‘Total Energy’ –
Energy efficient food chilling and freezing plant

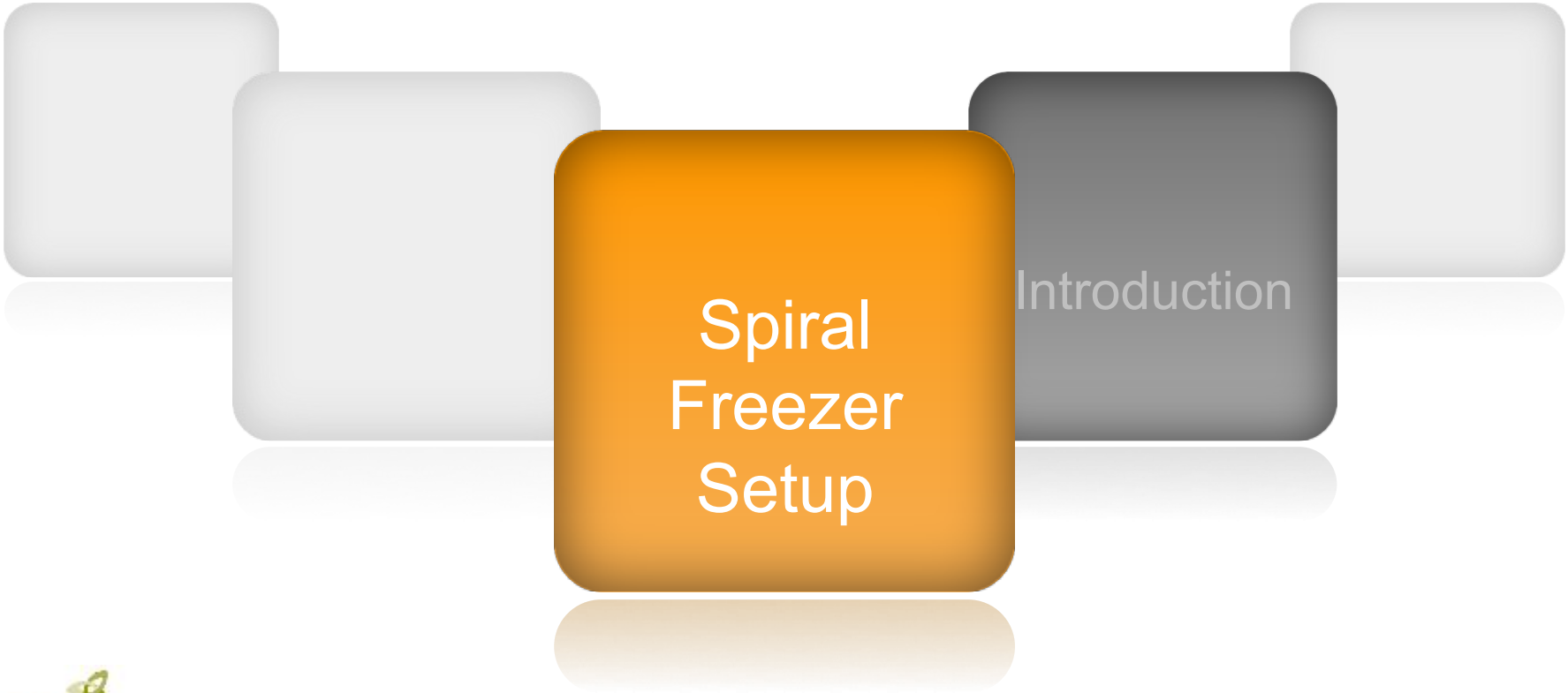
David Pearson
Director of Innovation
Star Refrigeration

