools

- Strategies and targets – visions
- Information, promotion, training
- Voluntary agreements, public reporting
- Regulation, standards
- Taxes and levies, pricing
- Incentives, subsidies and financial facilitation
- Market mechanisms
- Innovation, RD&D, commercialisation
- Government purchase and example
- Institutional frameworks and resourcing
- Managing access to markets and resources
- Management of perceived risks and opportunities
- **Other policies adapted to achieve energy goals too**

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

WEO Special
Report on
**Energy &
Climate
Change**



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

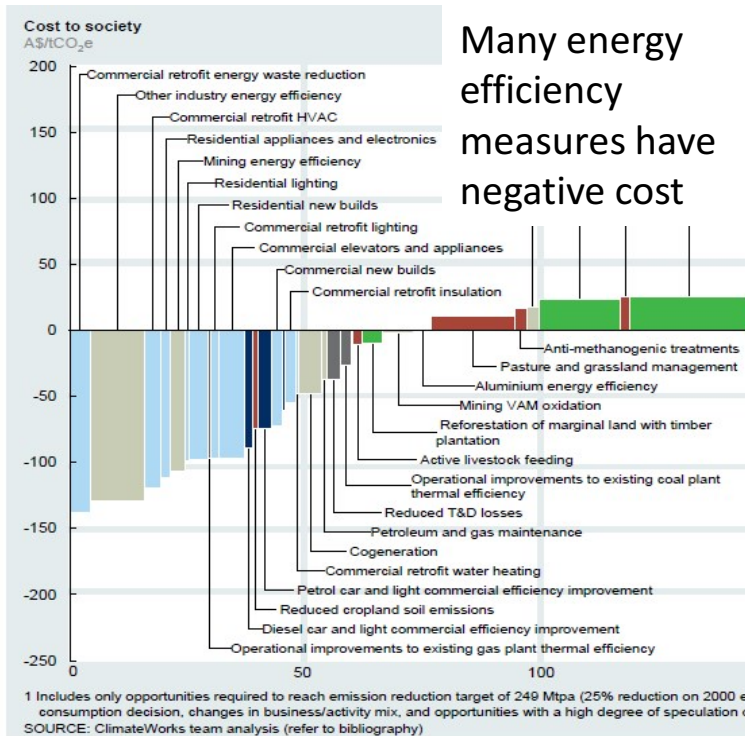
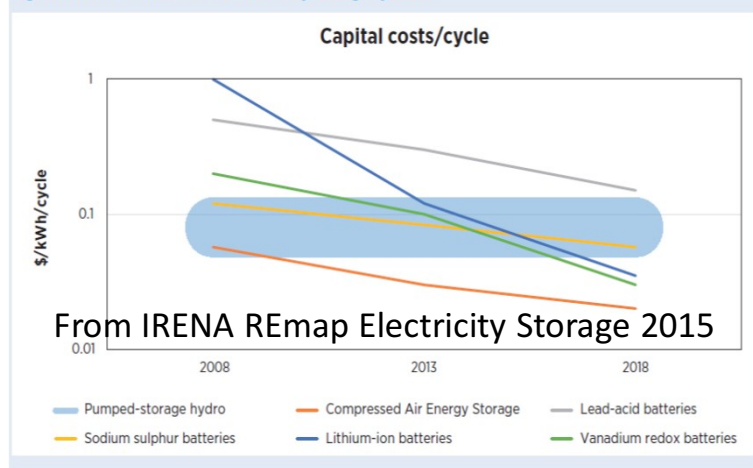


