



THE GRIMSBY INSTITUTE
of Further & Higher Education

An energy balance, a new way of approaching energy reduction

Stephen James

June 8th 2010

What is the purpose of the factory/ plant?

- Input
 - Raw materials (amount/temperature)
 - Packaging
- Output
 - Packaged finished product (amount/temperature)
- Purpose
 - Transform input into output in most cost effective manner

Input and Output

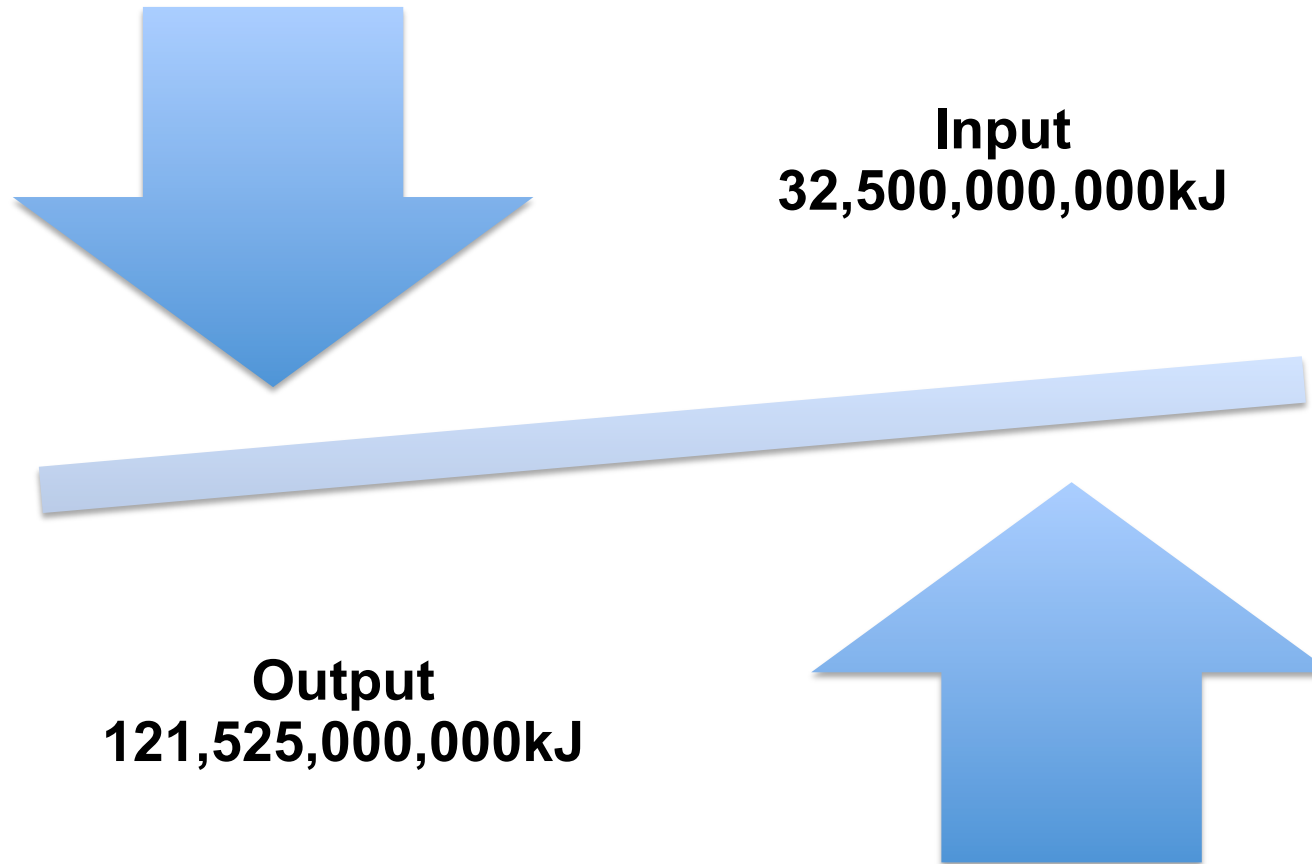
Input

- 350 tonnes at -20°C
- 125 tonnes at 0°C

Output

- 400 tonnes at 3°C
- 75 tonnes at 12°C

Heat energy in product



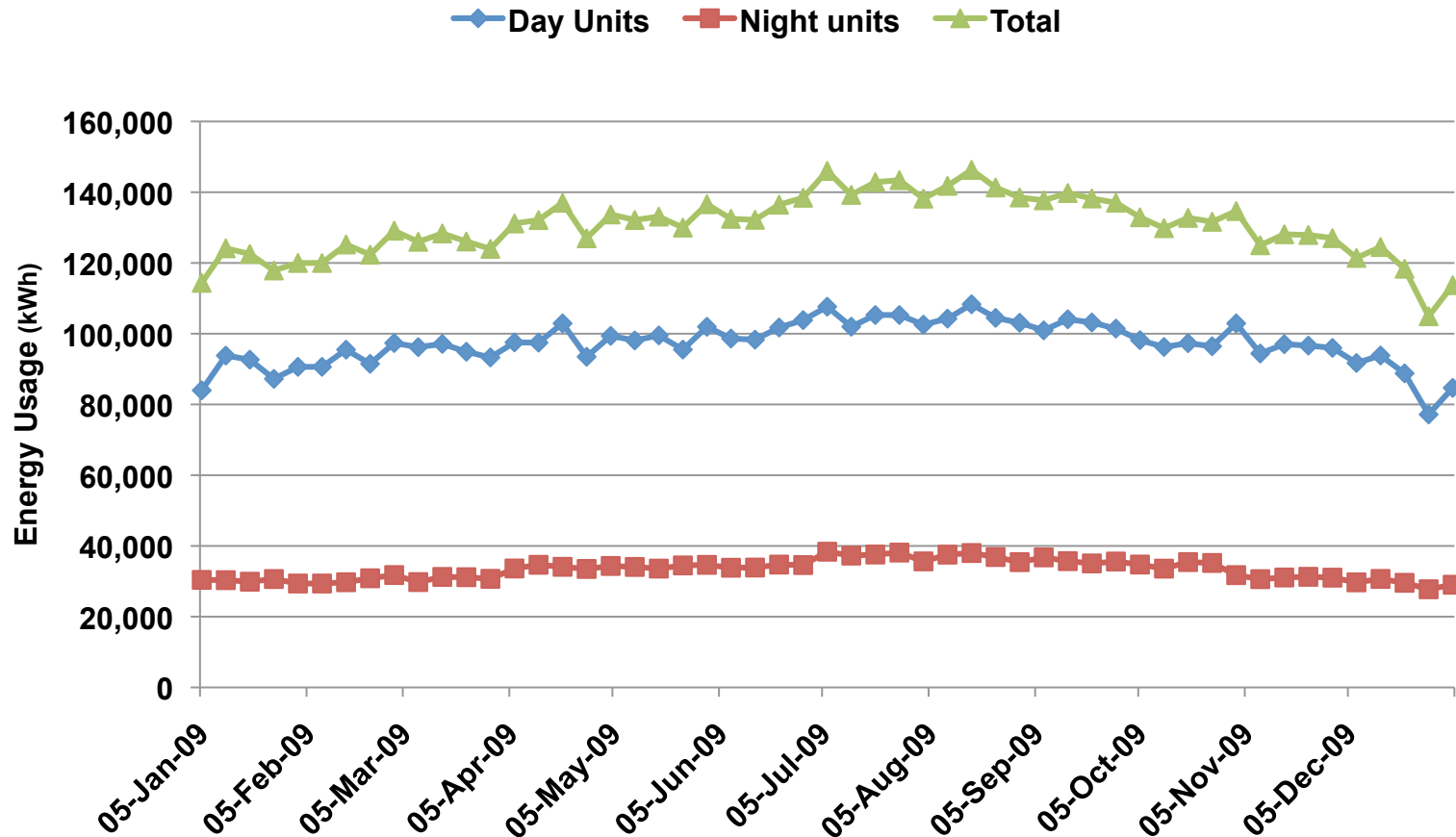
Question

Why are refrigeration systems required if the food has to gain heat?