2004-2008
Director

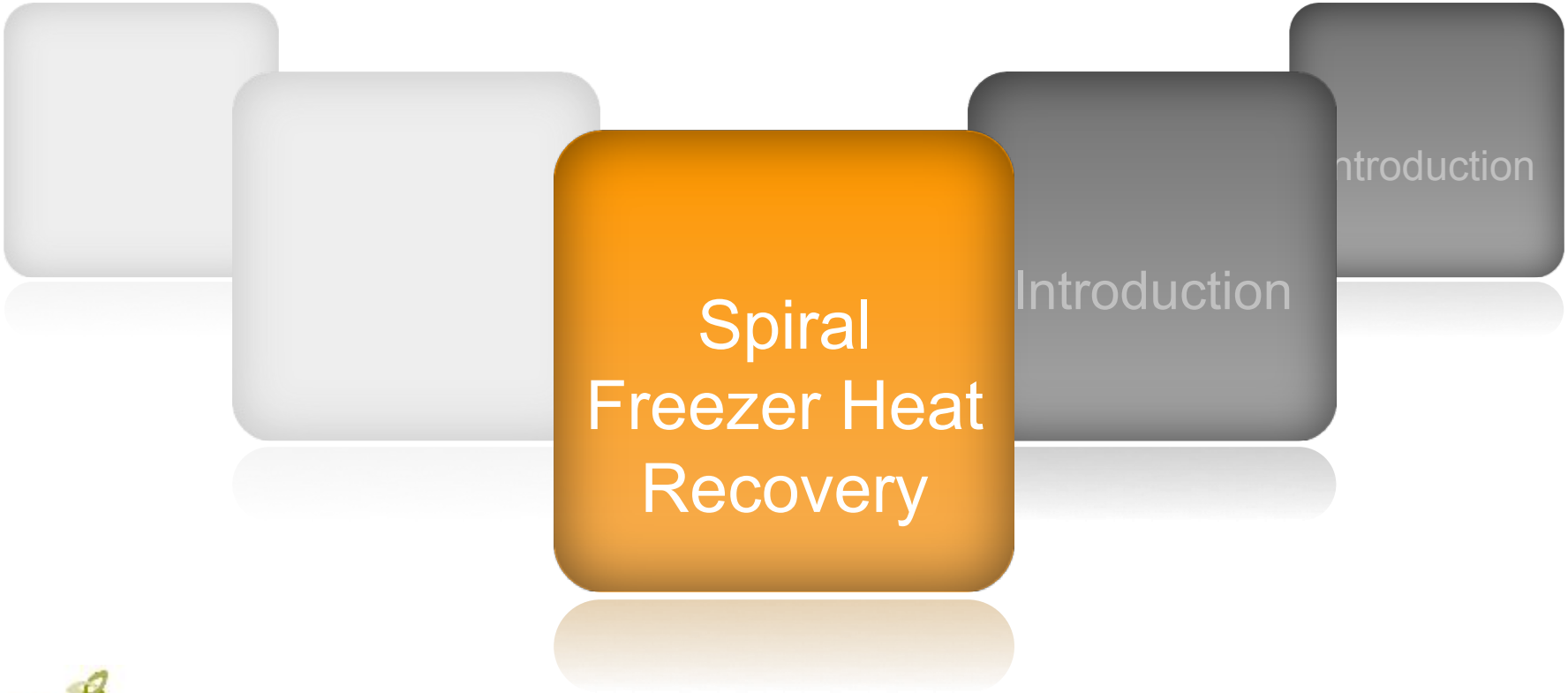
£/Kg

Introduction

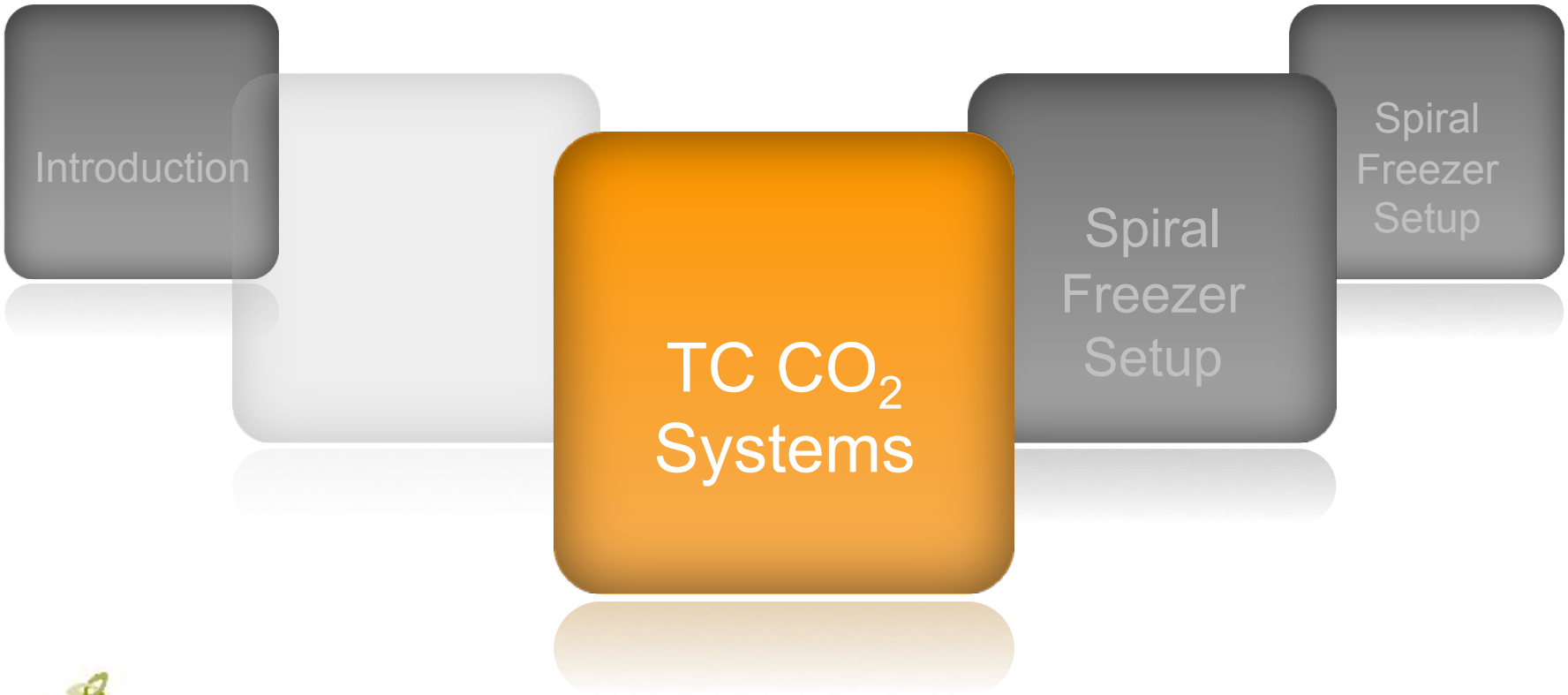
£/Kg



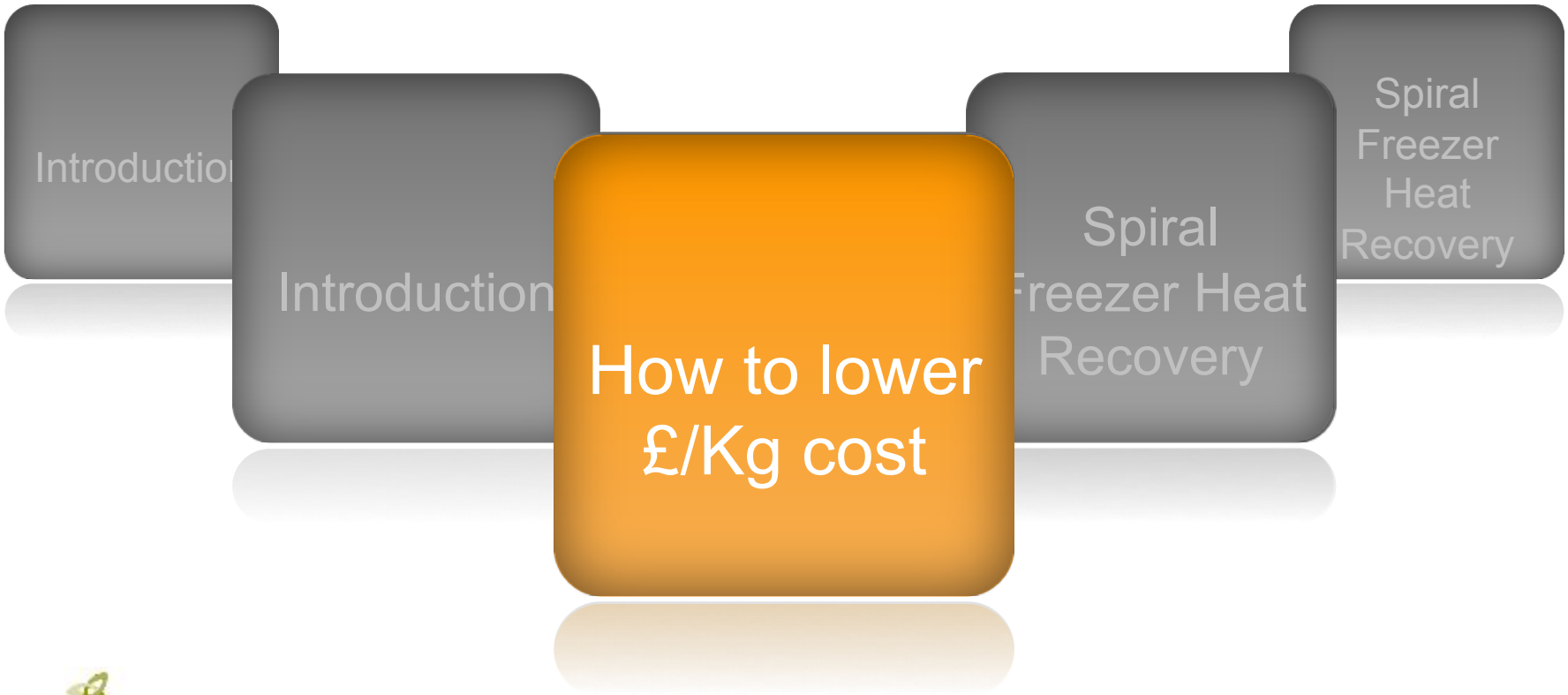
£/Kg



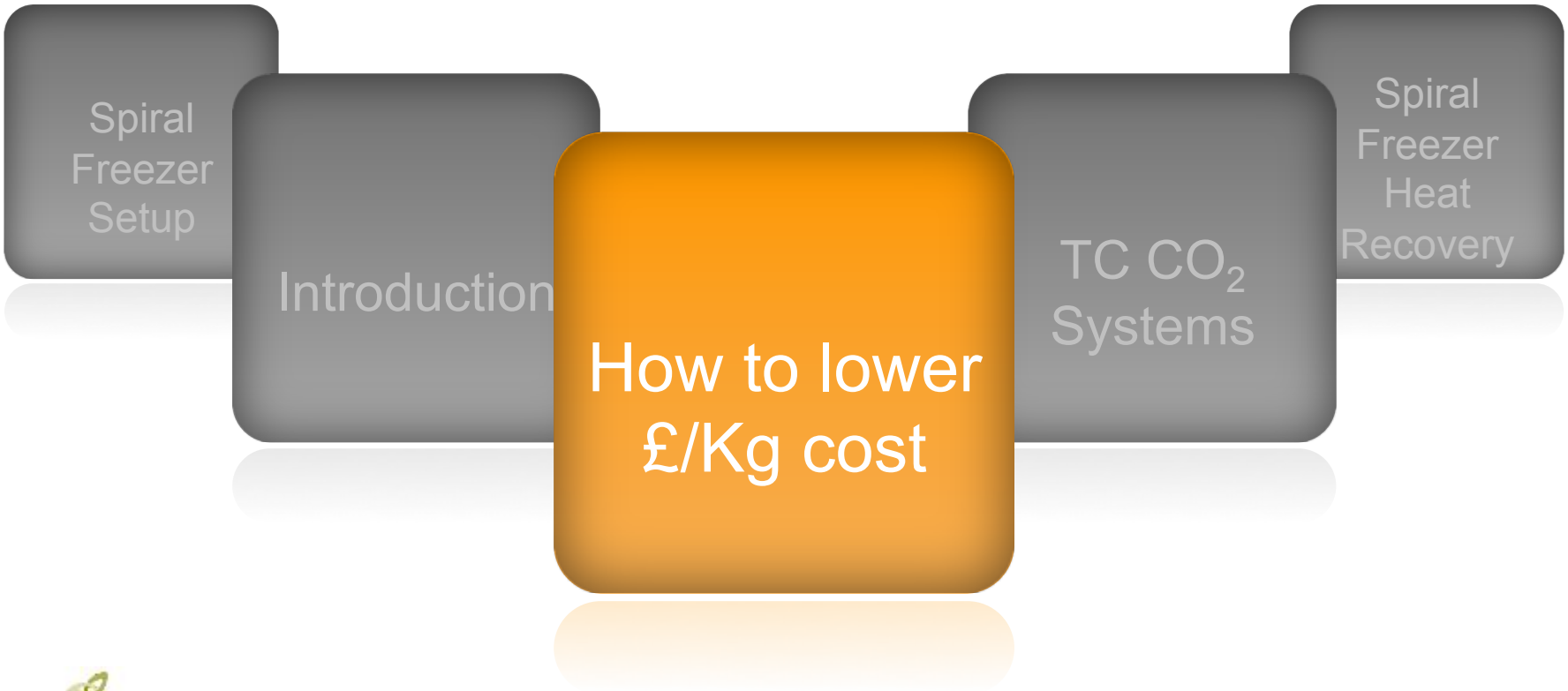
£/Kg


Introduction
TC CO_2 Systems
Spiral Freezer Setup
Spiral Freezer Setup

£/Kg


Introductio
Introduction
How to lower £/Kg cost
Spiral Freezer Heat Recovery
Spiral Freezer Heat Recovery

£/Kg


Spiral Freezer Setup
Introduction
How to lower £/Kg cost
TC CO_2 Systems
Spiral Freezer Heat Recovery

£/Kg
Introduction
Spiral
Freezer
Setup
How to lower
£/Kg cost
Introduction
How to lower
/Kg co
TC CO_2
Systems
Spiral
Freezer Heat
Recovery
Spiral
Freezer
Setup