Figure 2: Cost assessments for electricity storage systems

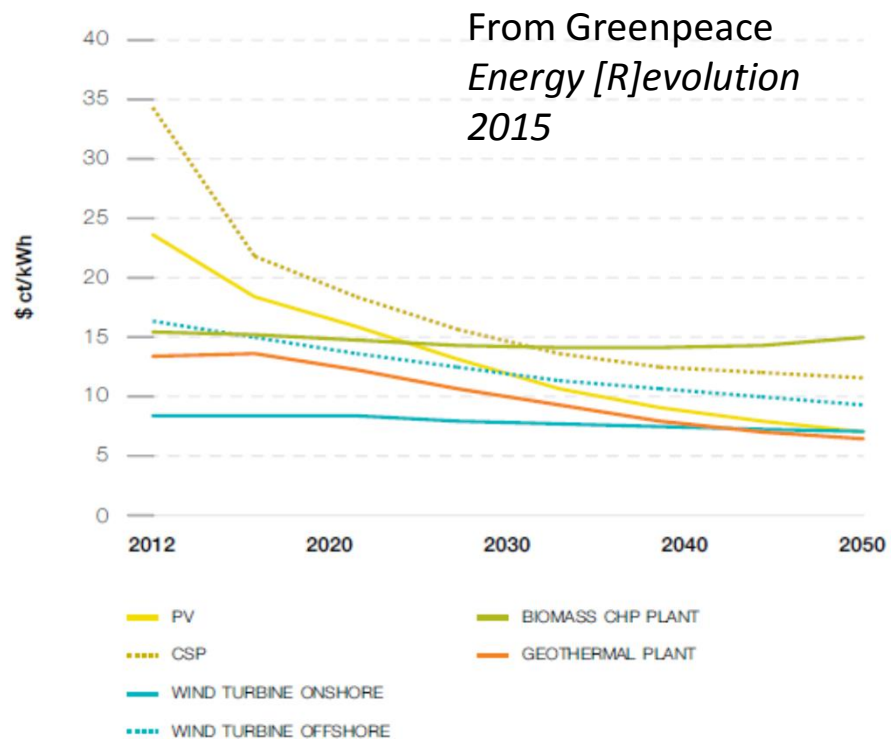


Source: The Brattle Group, 2014; Walawalkar, 2014.

Indicative technology cost trends:

NOTE: projected costs are very uncertain, but key trends are declining costs and more rapid roll-out than expected: typically 20% reduction for each cumulative doubling of production

FIGURE 5.2 | EXPECTED DEVELOPMENT OF ELECTRICITY GENERATION COSTS FROM RENEWABLE POWER GENERATION IN THE ENERGY [R]EVOLUTION SCENARIOS
DEPENDING ON THE ASSUMED DEVELOPMENT OF FULL LOAD HOURS PER YEAR, EXAMPLE FOR OECD EUROPE



Evaluation of Costs and Benefits

- Sophisticated evaluation of cost-effectiveness must consider many factors:
 - Local circumstances
 - What price does it compete with: wholesale, retail energy price? And what will those prices be?
 - For efficiency measures, what total service cost does it compete with?
 - What non-energy market(s) does it compete in?
 - What other costs does it avoid: avoided infrastructure costs; distribution/delivery costs and losses; peak loads
 - What other benefits: avoided blackouts; improved productivity, health, product quality etc (see IEA *Multiple Benefits of EE* report); benefits for rural and other disadvantaged groups
 - Impacts on total level of energy subsidies, energy security, social systems
 - Impact of likely future levels of carbon prices or equivalent policies on cost relative to competitors

Where to Now for APEC?

- No-one knows which options will be winners, so we need:
 - Flexible strategies, quality information and detailed monitoring of change
 - To encourage innovation, trials, knowledge sharing, creative finance models
 - To support emerging options to compete with powerful incumbent businesses
 - To manage disruption, inefficiencies and mistakes
- Different solutions will be best in different circumstances, depending on service requirements, available options and local cultures and policies
- There will be winners and (often powerful and noisy) losers
- Climate response and adaptation will be overarching drivers

