Efficiency, energy cultures and the low-carbon grid

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IAEE conference 2020

GREEN Grid

University of Otago | Centre for Sustainability Kā Rakahau o Te Ao Tūroa | energy cultures

Perspectives on efficiency

	Reduce total consumption
Technologies	e.g. insulation, efficient appliances

Energy cultures and efficiency

Energy cultures and efficiency

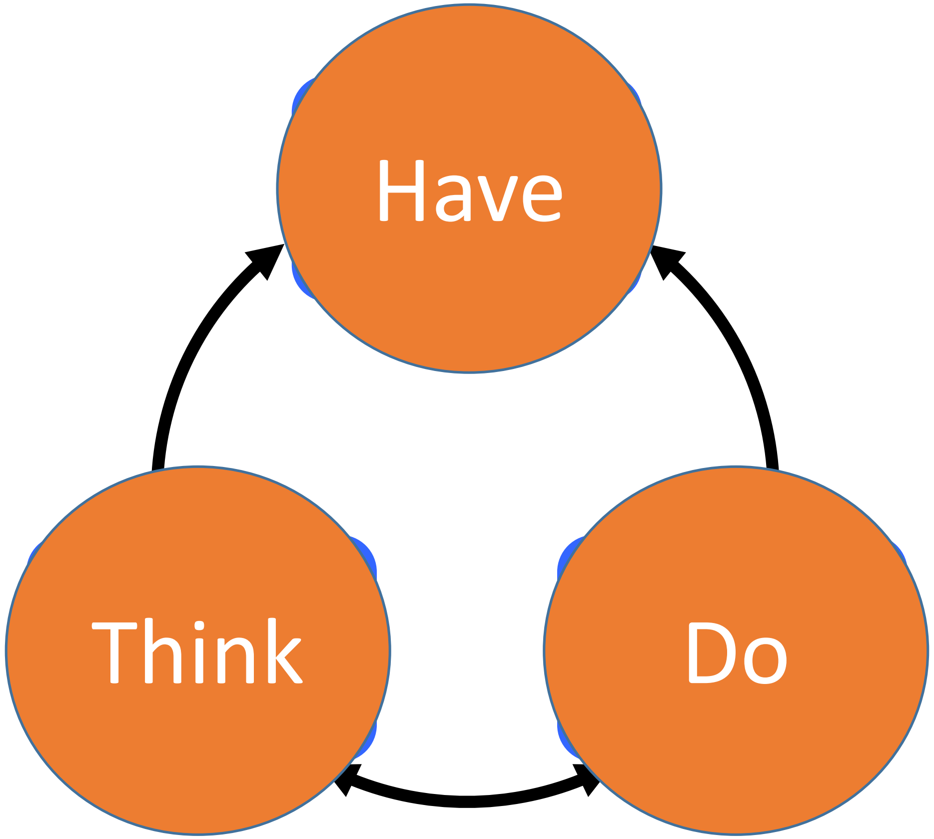
How many admirals does it take to change a lightbulb?

- Technical constraints?
- Weak incentives?
- ~~Alternative priorities?~~
- ~~Rational inattentiveness?~~
- ~~Informational deficiencies?~~
- ~~Capital constraints?~~
- Risk averseness?
- Status quo bias?

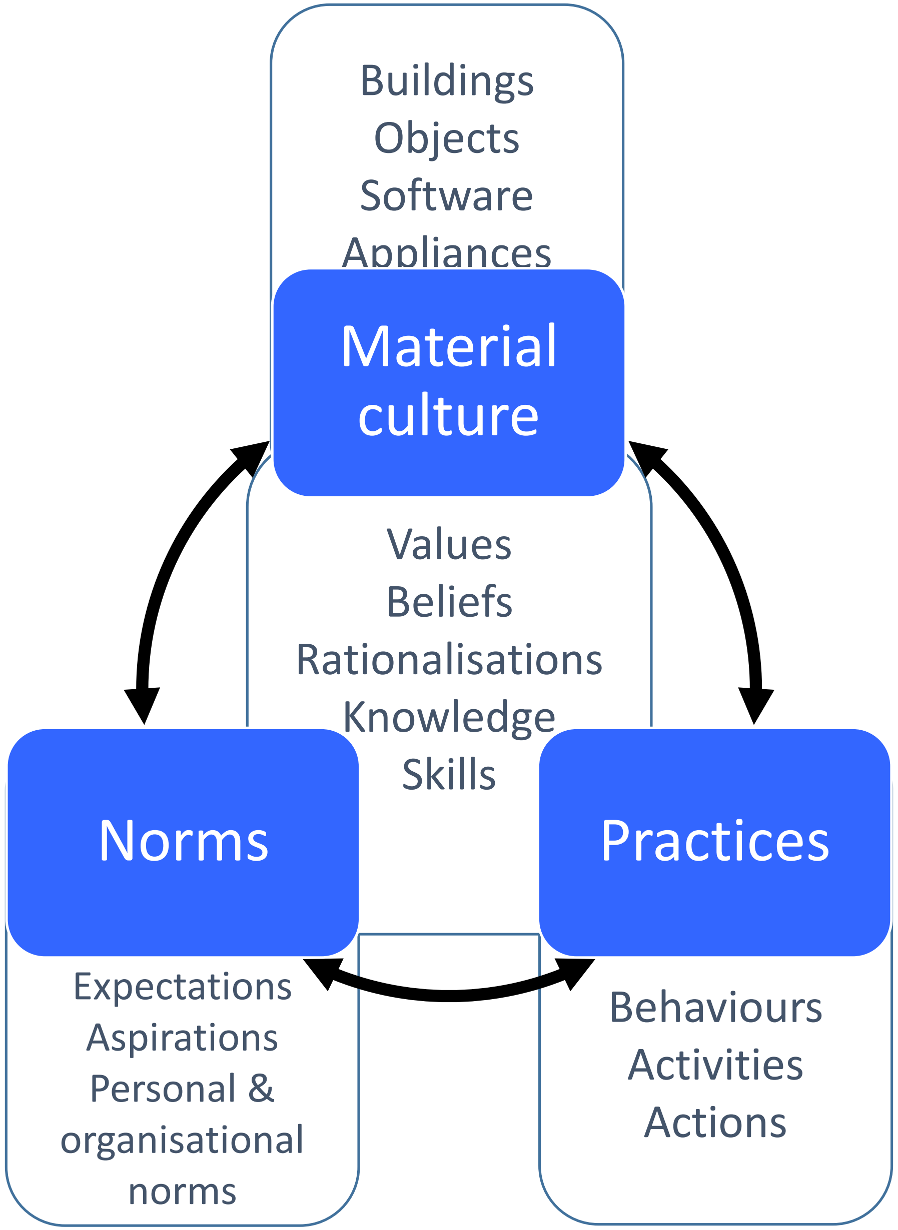
Dew, N., Aten, K., & Ferrer, G. (2017). How many admirals does it take to change a light bulb? Organizational innovation, energy efficiency, and the United States Navy’s battle over LED lighting. *Energy research & social science*, *27*, 57-67.c

Technologies

The energy cultures framework

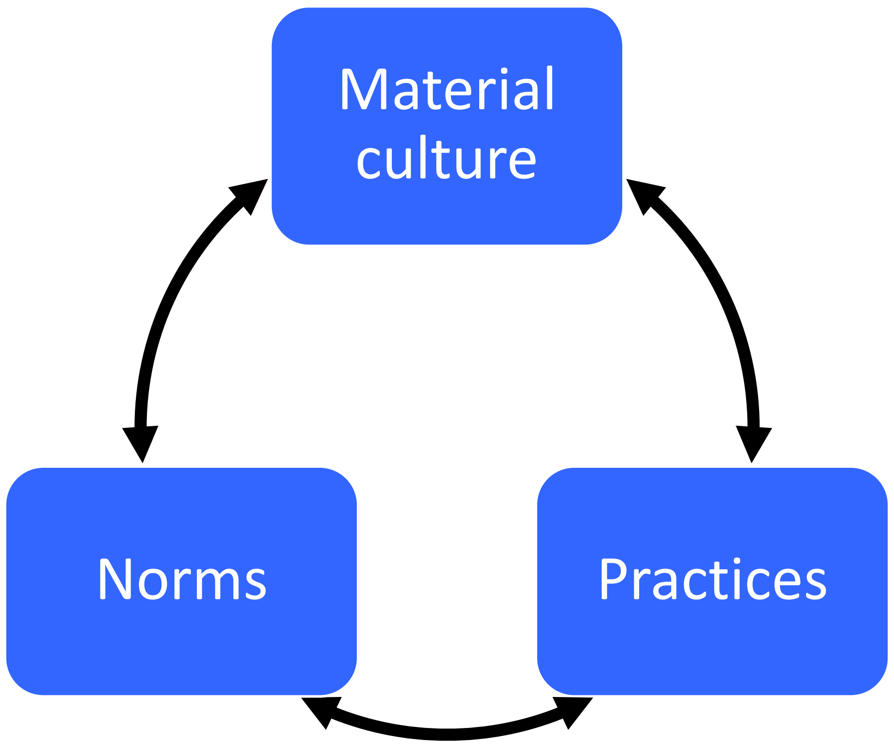


- Stephenson, J., Barton, B., Carrington, G., Gnoth, D., Lawson, R., Thorsnes, P. (2010): Energy Cultures: A framework for understanding energy behaviours. *Energy Policy.* 38: 6120–6129.
- Stephenson, J., et al. (2015). The energy cultures framework: Exploring the role of norms, practices and material culture in shaping energy behaviour in New Zealand. *Energy Research & Social Science*, *7*, 117-123.

