# New Opportunities for Energy Efficiency Innovation in Food Manufacturing

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EPSRC CENTRE FOR INNOVATIVE MANUFACTURING IN Food

# Research Questions: Is there unused potential for energy efficiency innovation in food manufacturing? If so, how could it be realised?

## Stage 1: Review

### Well-known available technologies being implemented

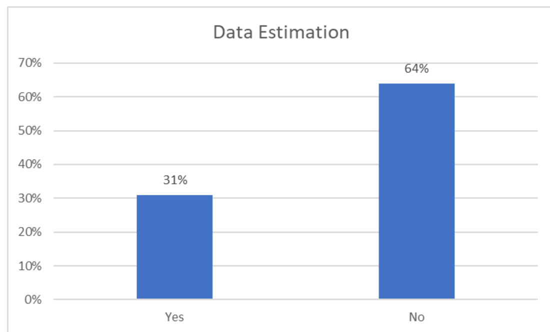
*For example:*

- Condensate return
- Boiler load management
- Waste heat recovery
- Minimise idle time
- Eliminate compressed air leaks
- Install variable speed drives

### Absence of data at machine & process levels - due to cost & awareness barriers

Unique analysis of ESOS responses by F&D manufacturers:

**ESOS Question**: Did you have to estimate any of the data to calculate your total energy consumption … (i.e. you didn't have 12 months actual data for all supplies)?




### Well-known radical technologies

*For example:*

- High pressure processing
- Pulsed electric field
- Ultrasound
- Microwave
- Heat pumps with heat exchangers
- Liquid air

Probably <30% of large UK F&D manufacturers have energy targets or benchmarks

## Stage 2: Solutions Potential

### ① How much energy savings potential lies in machine design & quality innovation?

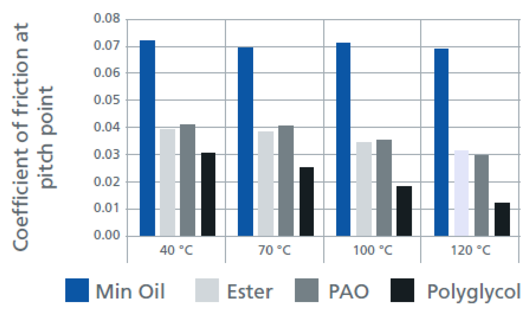
- Geometries of machine components
- Materials densities of moving machine components
- Suitability of machine components related to functions (particularly type of motors)
- Surface energy & lubrication of machine components
- Efficiency of machine-embedded power & heat conversions
- Heat losses & recovery
- Process agents
- Process sequencing
- Throughput
- Ingredient & product properties
- Power supply, motors & power factor
- Machine components
- Installation
- Operation

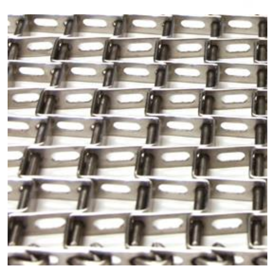
### Examples

Hybrid tunnel ovens: convection + infrared => 28% reduction over convection only

Steam peeling: changed geometry and faster heat transfer system => 25% reduction

Lubes: Synthetic oils 1-30% savings on various food machinery compared to mineral oils



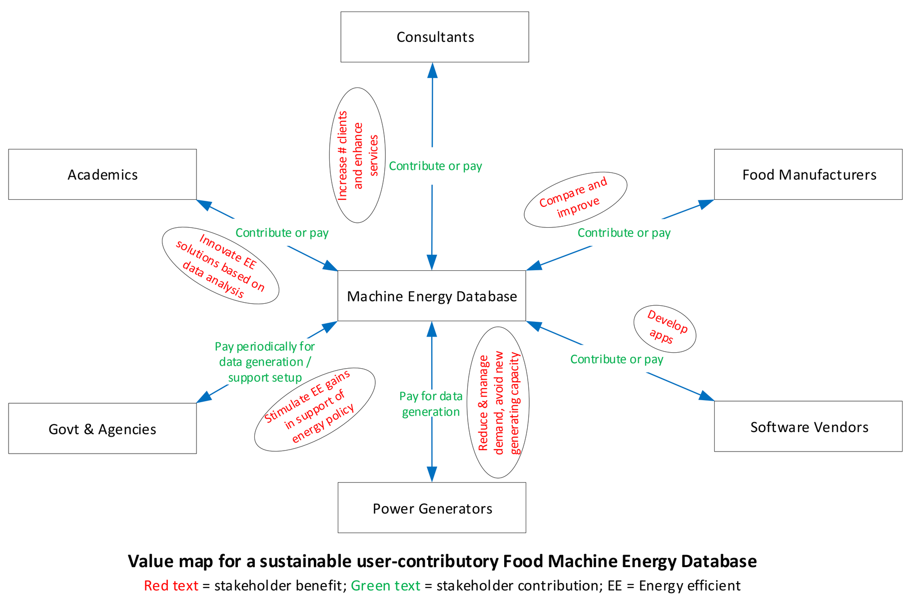
Flatwire conveyor: 30-50% stronger than a standard flatwire belt and weighs 10% less than its predecessor