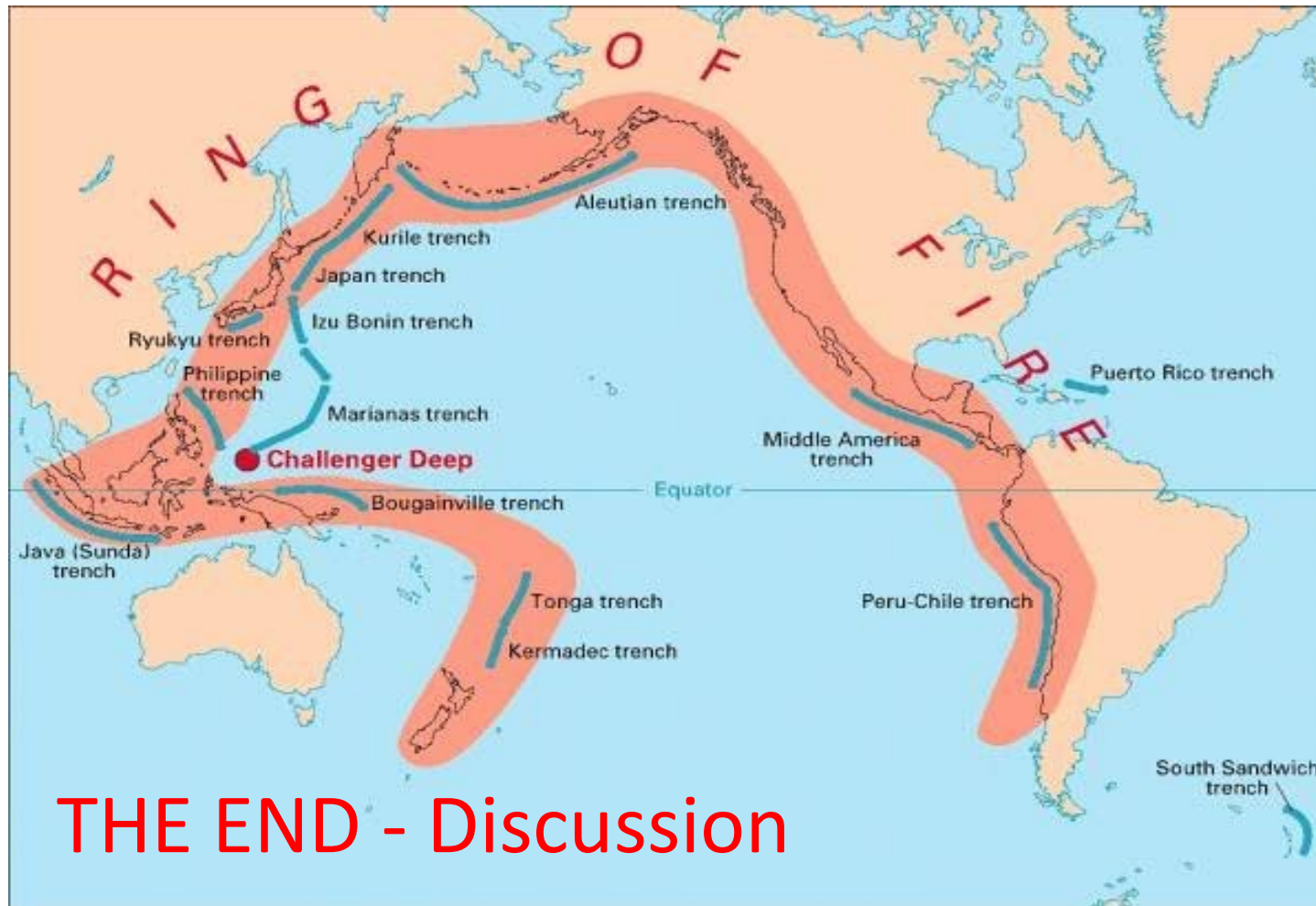
APEC Actions?