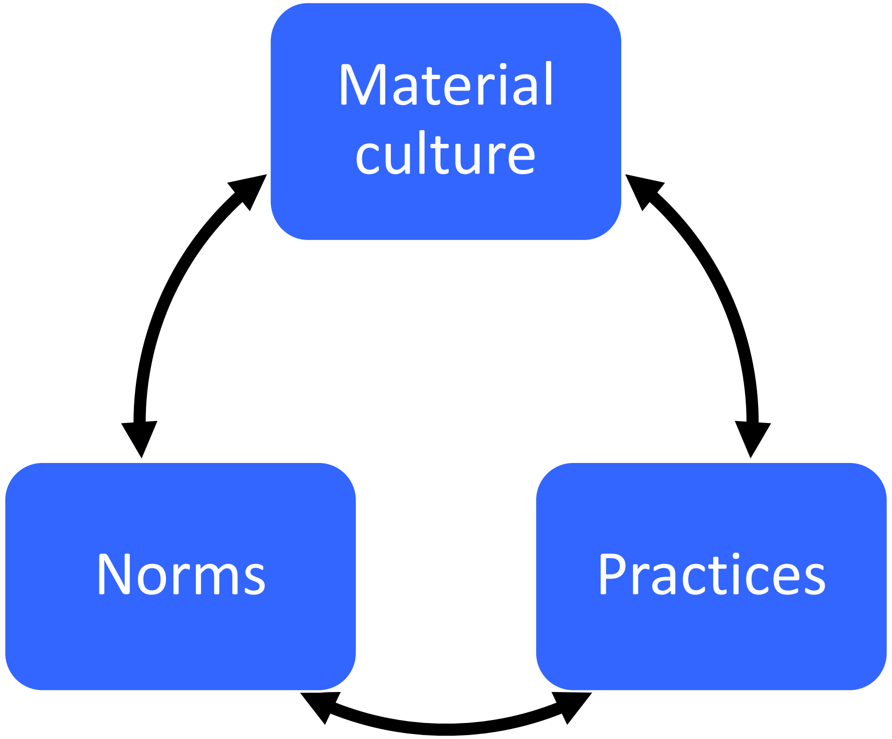


An 'actor-centred' framework

Cultural attributes – interactive and dynamic



Outcomes of these dynamics



Efficiency?
Fuel poverty?
Health?
etc

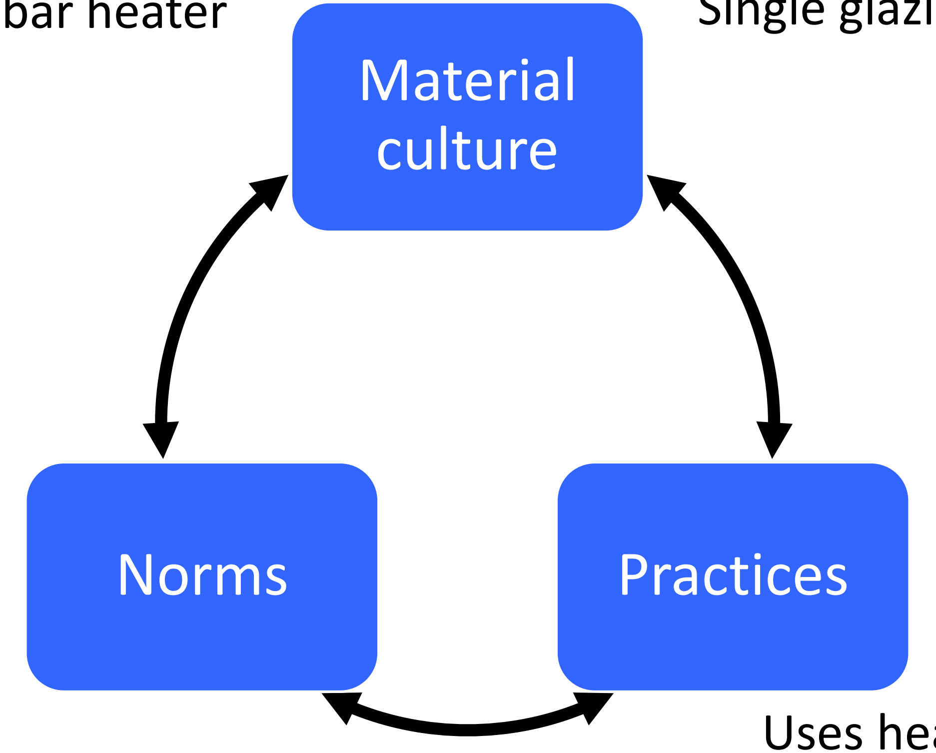
Internally consistent and thus habituated energy culture