Industrial Drive: AC-AC matrix design => >90% total harmonic distortion reduction, near unity PF and power regeneration direct to the line

CONTROL ENGINEERING 2016 ENGINEERS' CHOICE AWARDS

### How could the innovation potential be realised and/or accelerated?

Self-sustaining comparative machine-level database to support the power of peer benchmarking in industry – a cycle of data acquisition, visibility and innovation



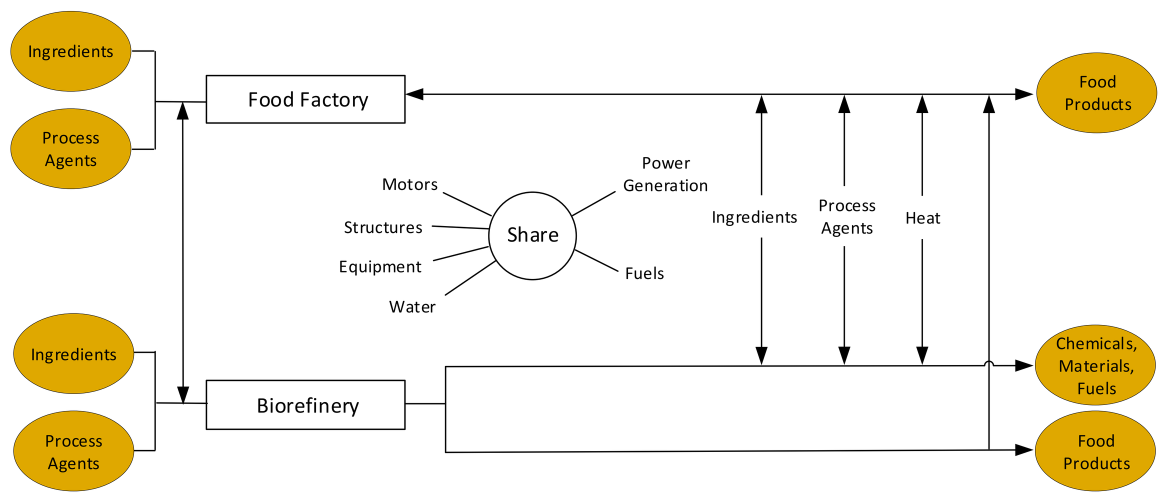

| Company | MWh |
|---|---|
| A | 20 |
| B | 30 |
| C | 40 |
| **You** | **50** |
| E | 60 |
| F | 70 |