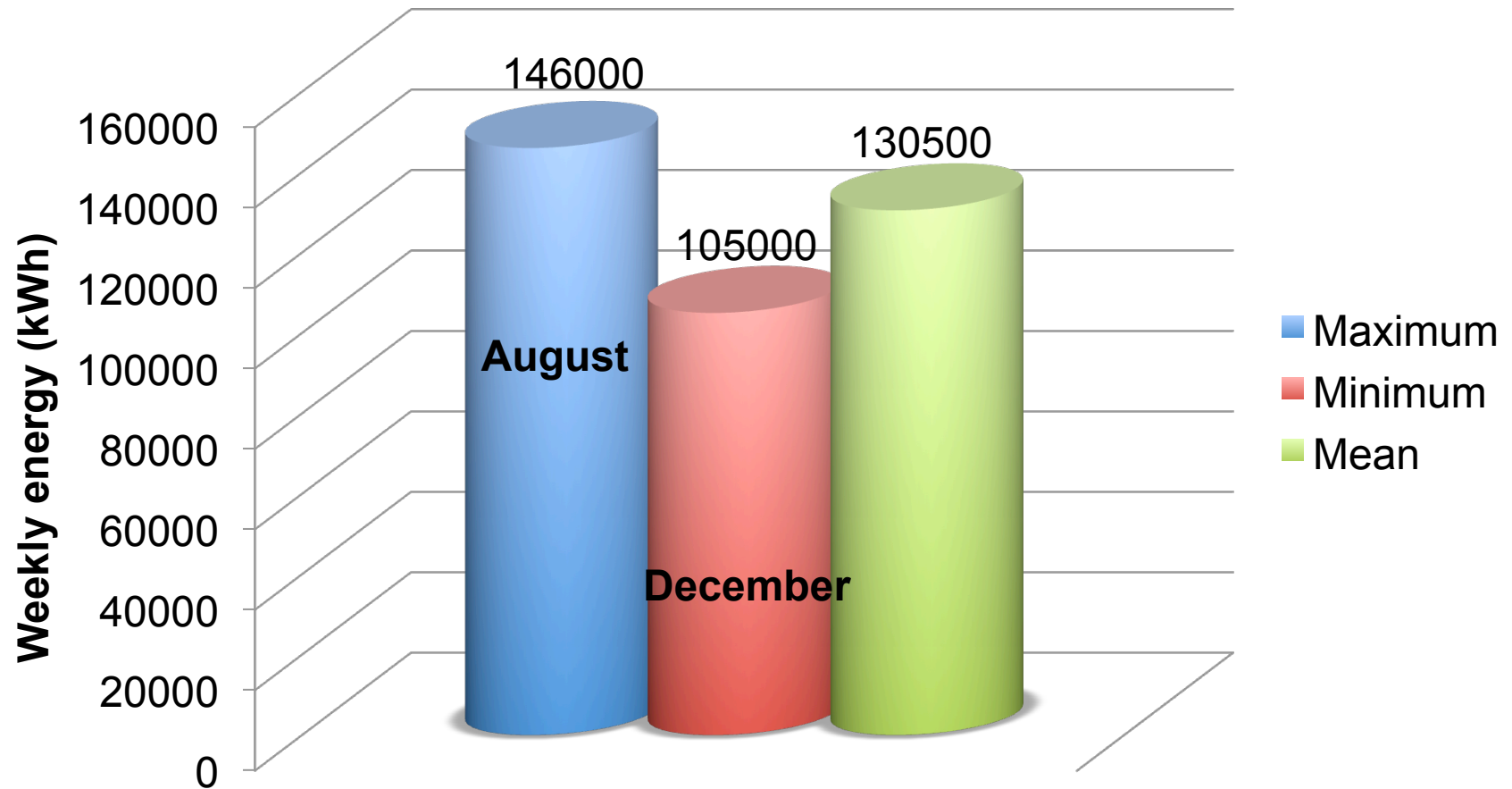
Previous an extreme example

- However, in many cases the temperature of the raw materials entering a food factory are very similar if not lower than the product produced.
- So the aim of the production processes should be to minimise any heat gain.