Poor insulation

Single bar heater

Knitted jerseys

Single glazing



Low expectations of warmth

Maintaining traditions from upbringing

A ‘luxury’ to heat the kitchen

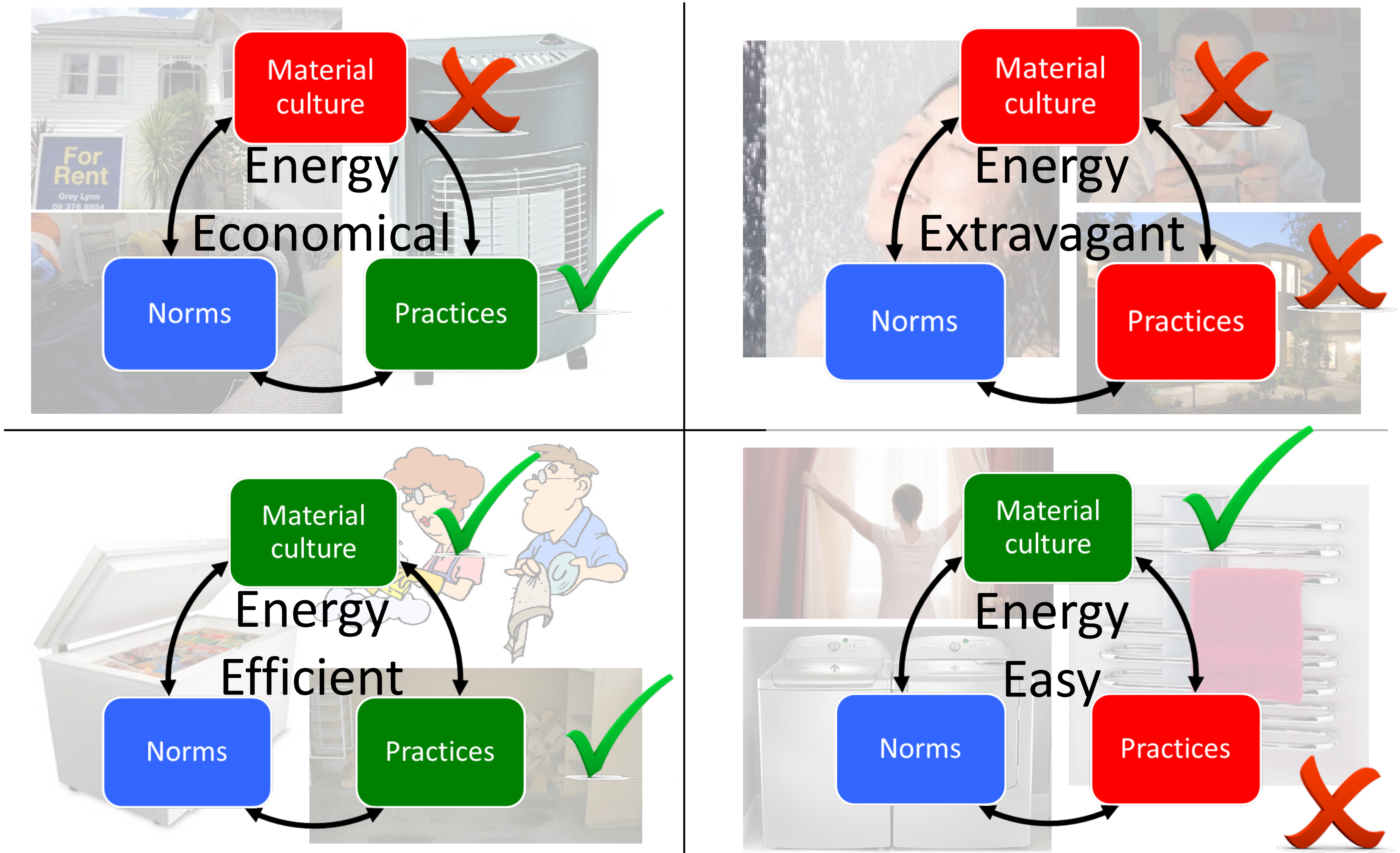
Puts on more clothes when cold

Draws curtains & closes doors

Uses heater sparingly

Doesn’t heat bedroom

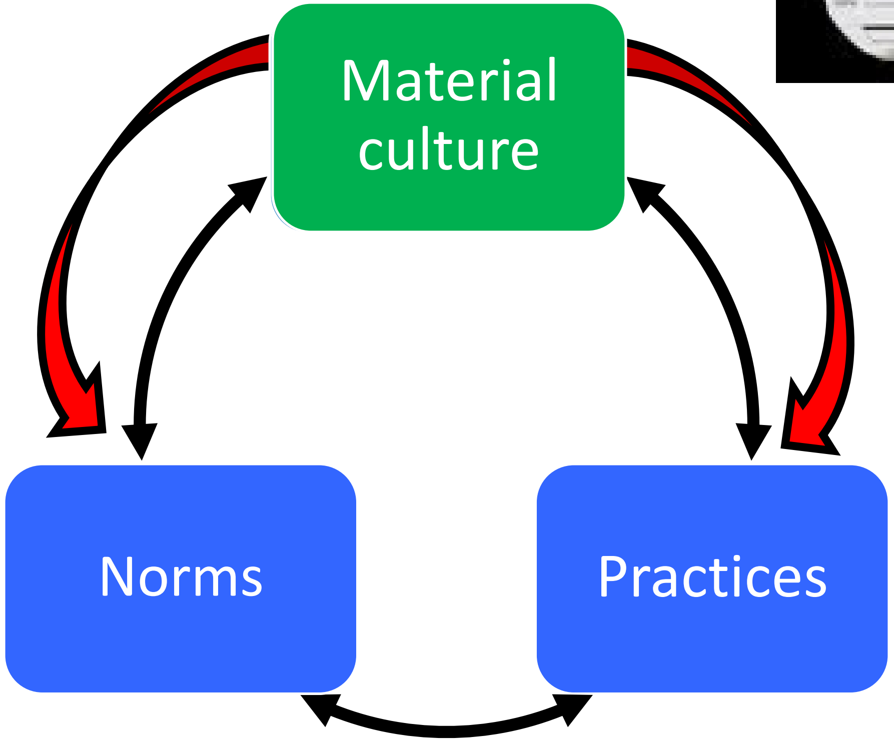
Energy cultures with different efficiency outcomes



Lawson, R., Williams, J. (December 2012). Understanding Energy Cultures. Annual conference of the Australia and New Zealand Academy of Marketing (ANZMAC), University of New South Wales, Adelaide

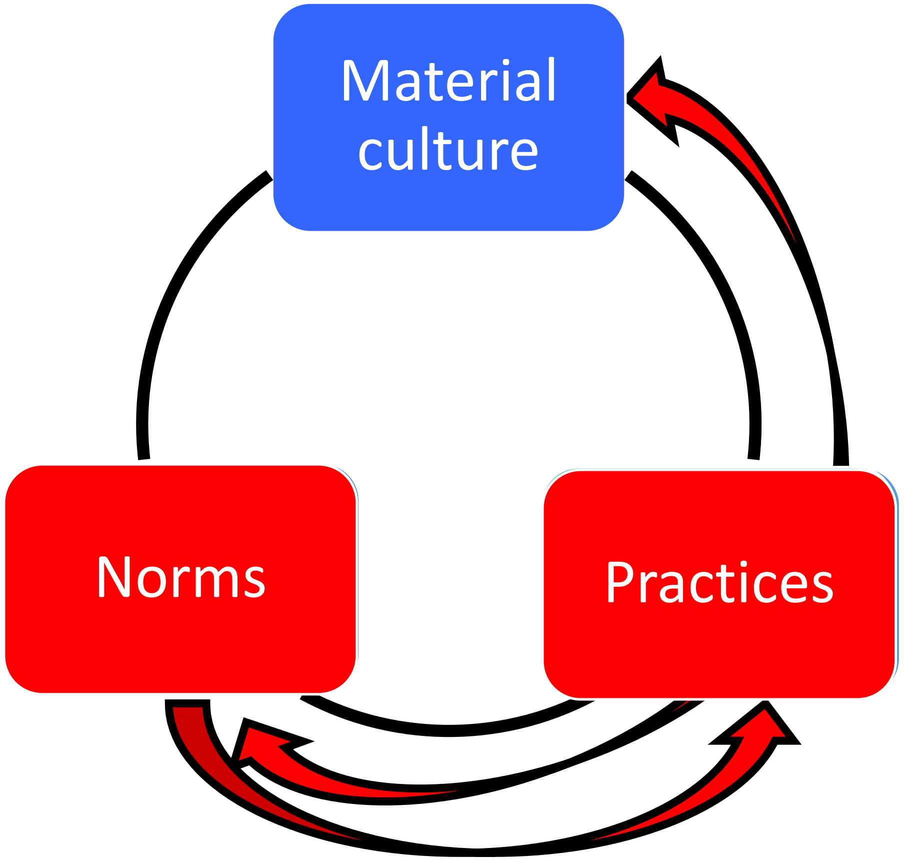
Efficiency as a cultural change

New material culture

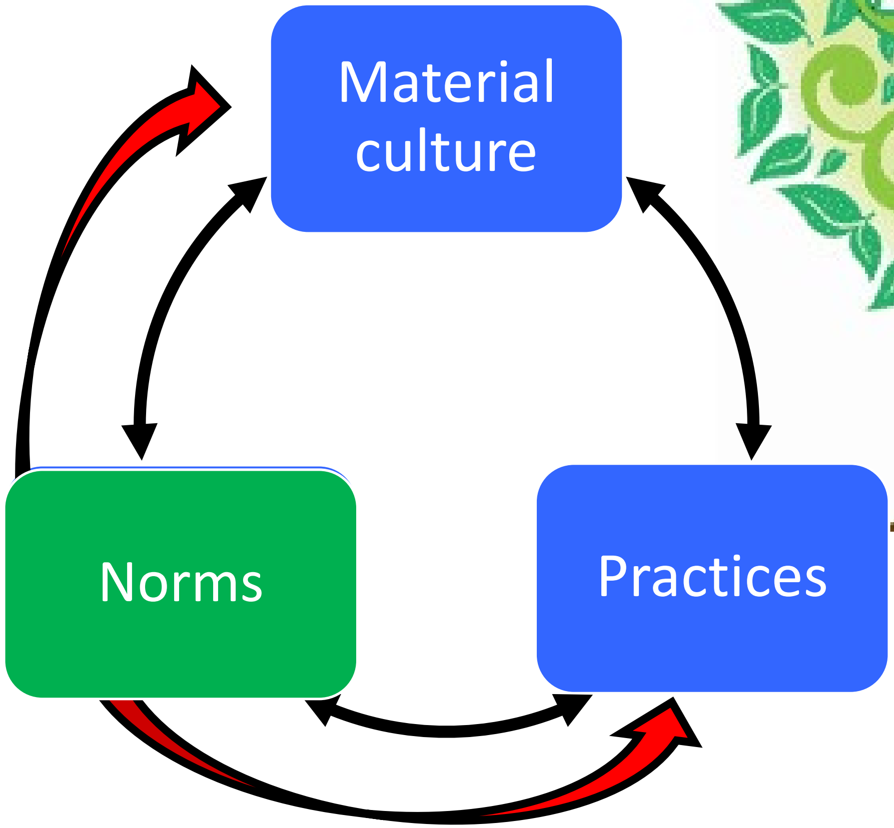


"Rebound effect"