- Encourage APEC members to develop and implement energy strategies that:
 - Are consistent with decarbonisation by 2050 or earlier
 - Are flexible and adaptable to unexpected changes, innovation
 - Factor into energy option evaluation factors such as reframing of 'energy needs', economies of scale, learning by doing, 'multiple benefits', innovation in and from other sectors, etc
 - Incorporate clean energy elements into policies across the economy and society (eg housing, social welfare, taxation)
- Work with member countries, IEA etc to:
 - Track and share actual costs, benefits, experience and progress of emerging technologies and underlying policies and measures
 - Develop, trial and implement planning methodologies, institutional arrangements and funding systems (eg through ABAC) that support integrated energy solutions
- Ensure emerging technologies are not blocked by institutional inertia or incumbent power

The international energy scene will change

Will new 'energy giants' emerge, eg countries leading in smart, efficient energy solutions; with major renewable energy resources such as solar, geothermal resources using advanced drilling techniques from the oil industry?

Source: <http://pubs.usgs.gov/gip/dynamic/fire.html>

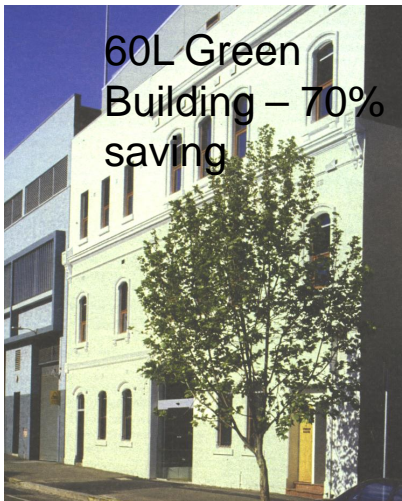


Selected slides from ANU talk, presented at A2SE Summer School, 26 Feb 2016

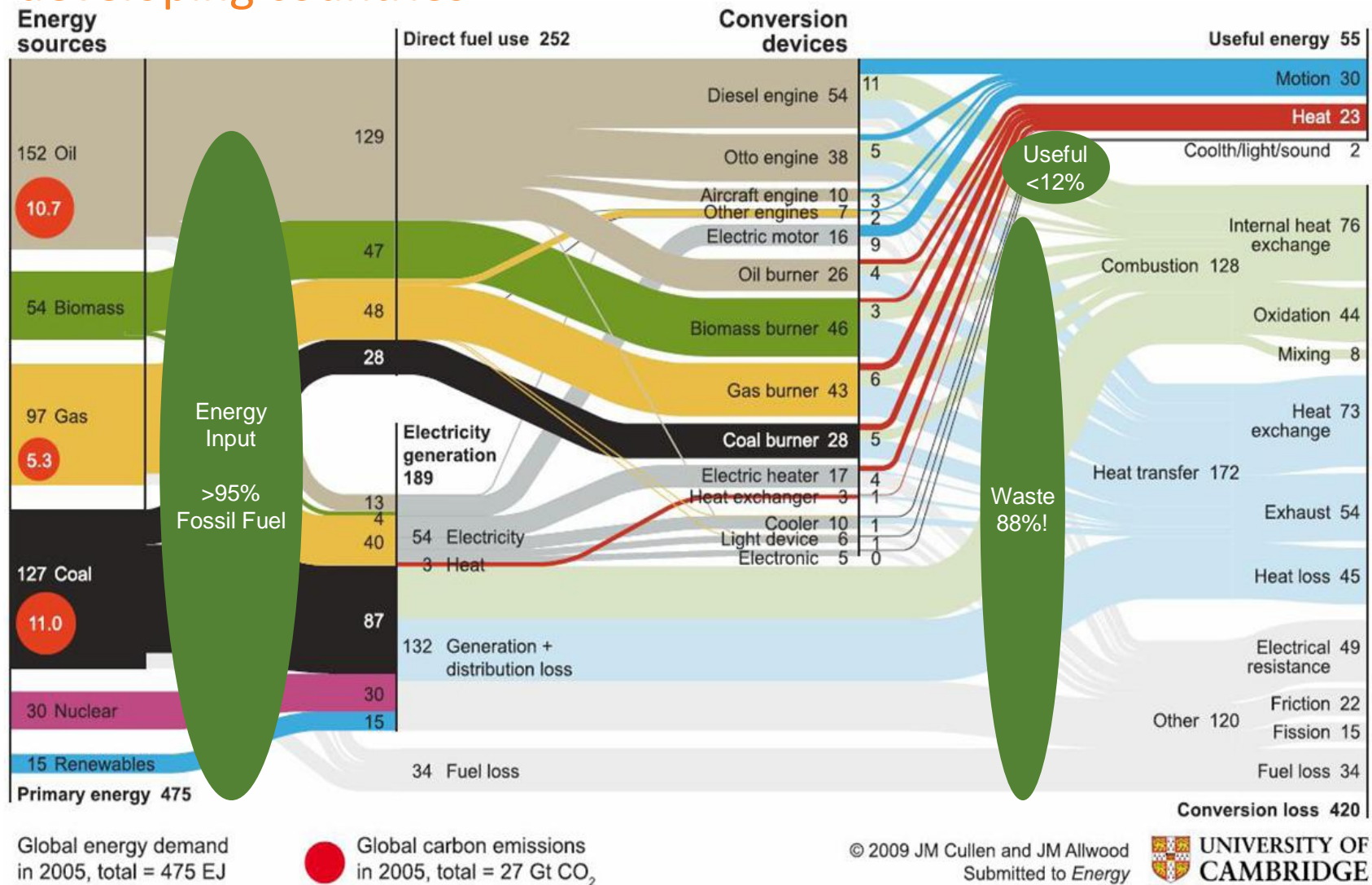
Energy Efficiency: the invisible 'poor cousin' of energy supply that offers much better value