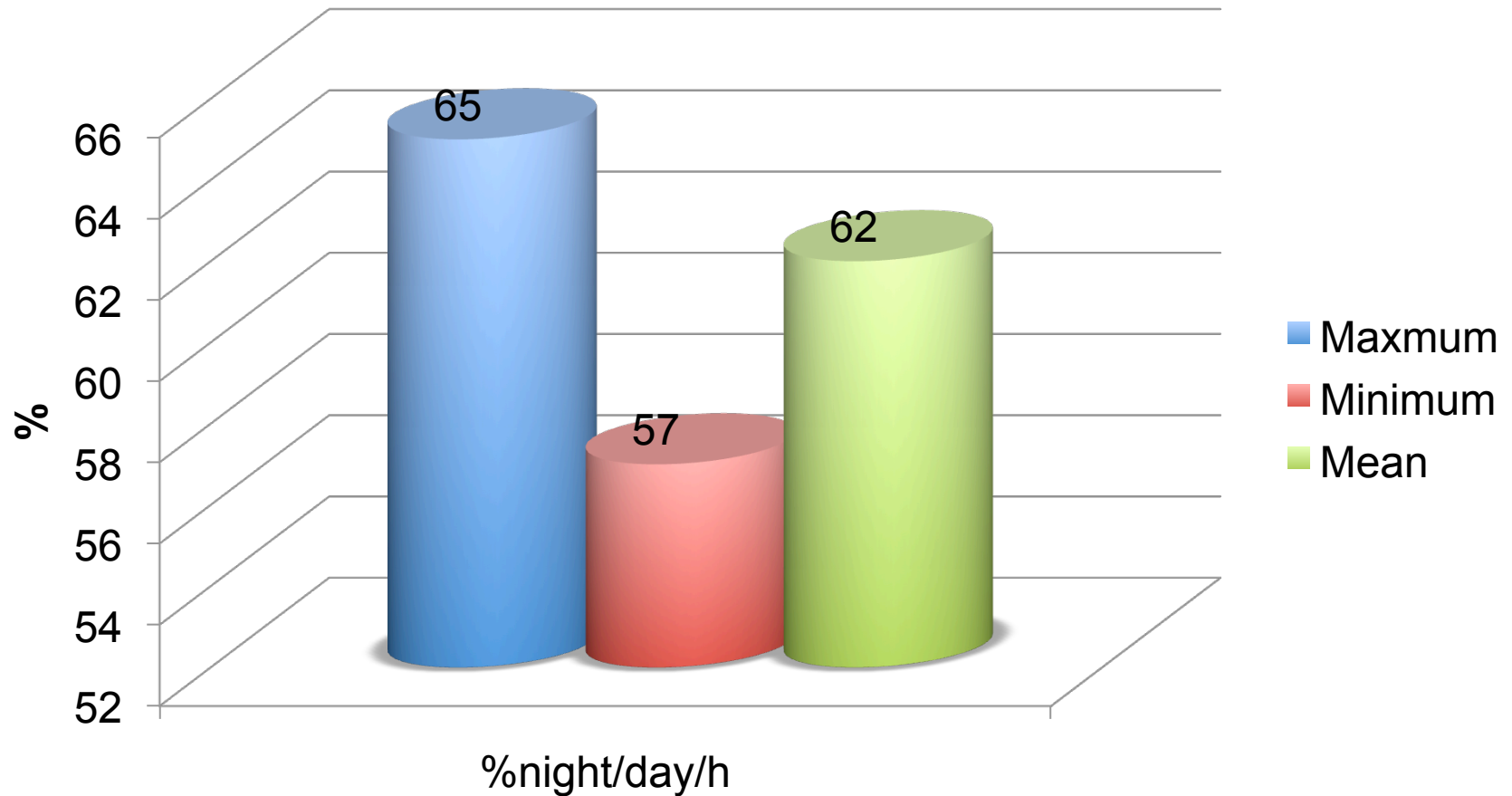
Factory electrical energy per week



Maximum, minimum and mean energy/week (kWh)