New practices



New norms, aspirations



US Navy’s inefficient energy culture: entrenched and self-reinforcing

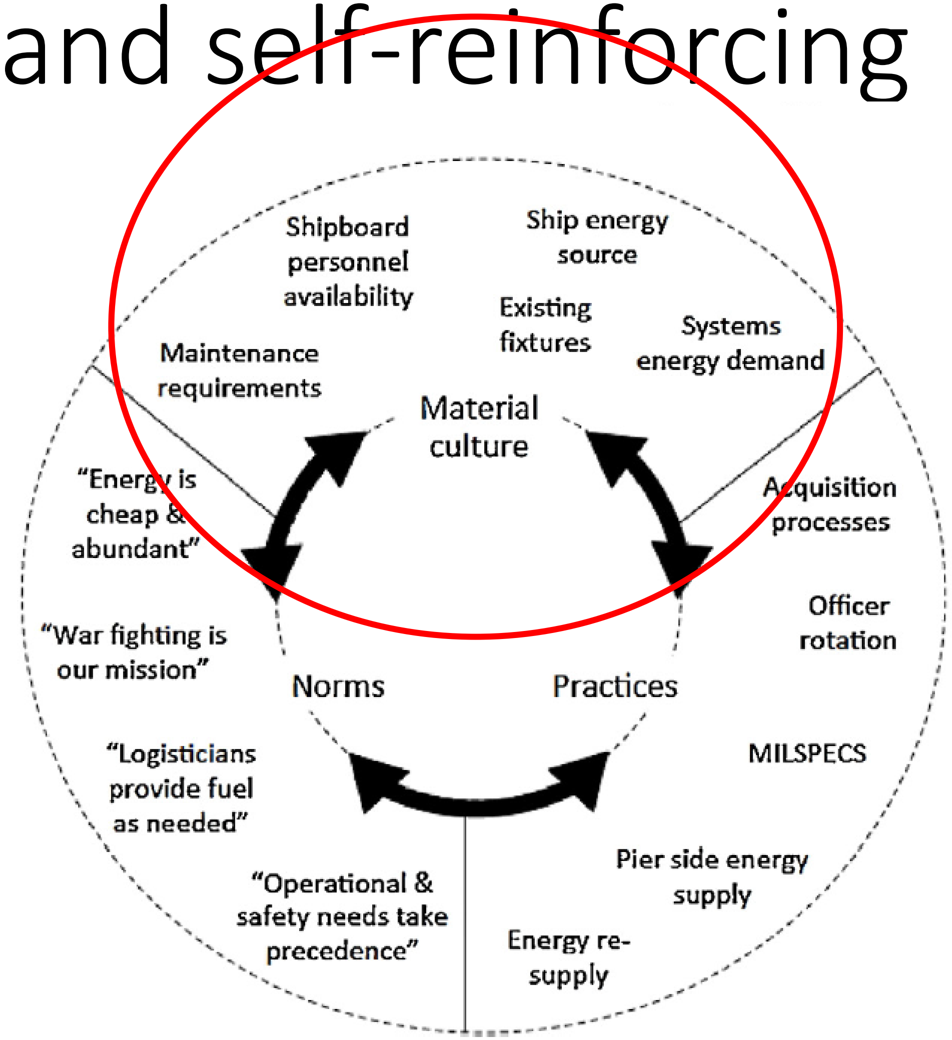
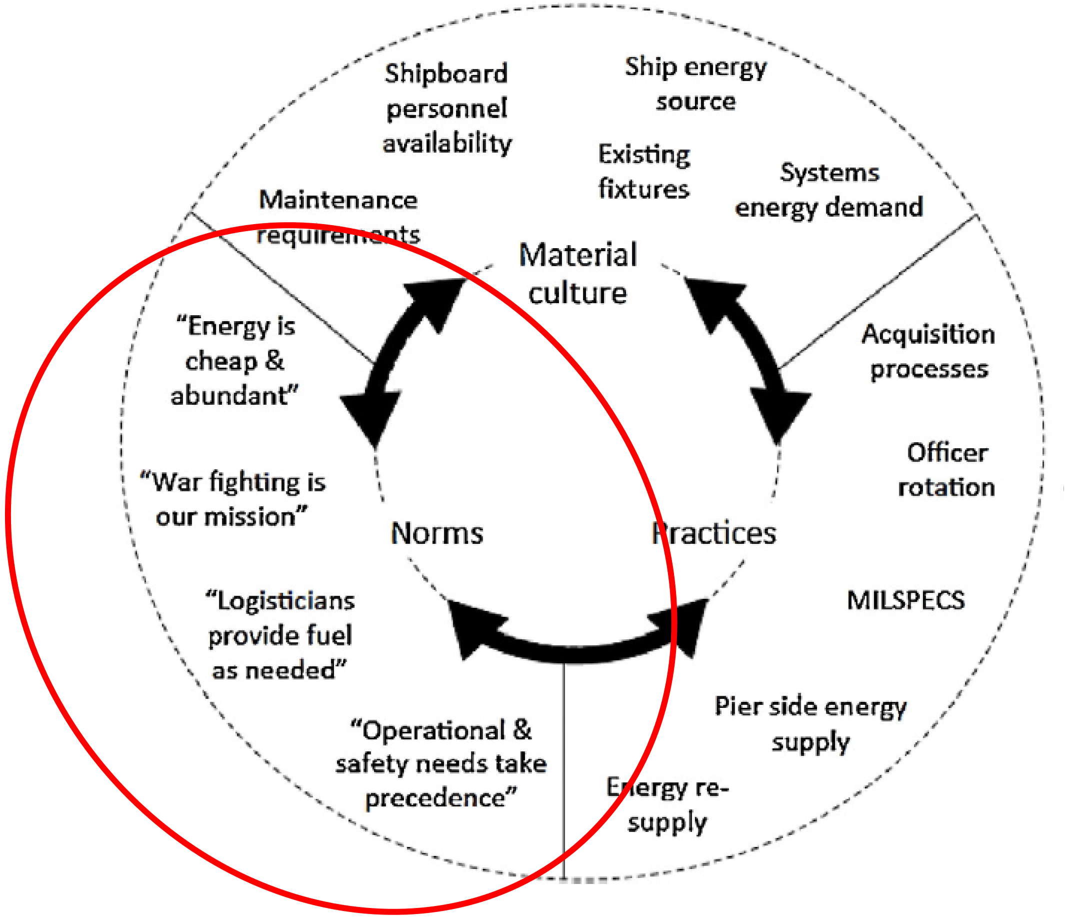


Fig 2. Internal elements of U.S. Navy energy culture.

US Navy's inefficient energy culture: entrenched and self-reinforcing



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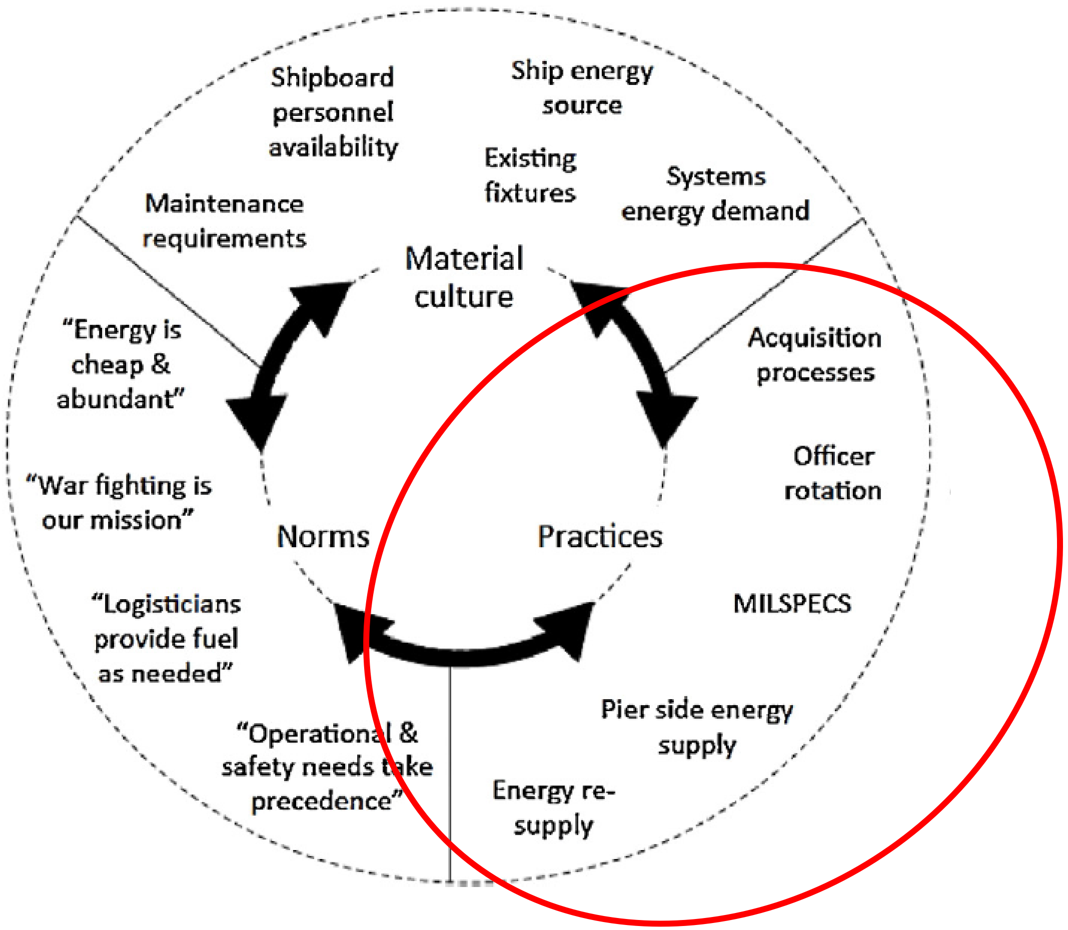