Alan Pears AM Senior Industry Fellow
RMIT University

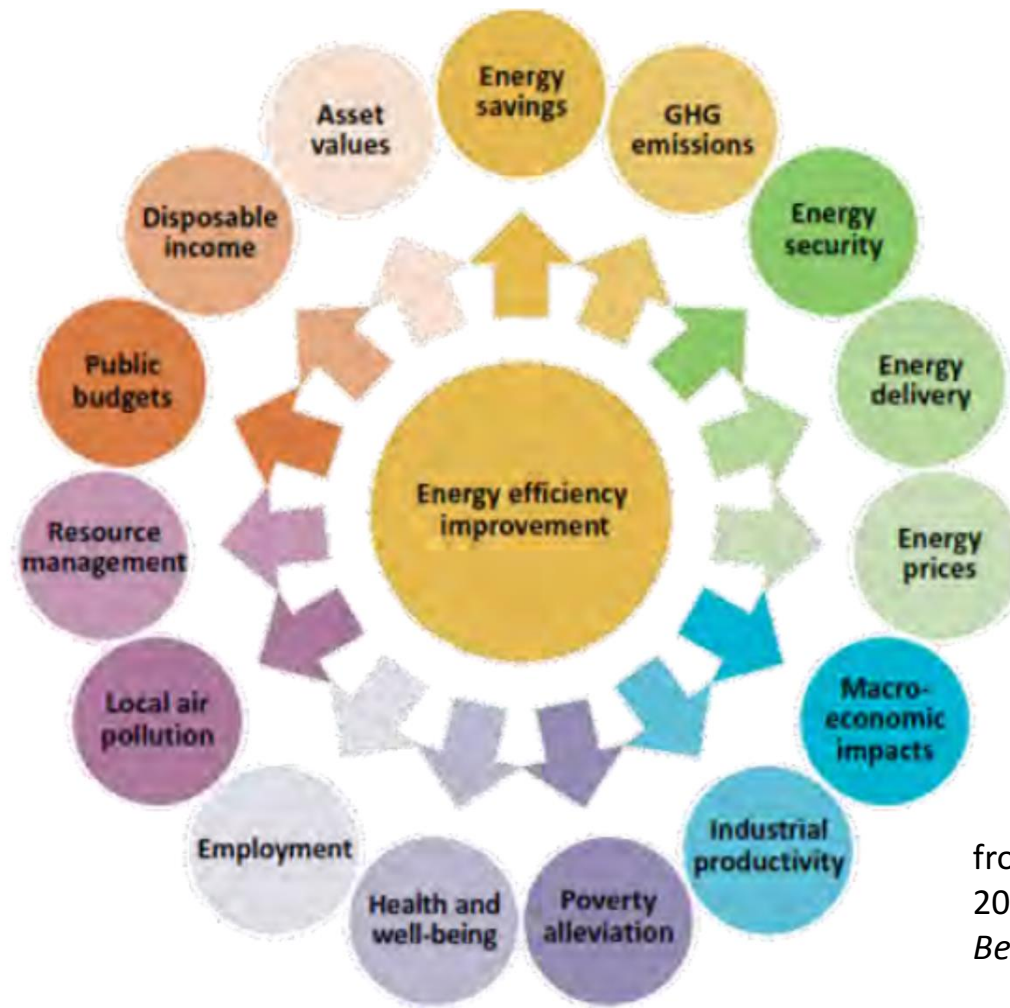
ANU Energy Outlook Workshop
Canberra 9 December 2015