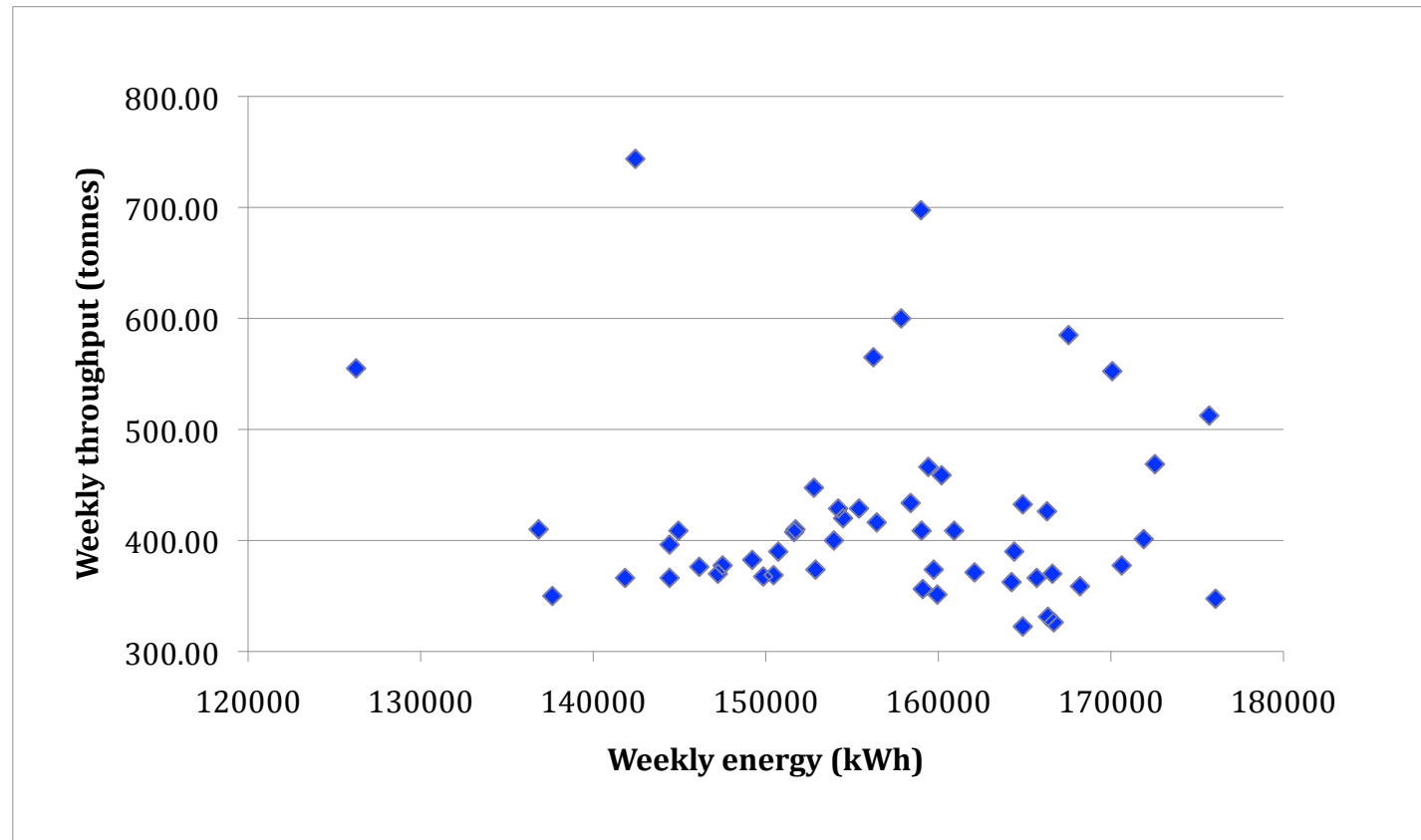
Maximum, minimum and mean night/day use