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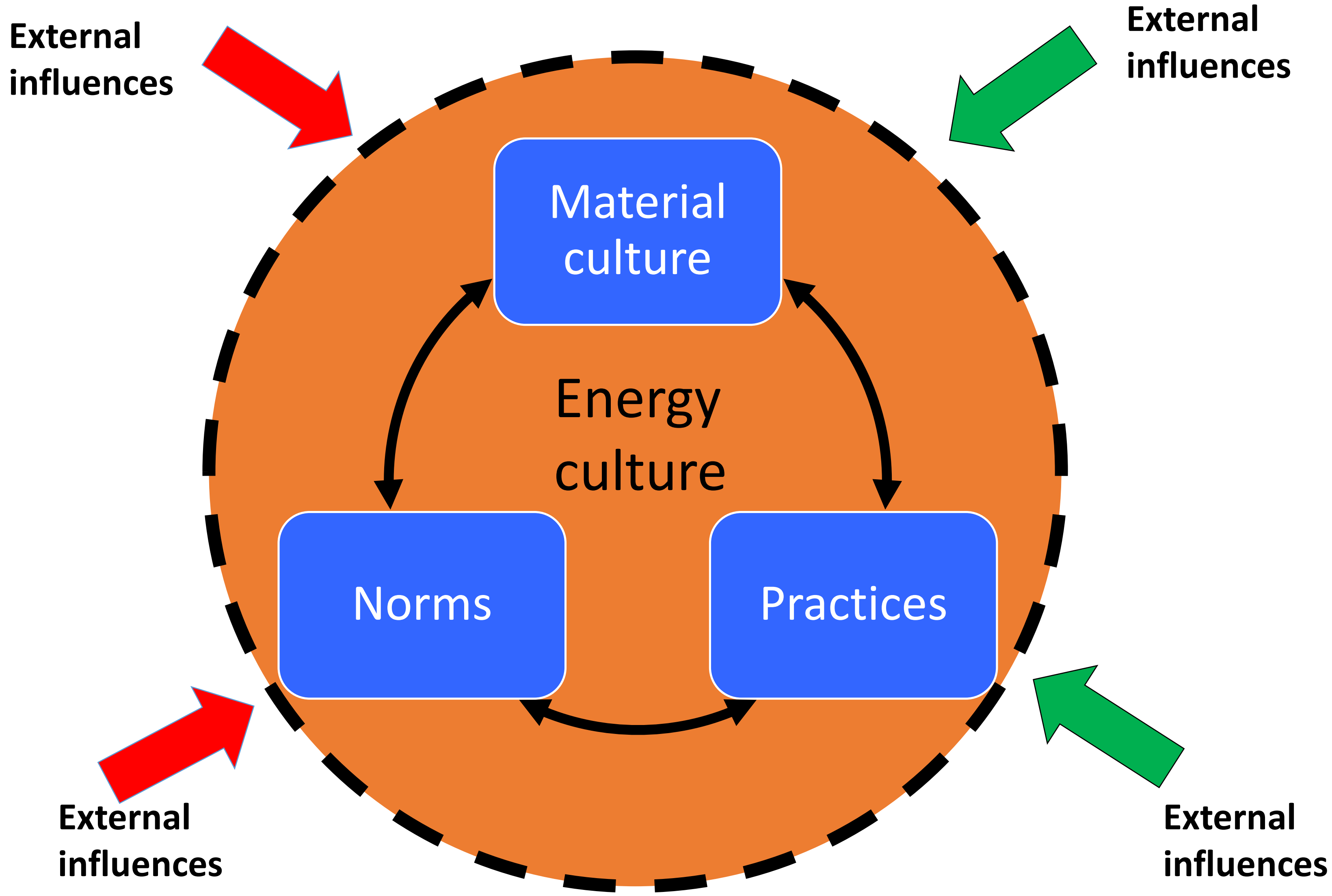

External
influences
External
influences
Material
culture
Energy
culture
Norms
Practices
External
influences
External
influences

Navy also locked in by external influences

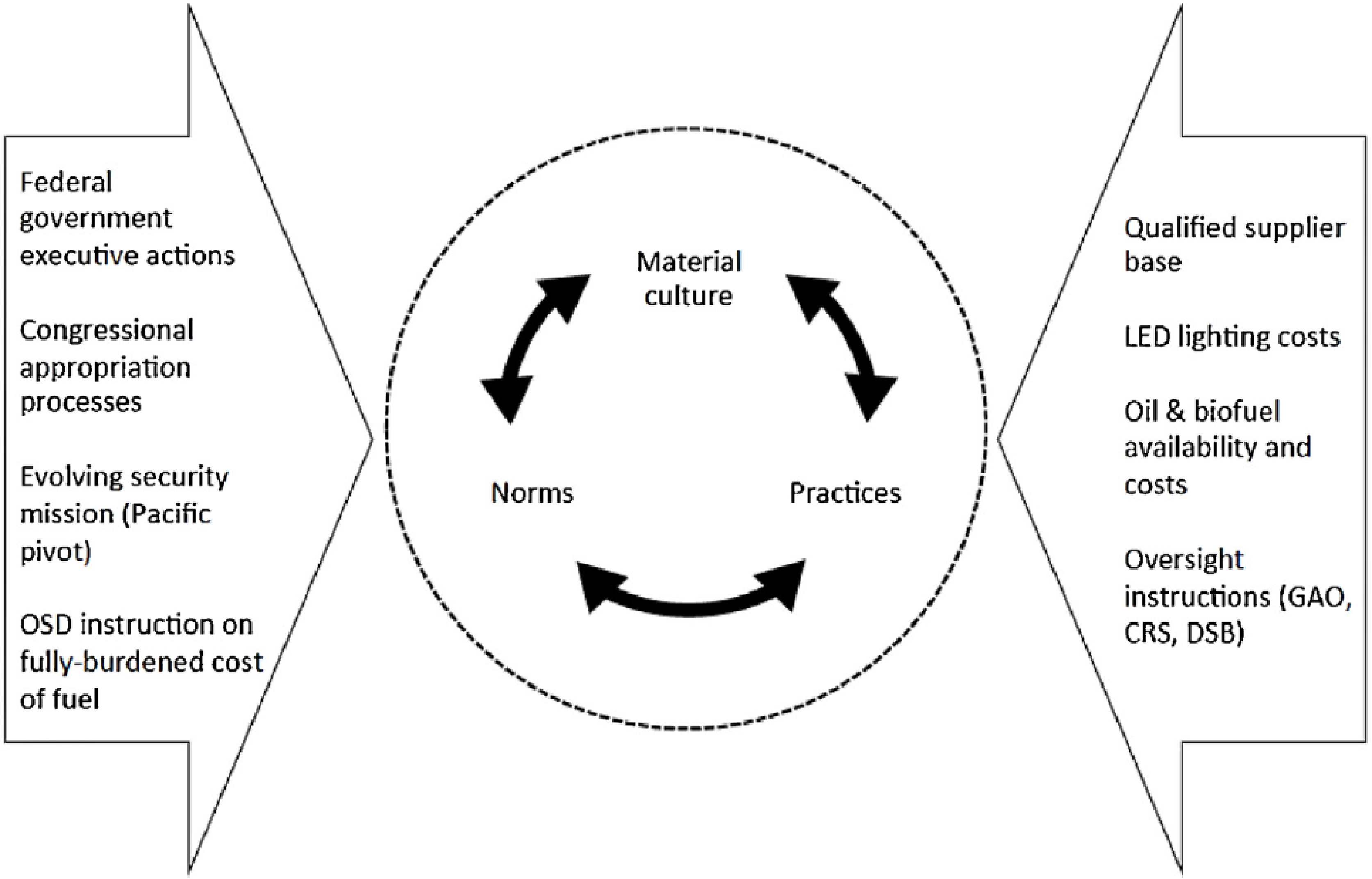


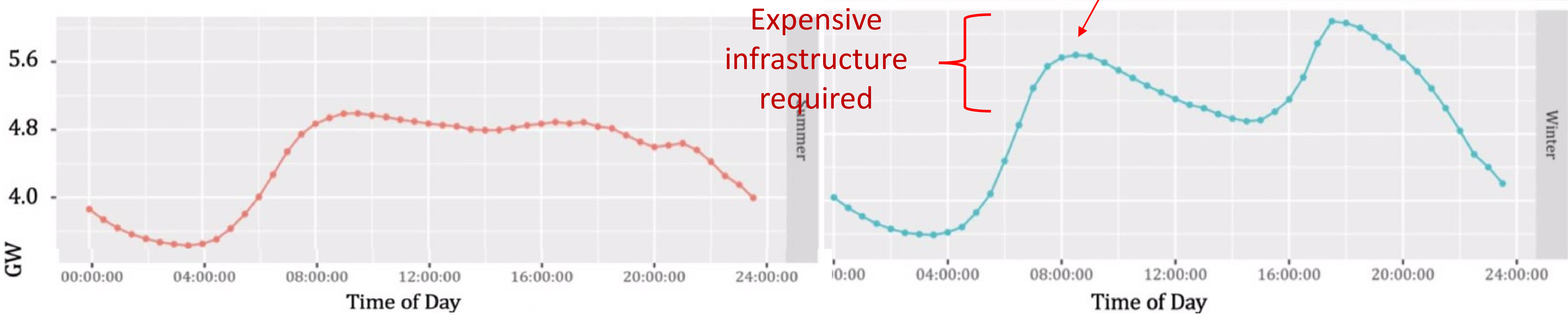
Fig. 1. External influences on U.S. Navy energy culture.