### ② How much energy savings potential lies in Industrial Symbiosis?

**Hypothesis**

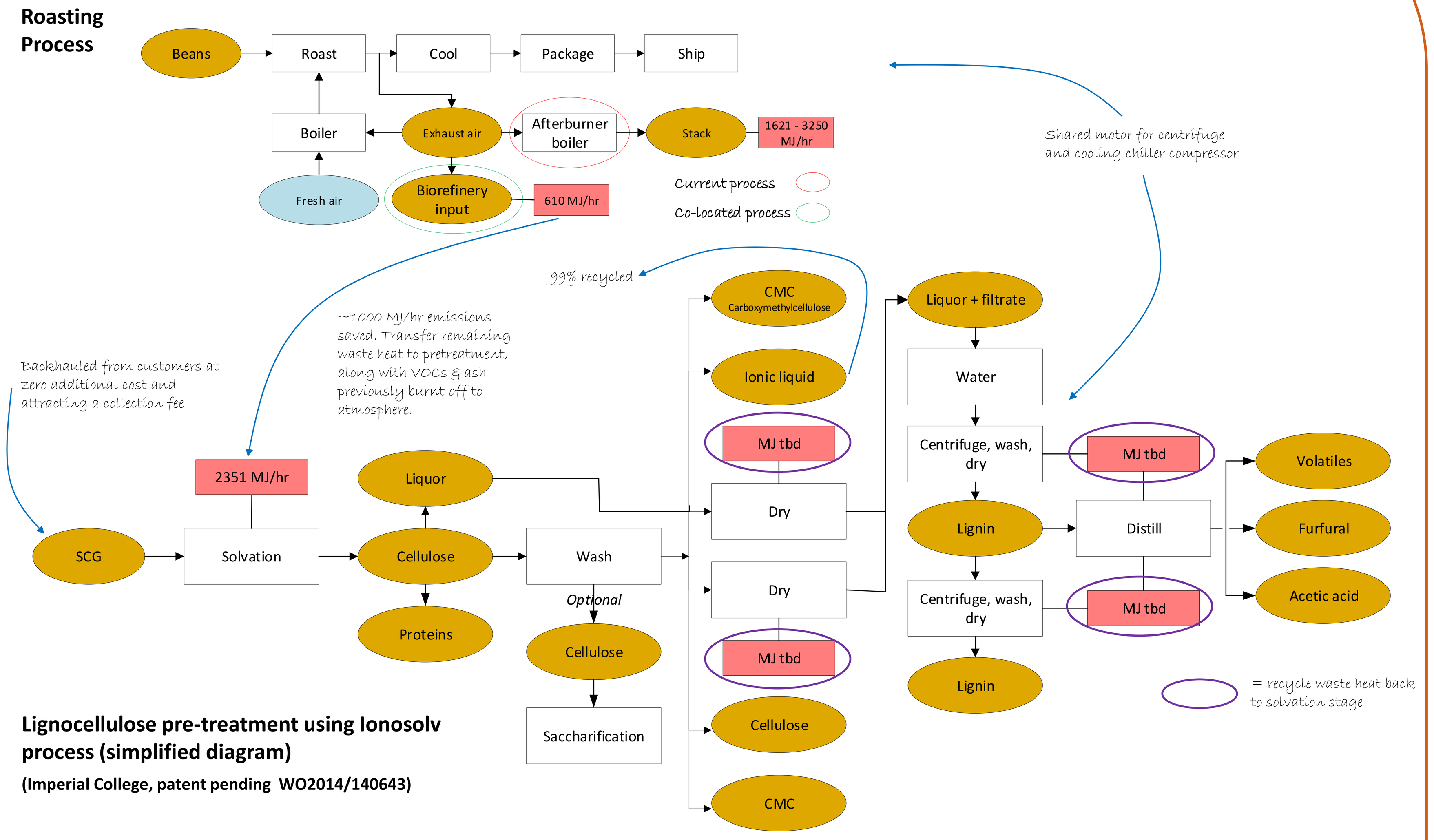
The thermodynamic and physical synergies between food manufacturing and fractional biorefining of lignocellulosic materials which does not prioritise biofuel production, together with the value of their outputs, make co-location of facilities commercially and environmentally attractive.




**Method**

1. Model 1-3 processes as proof of concept
2. Initiate larger project to systematically model further food-biorefining combinations using data acquired from the field
3. Make available to the food and biorefining industries as business cases for co-investment

### Proof of Concept Case Study: Coffee Roasting and Spent Coffee Grounds




**Notes**

**1. Biorefinery pre-treatment - economics estimates**

| Item | Value ($k/yr), rounded |
|---|---|
| Operating costs | 473 |
| Revenues | 940 |
| Profit | 467 |

**2. On-site combined heat & power**
Viability significantly enhanced by co-location.

**3. Food products**
Protein, furfural and acetic acid outputs could be used in additional food products manufactured on the site.

**4. Water**
Water sharing n/a in this example, but in other cases would apply. Also shared water infrastructure.

**5. Other biorefinery processes**
Only half the biorefinery potential has been modelled. The production of chemical building blocks and then products from these is likely to be more profitable and yield further synergies.

Further research would produce a comprehensive league table of co-location opportunities for the benefit of both industries and the industrial sustainability of cleaner modern societies..

### ③ Next steps

1. Test the identified energy saving potentials in dedicated projects. 2. Research vacuum insulation panels for oven insulation. 3. Explore the savings potential of machinery-based Energy as a Service in food manufacturing.

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