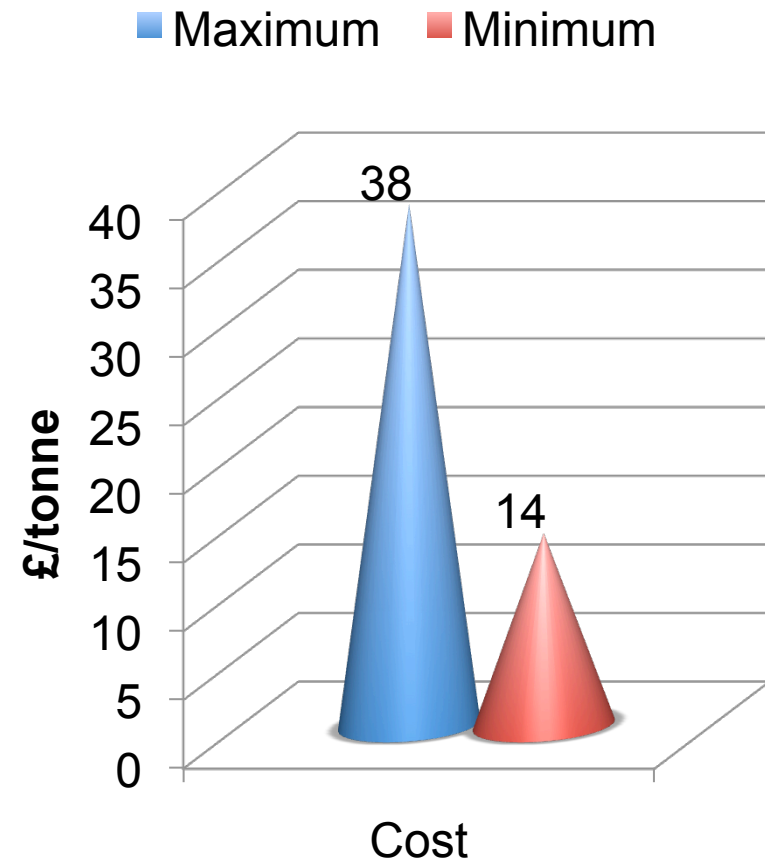
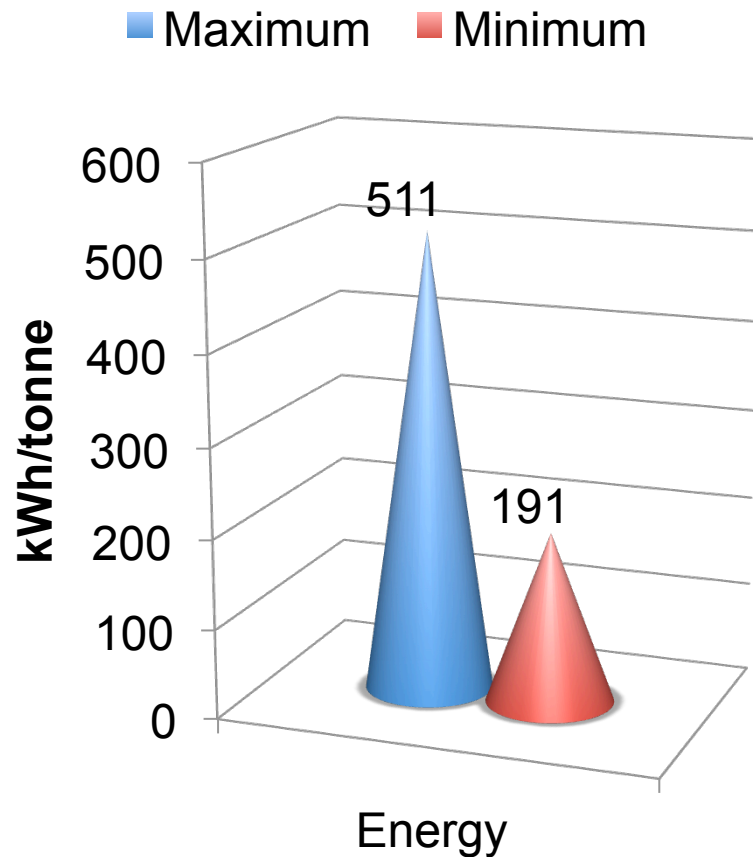
Base electrical load