Demand peaks and efficiency of the electricity grid

Daily & annual peak electricity demand is driven by households

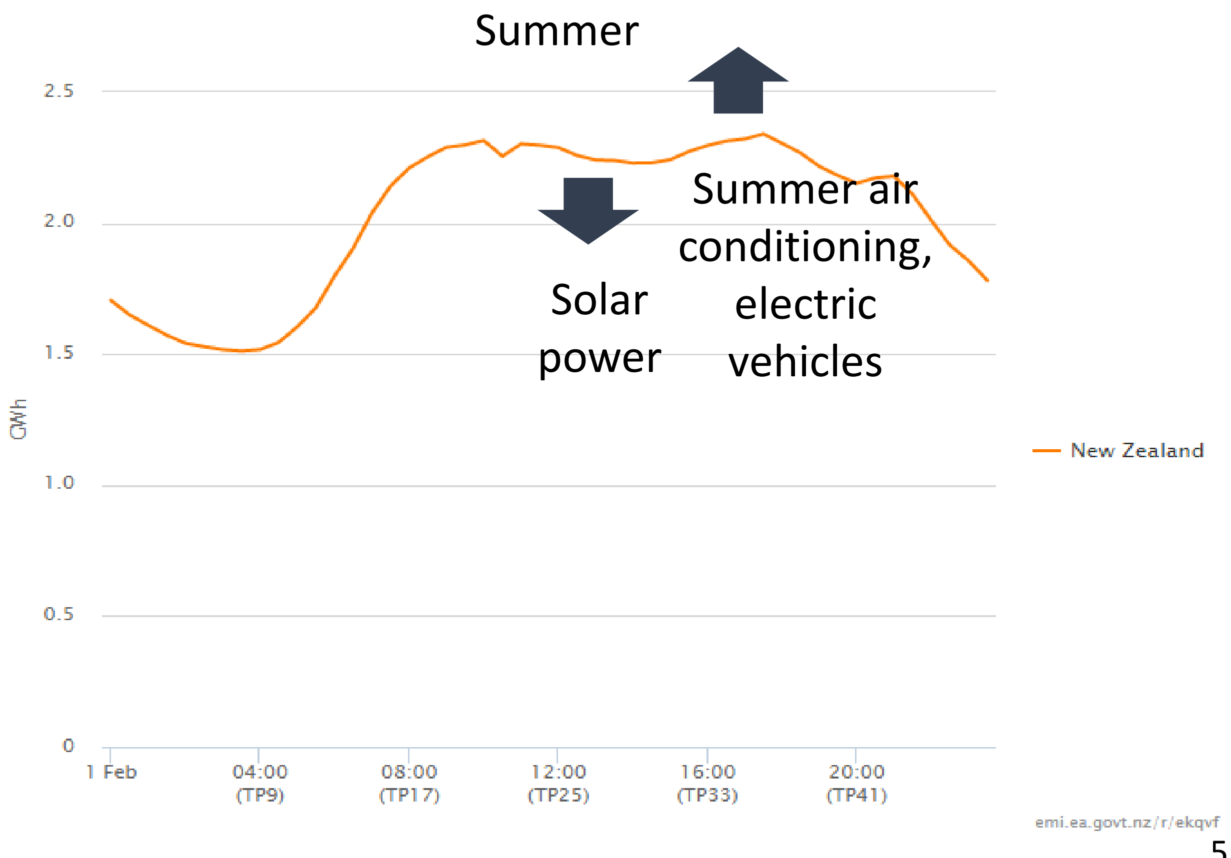
Every additional kW costs \$150-\$200/year (GW =10^6 kW)

Expensive infrastructure required

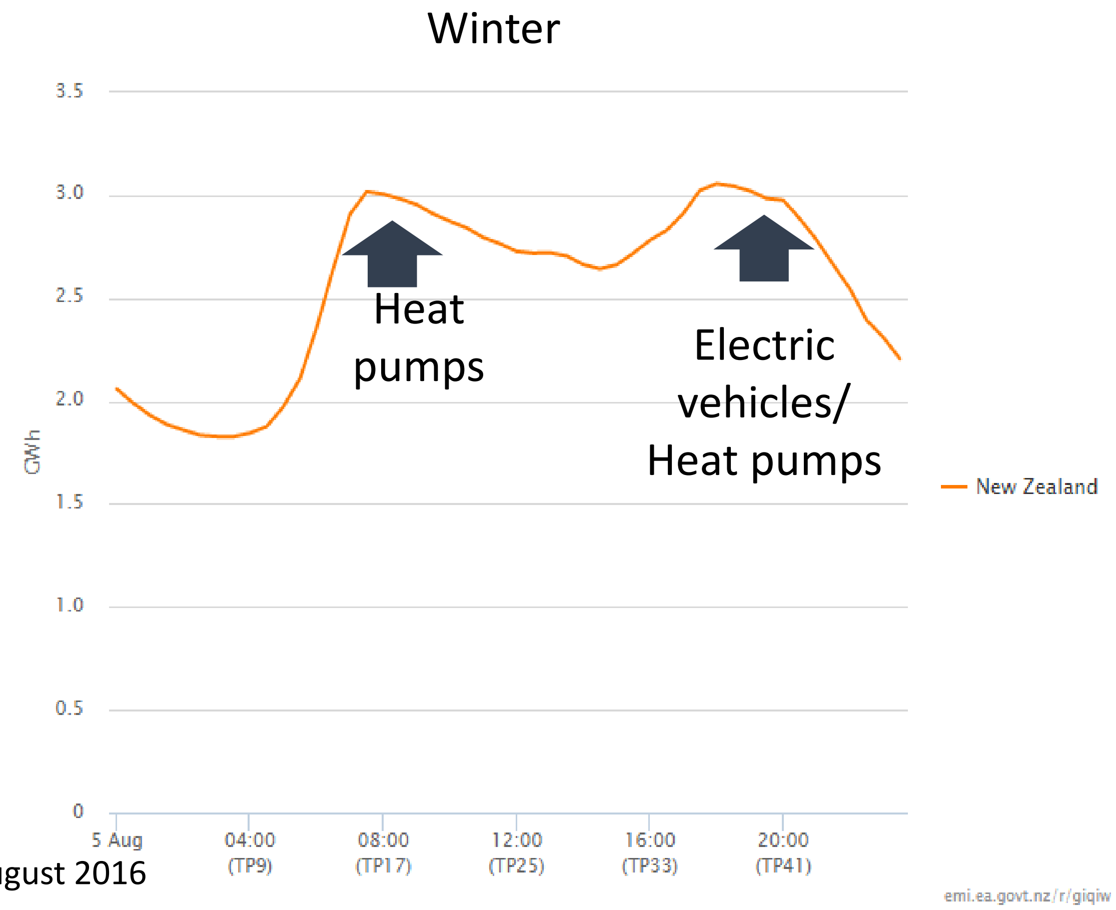


Dortans, C., Anderson, B., Stephenson, J., & Jack M., *Estimating the Technical Potential of Residential Demand Response in New Zealand: A Summary of Results* (GREEN Grid Technical Report, 2018). http://hdl.handle.net/10523/8616 ;
Dortans, C (2019) MSc Thesis, University of Otago

Increasing wind and solar will increase supply variability; grid-edge changes could increase peaks



2 February 2016

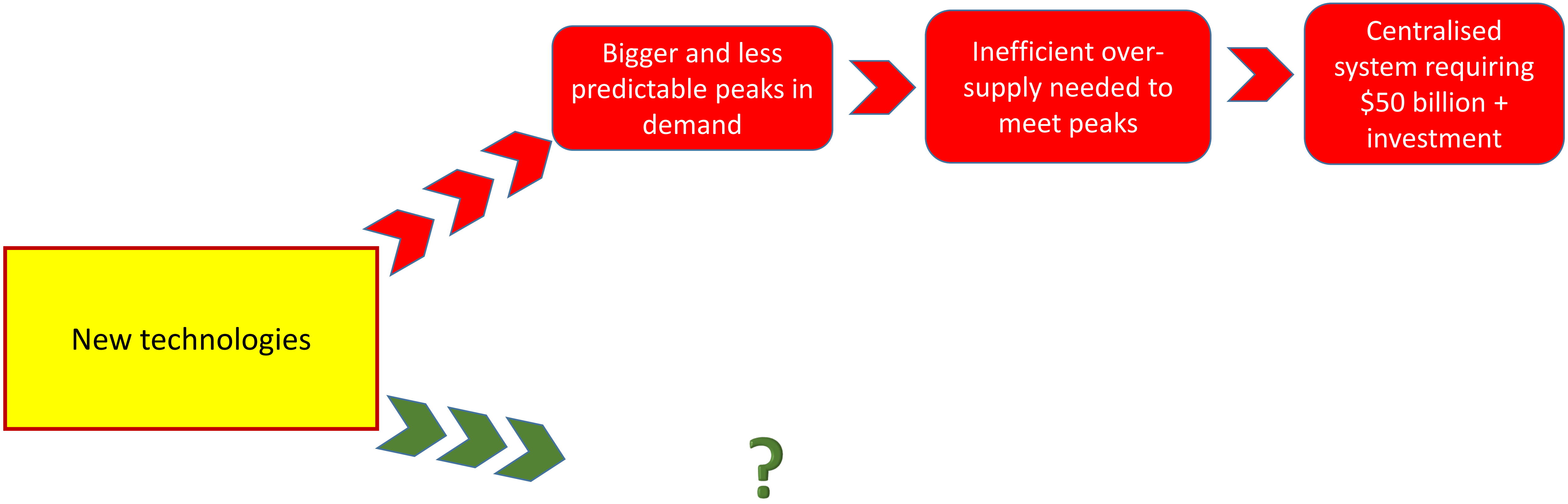


5 August 2016

Jack, M. W., Suomalainen, K, *Potential future changes to residential electricity profiles-findings from the GridSpy dataset*, GREEN Grid project report (2018). http://hdl.handle.net/10523/8074