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*

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)

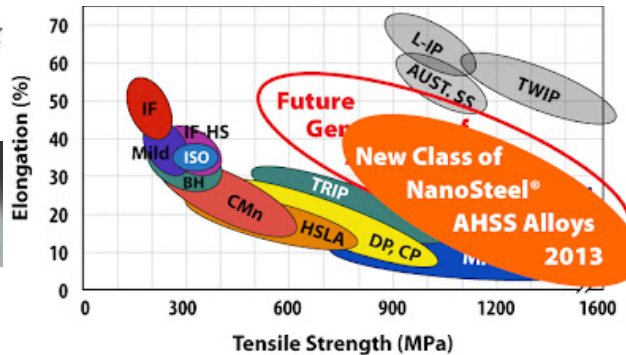


High energy efficiency and low embodied energy (and CO2 emission) design techniques and materials are becoming available and improving



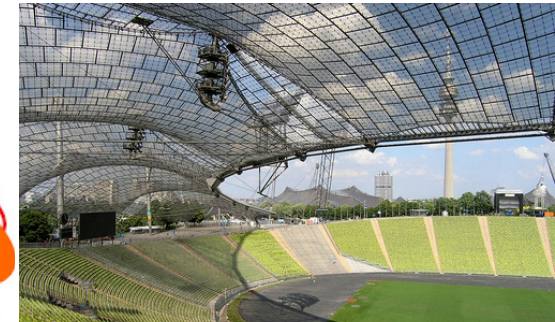
Engineered timber structural elements

http://www.hobbitthouseinc.com/personal/woodpics/_g_IJK.htm



High strength steel from car industry

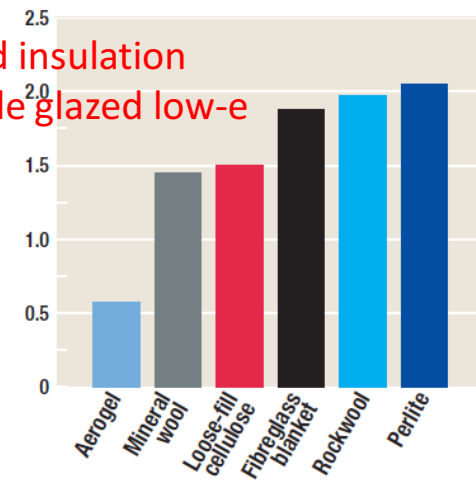
<http://nextbigfuture.com/2012/08/nanosteel-has-new-high-strength-light.html>