- On nights in December 2009
 - Average temperature $<0^{\circ}\text{C}$
 - No production in factory
 - No door openings
- **500 kWh used every hour!**
- **Rises to over 700 kWh in August**

Throughput and energy



Energy per tonne of throughput

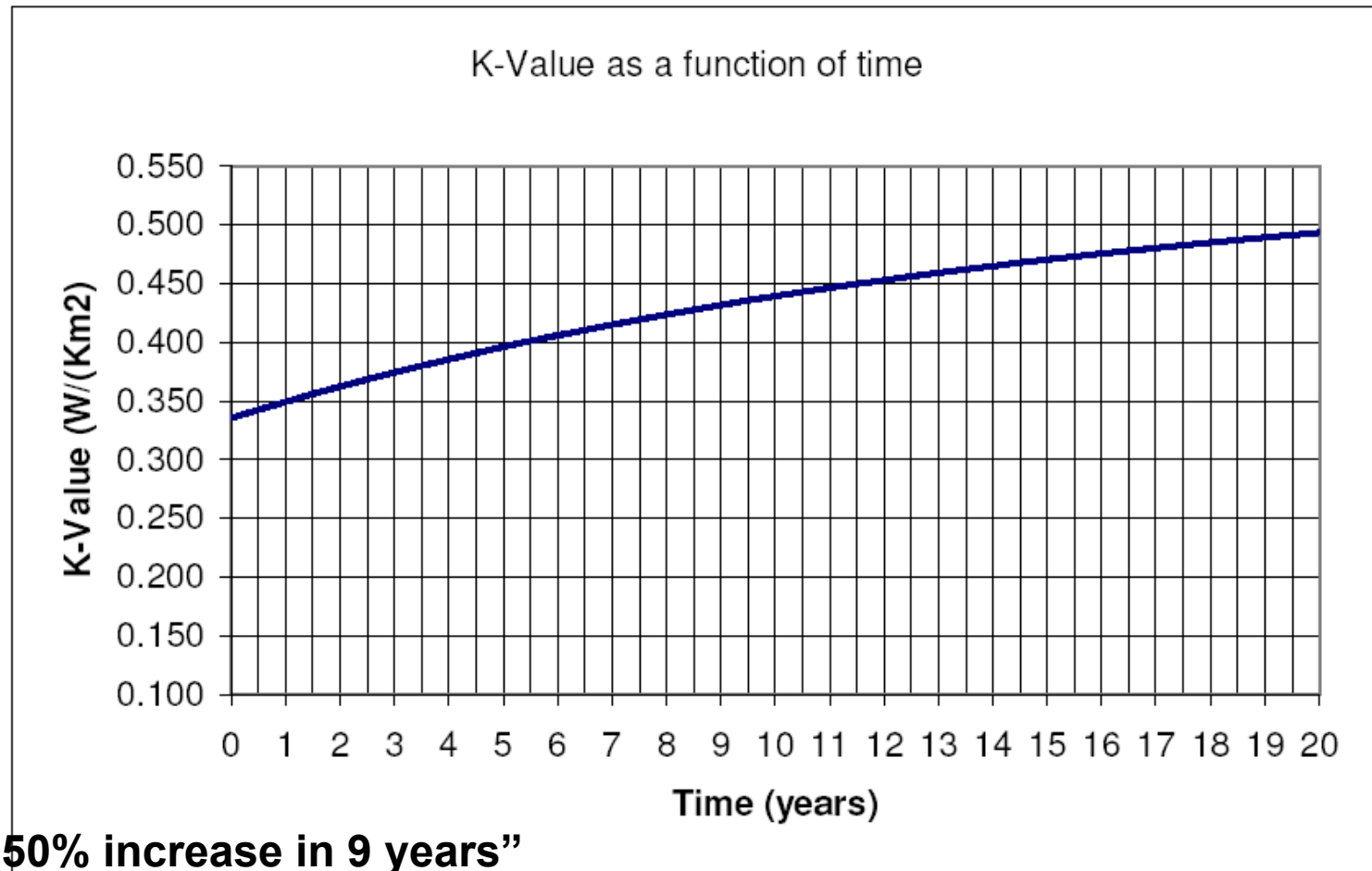


Refrigeration load on factory

- Product load – ‘Negative’

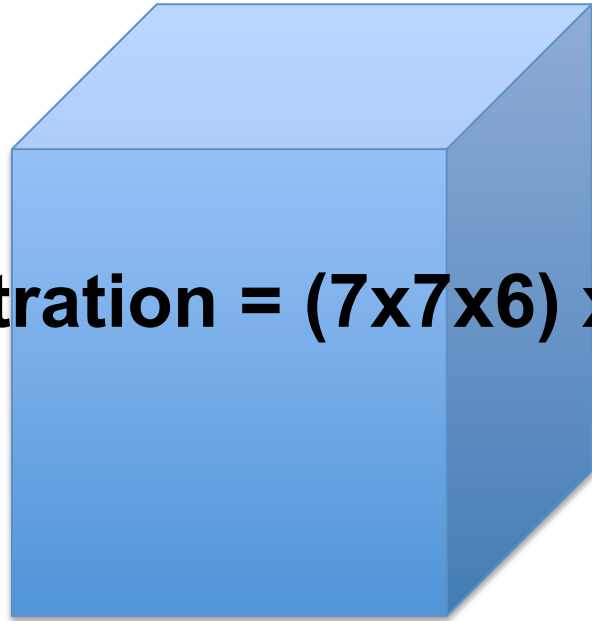
	Direct	Refrigeration	Total
• Lighting	70kW	35kW	105kW
• Fans	72kW	36kW	108kW
• Defrosts	27kW	13kW	40kW
• People	47kW	0kW	47kW
• Plant	80kW	40kW	120kW
• Infiltration	960KW to 2000KW		

Ageing of insulation



Minimum infiltration

- 300 tonnes is a 6.7 m cube



$$\text{Infiltration} = (7 \times 7 \times 6) \times 0.35 \times 30^\circ\text{C} = 3.08 \text{ kW}$$

Plant

- Do not refrigerate processing halls.
- Remove heated air from halls
- Use heat to heat office spaces if required
- Minimise exposure time of products during processing
- If still a problem with product warming only refrigerate air/surfaces in contact with food

Evaporator fans

- Minimise air distribution in any area where the temperature of the food is not being purposely changed
- Control fans using surface temperature of the food.

Lighting

- Very large developments in lighting
- 450w lighting can now be replaced by 130w
- However, food keeps its colour better in the dark!
- Do not expose the food to the lighting or the heat generated by the lighting.

Defrosts

- Minimise total use of refrigeration systems except where heat has to be removed from food
- Run coils above 0°C if possible
- Use waste heat to defrost coils
- Use large efficient coils and allow natural defrost when not in use

People

- Heat loss from a person at 0°C is twice that at 20°C
- Keep people warm and only cool the food

Conclusions

- Look at the overall energy balance on the factory
- Set up the process to minimise heat loads
- Only refrigerated when needed

The energy efficiency of an empty room is “zero”

