Prometheus stole fire from Zeus and gave it to humanity – and Zeus made him pay. Now we are paying through climate change and high energy bills

# Towards a Post-Promethean World: beyond process heat from fire

Alan Pears AM

RMIT and A2EP

For

Australian Alliance for Energy Productivity
Innovation X-Change on energy productivity,

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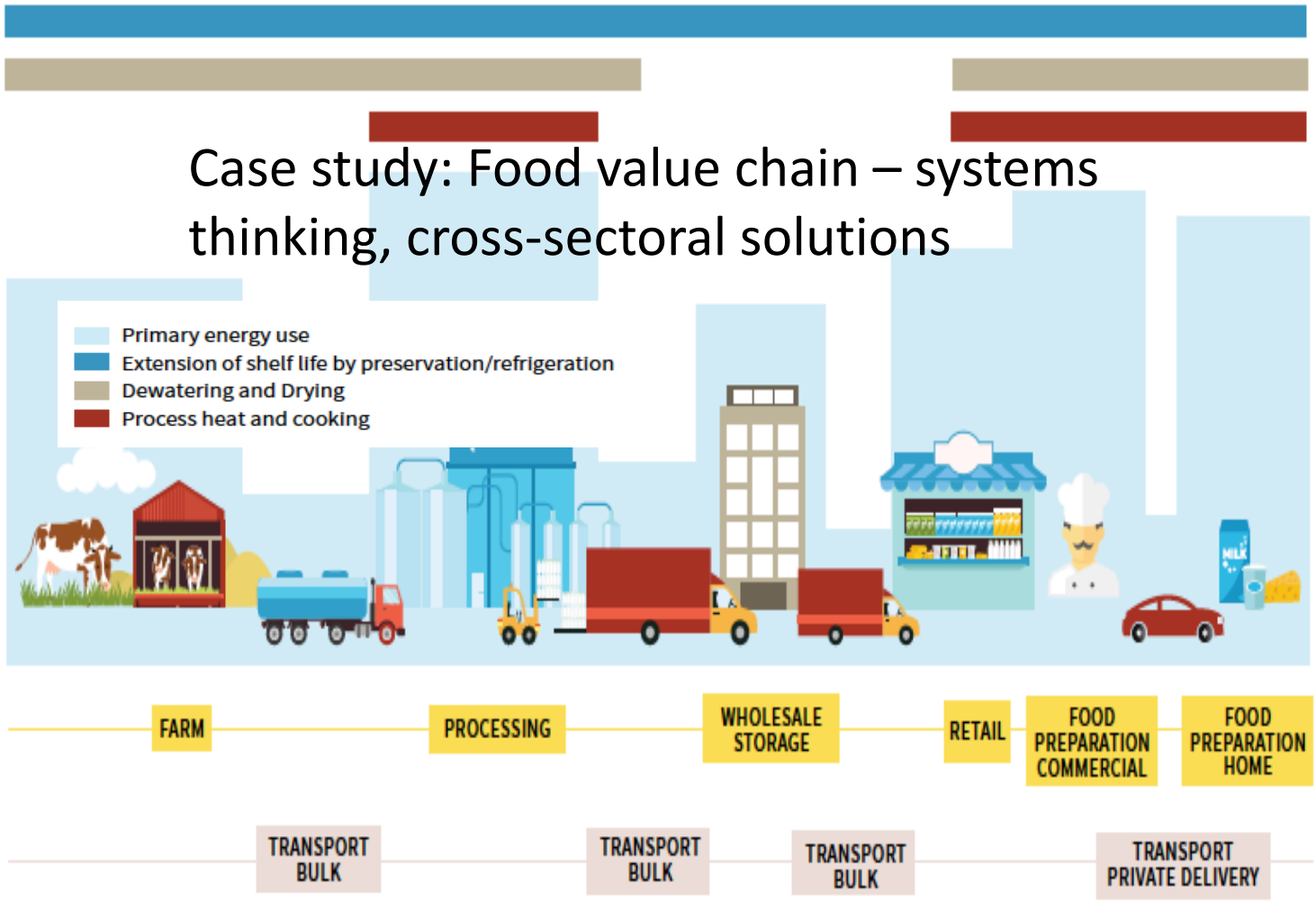
# Beyond Energy Efficiency to Energy Productivity