Tensile structures

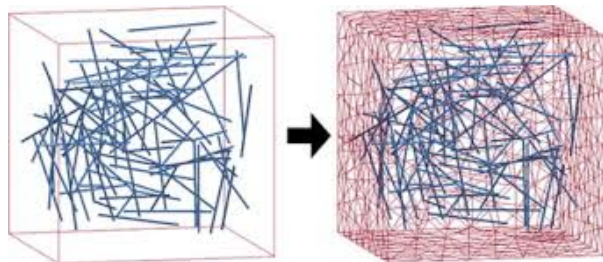
<http://www.tensilefabricstructure.com/kolkata/stadium-tensile-structure.html>

Comparison of U-Values of 25 mm Thick Insulation Materials ($W/m^2.K$)



Fibre reinforced concrete and geopolymers, extenders etc

<http://www.sciencedirect.com/science/journal/09500618/44>

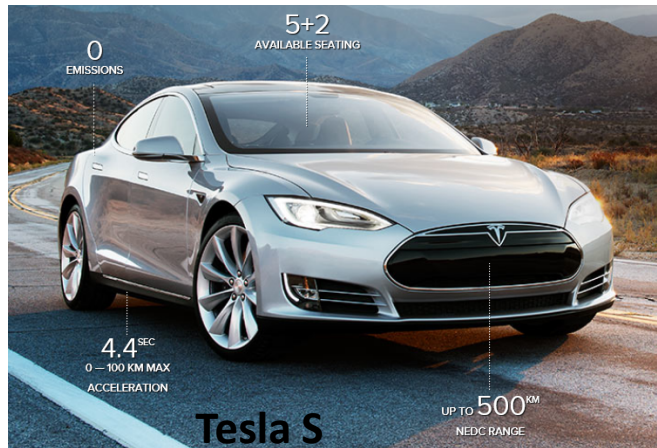


Silica aerogel – daylight and insulation
 25 mm aerogel=R1.5; double glazed low-e argon filled glazing=R0.5

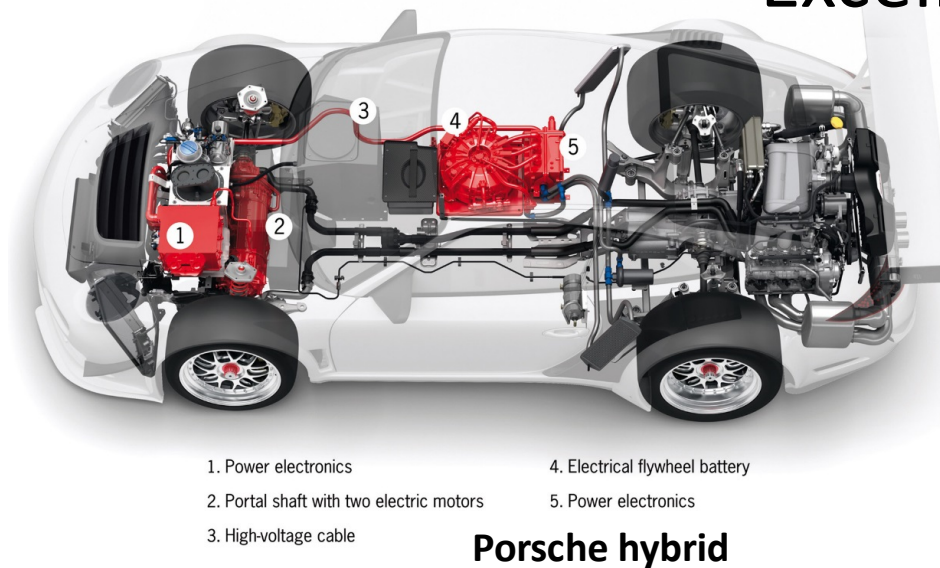


Wood 'foam' Source: Fraunhofer WKI

Where to: the new 'black'



- Extreme energy efficiency
- Outstanding performance
- Renewable electricity
- 'smart'
- Excellent design



Ferrari hybrid marks the beginning of the end for gas-powered automobiles

Why the gasoline engine is on the way out

by Martin Patriquin on Monday, September 16, 2013 10:52am - 8 Comments

[VIEW IN CLEAN READING MODE »](#)

[WHAT IS THIS](#)