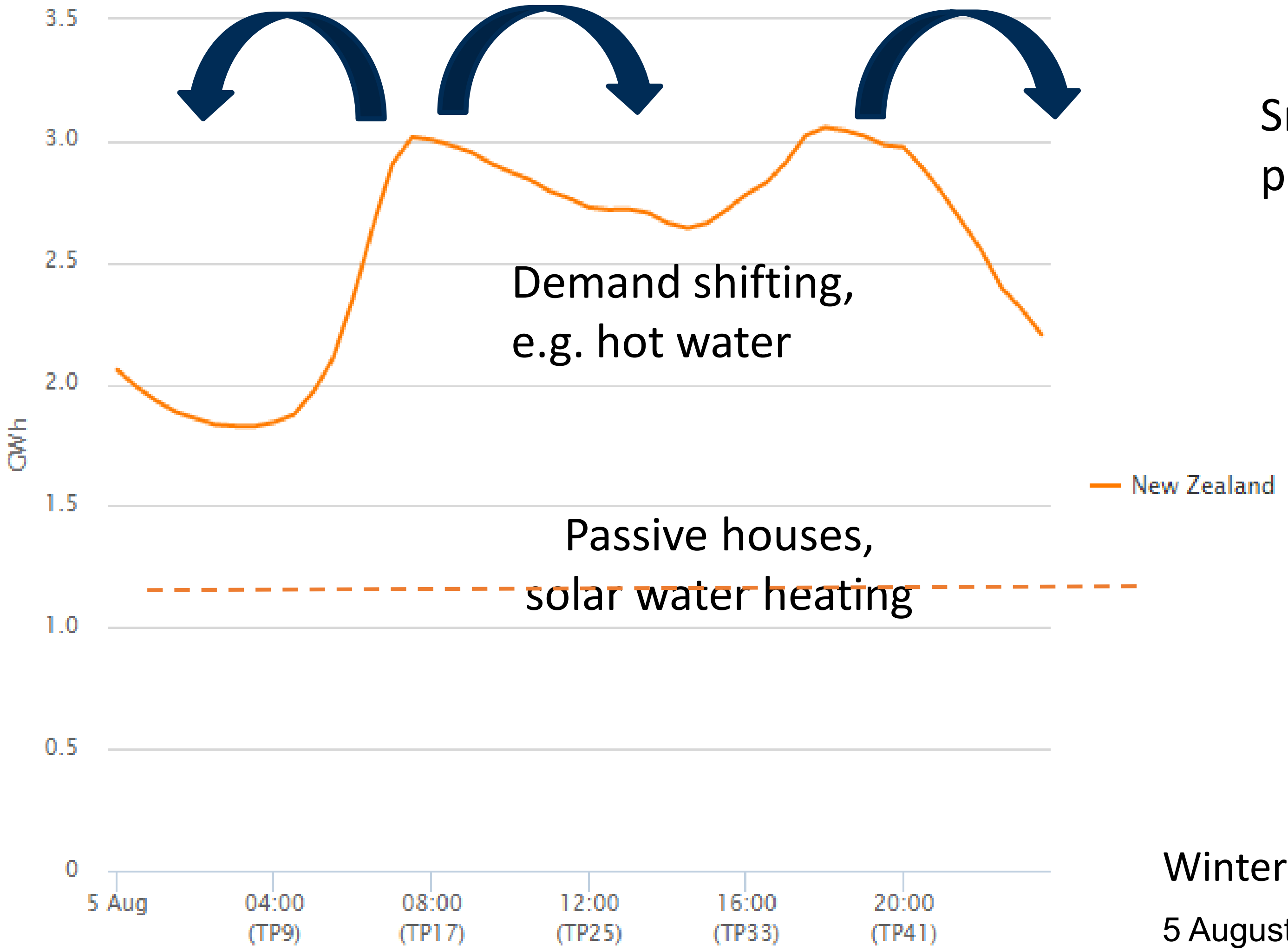
Low-carbon grid will be shaped by changes at the grid edge ….

Pathways to NZ’s energy transition



New technologies & practices to reduce daily peaks

Battery storage
Vehicle to grid
Smart appliances



Smart EV charging off-peak

Winter

5 August 2016

Jack, M. W. Suomalainen, K. Dew, J. J. W., and Eyers, D., *A minimal simulation of the electricity demand of a domestic hot water cylinder for smart control*, Applied Energy, 211, 104 (2018).

Demand shifting to reduce daily peaks

Hot water systems, heat pumps, fridges?

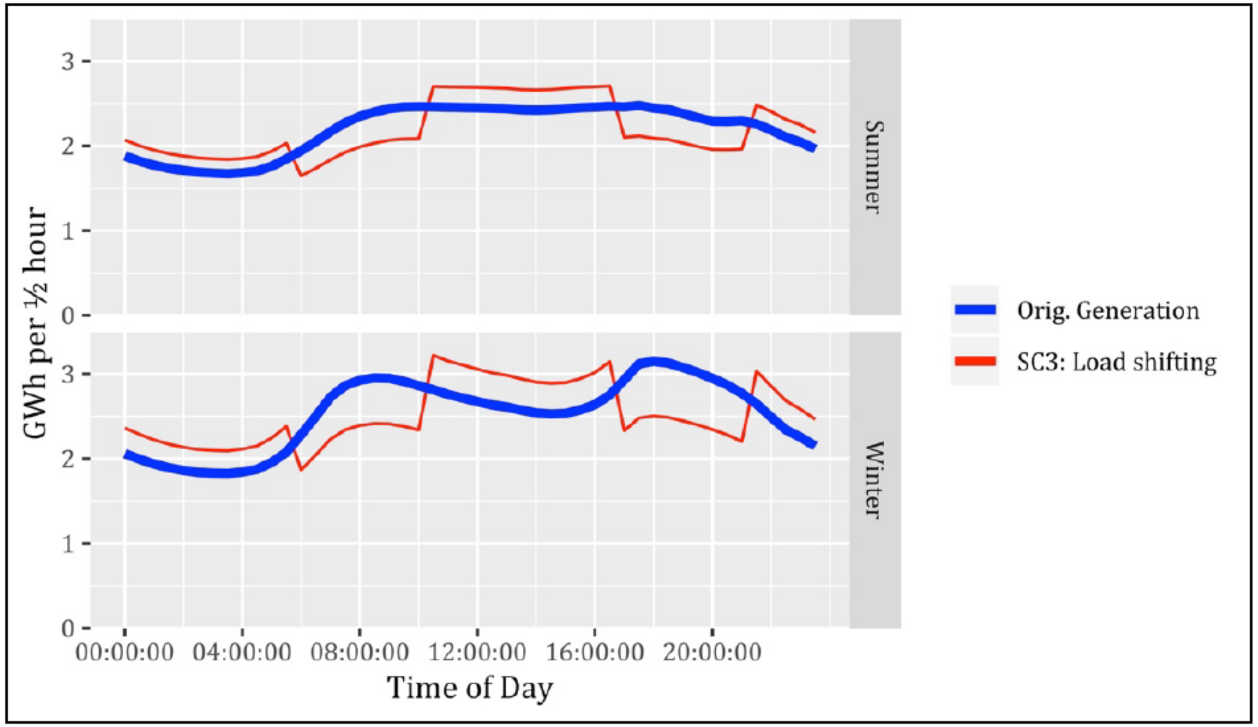
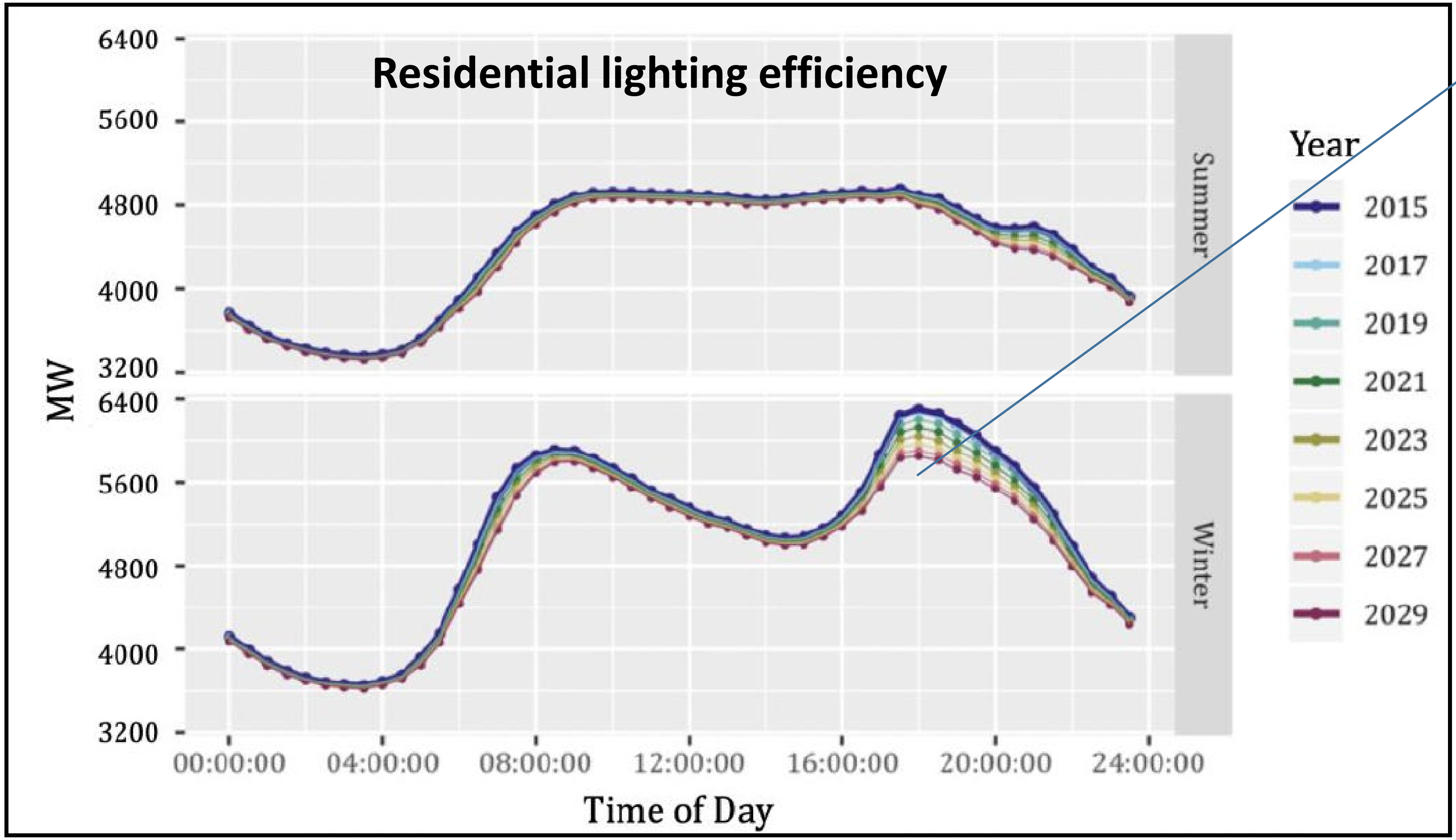