**What is Energy Productivity:** increasing business benefit/profit/economic output (Value Added) from each unit of (primary) energy consumed

**Captured through:** Innovation, new business models, IoT, smart data analytics, emerging technologies, Demand Response/Management, on-site renewable energy, energy storage, system integration, energy trading, etc

**Process Heat – Food Value Chain**

- End-use data by activity are very poor
- Commercial and residential are surprisingly high c/f industry because:
  - Industry captures economies of scale and mostly uses gas
  - Commercial and residential sectors have poor economies of scale and operating efficiency



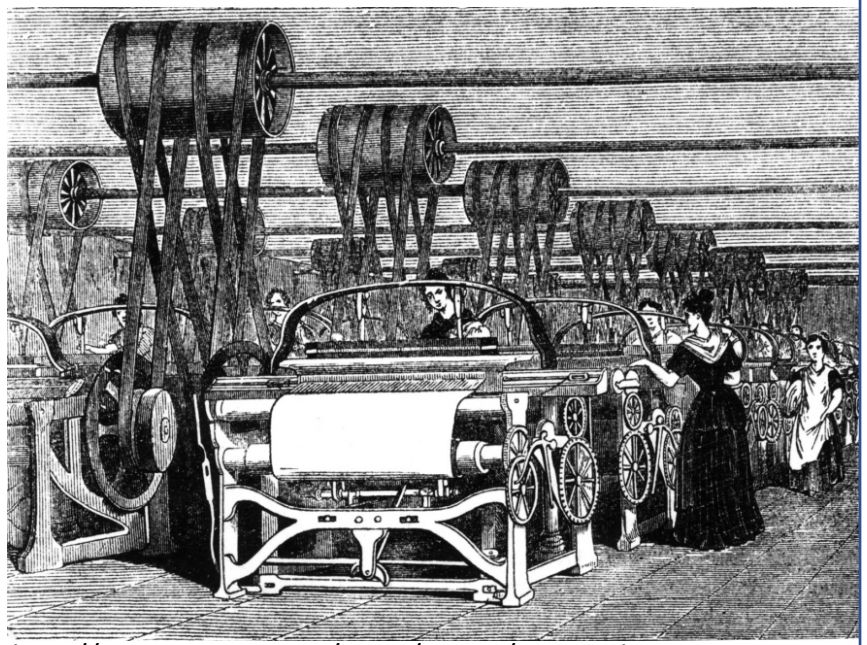

Very rough process heat estimates based on 2014-15 OCE Table A2 (final energy from thermal fuels) converted to PJ primary energy)

7 PJ 70 PJ 110 PJ 50 PJ

2xEP Doubling Australia's Energy Productivity

AUSTRALIAN ALLIANCE FOR ENERGY PRODUCTIVITY

# Steam Boiler System



http://www.core77.com/posts/58982/How-Did-Factories-Get-Power-to-Their-Machines-Before-Electricity

Scientific American (1991):

"..At the turn of the century, a typical workshop or factory contained a single engine that drove dozens or hundreds of different machines through a system of shafts and pulleys. Cheap, small, efficient electric motors made it possible first to give each tool its own source of motive force, then to put many motors into a single machine."

# Beyond Centralised steam

- Process options:
  - Avoid the process
  - Minimise the need for the process
  - Use non-heating processes – eg mechanical, chemical
  - Use energy in precise, targeted ways
  - Use flexible point-of-use or distributed modular heat sources
  - Recover (and upgrade temperature of) heat
  - Capture sensible AND latent heat
- Improved measurement, monitoring and analytics
  - Optimise operation of plant, operator practices, capture of multiple benefits, input to future plant and process design
- New business models, eg small plants, relocatable process equipment, located beyond gas grid

## Technology options and benefits

- Heat pumps:
  - Recover latent heat efficiently
  - Provide heating + cooling efficiently
  - Modular, distributed
  - Cascaded, multi-stage, MVR can deliver large temperature changes efficiently
  - Integrate into core process using mix of (renewable, low carbon, grid, storage) electricity sources
- Modular heat sources, eg local hot water generators, infrared, induction
  - More flexible, controllable, precise, cut distribution and standby losses
- Non-thermal, eg micro-filtration, High Pressure Processing, centrifuge, vacuum
  - Product quality, taste, shelf life, etc