Figure 5: Estimated daily effects of the peak load shifting scenario on total electricity generation profile assuming 100% HW unit availability

Dortans, C., Anderson, B., Stephenson, J., & Jack M**.,** *Estimating the Technical Potential of Residential Demand Response in New Zealand: A Summary of Results* (GREEN Grid Technical Report, 2018). http://hdl.handle.net/10523/8616

Efficient lighting to reduce winter peak demand

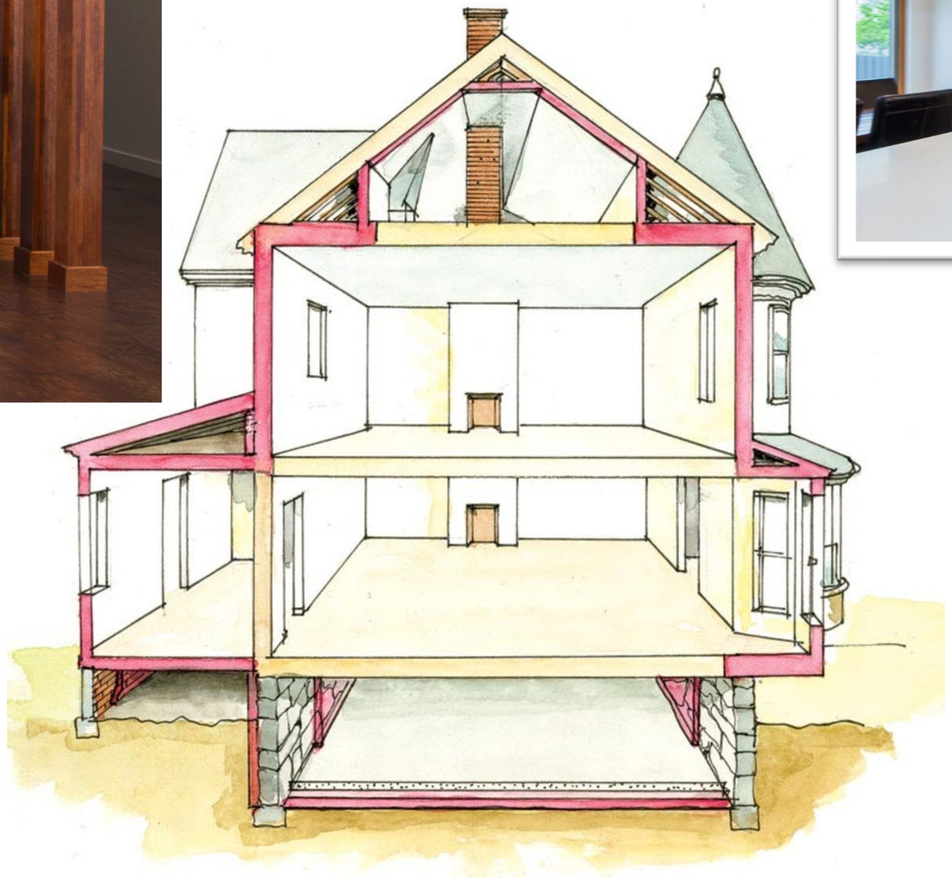


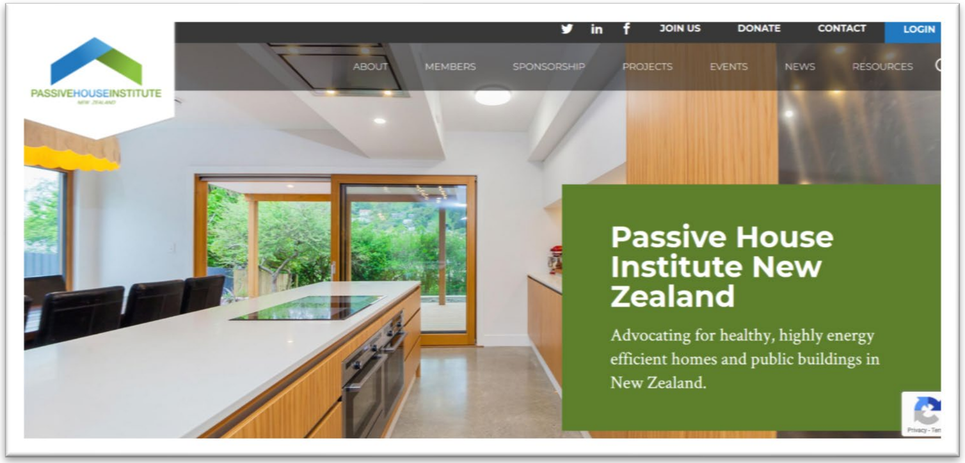
9% reduction in winter peak

Winter morning 300 MW
Winter evening 500 MW

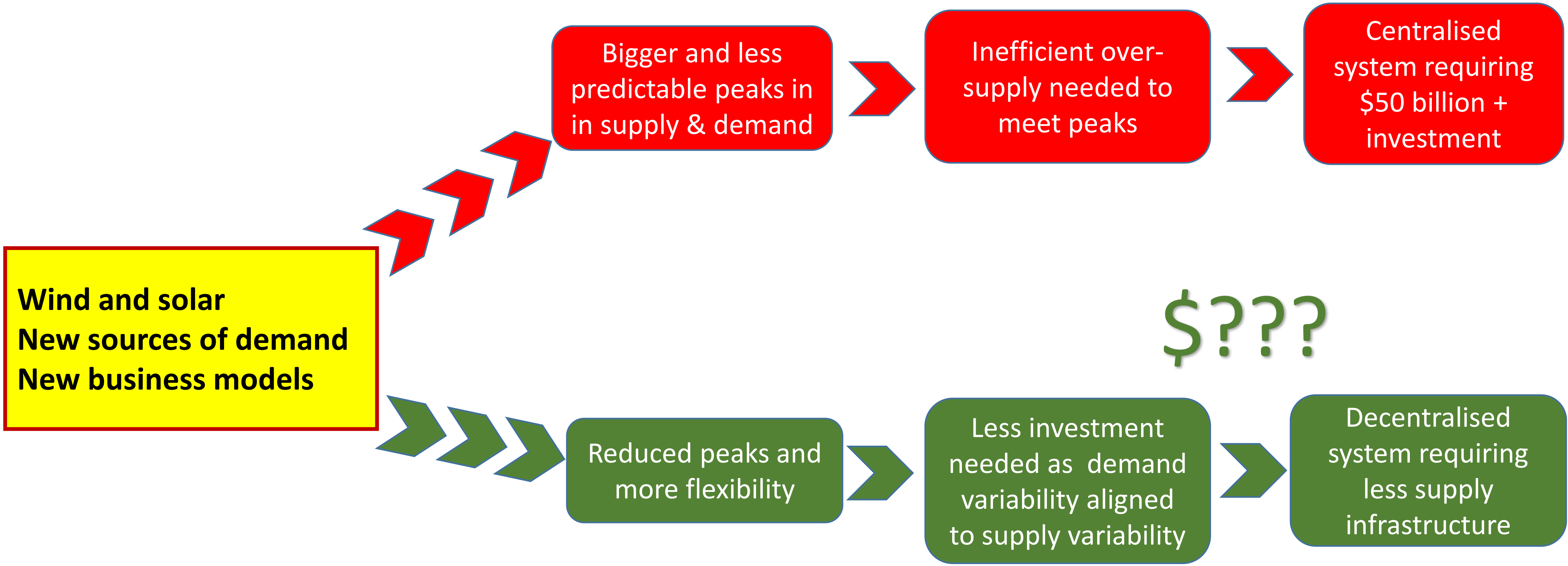
Dortans, C., Jack, M., Anderson, B., & Stephenson, J. (forthcoming). Lightening the load: quantifying the potential for energy efficient lighting to reduce peaks in electricity demand. *Energy Efficiency.*

Reducing daily and winter peaks





Time-sensitive efficiency and flexibility – a pathway to the low-carbon transition?



Summary: the growing efficiency landscape

	Reduce total consumption
Technologies	Insulation, efficient appliances, etc …

… and shifting focus from energy efficiency to carbon efficiency

energy cultures

Our main funder:

Ministry of Business, Innovation & Employment

Our co-funders:

EECA
Energy Efficiency and Conservation Authority
Te Tari Tiaki Pūngao

Ministry of Transport
TE MANATŪ WAKA

Questions?

GREEN Grid

Primary Funder

Ministry of Business, Innovation & Employment

Co-funders

TRANSPOWER

eea
Electricity Engineers' Association