Spiral
Freezer
Heat
Recovery
TC CO_2
Systems

Introduction

How to lower £/Kg cost

£/Kg

Spiral Freezer Setup

TC CO_2 Systems

Spiral Freezer Heat Recovery

Introduction

‘Total Energy’ –

Energy efficient food chilling and freezing plant

- **Most large scale food production passes through a spiral or tunnel freezer**
- **Most processes first heat then cool the product**
- **Most factories do not conserve extracted heat**
- **Most factories complain of high energy costs and low margins**

Spiral Freezer Setup

For spiral freezer read, chiller, tunnel, blast……

1. **Know the effect of temperature and air velocity on retention time and base load power e.g. fans**
2. **Know the effect of belt and rack loading on air velocity (and hence retention time) and absorbed power**
3. **Know the effect of air direction on retention time and other losses such as moisture**
4. **Know the effect of frost build-up on coils**
5. **Know the cost of defrost (lost production, energy, services, lead-in-time etc)**

<u>Beware of robbing Peter to pay Paul!</u>

Spiral Freezer Setup - Examples

Spiral A: **Open trays of Mash potato** **Capacity = 1000Kg/hr** **Vertical Air Down** **Open Belt Air Speed =3m/s** ***Belt loading 50%*** ***Actual Belt Air Speed =6m/s*** ***Retention time = 40 mins*** **Ave. Air temp =-7C** **Absorbed Fan Power = 36kW** **Absorbed Comp. P = 40kW** **Run duration = 5*16hrs/week** **Cost per Kg = £0.0080/Kg** **Production per week =80T** **Cost per week = £608**	**Spiral A:** **Open trays of Mash potato** **Capacity = 1000Kg/hr** **Vertical Air Down** **Open Belt Air Speed =3m/s** ***Belt loading 40%*** ***Actual Belt Air Speed =5m/s*** ***Retention time = 32 mins*** **Ave. Air temp =-14C** **Absorbed Fan Power = 34kW** **Absorbed Comp. P = 52kW** **Run duration = 5*16hrs/week** **Cost per Kg = £0.0086/Kg** **Production per week =80T** **Cost per week = £689** **+13%**

Spiral Freezer Setup - Examples

Spiral A: **Open trays of Mash potato** **Capacity = 1000Kg/hr** **Vertical Air Down** **Open Belt Air Speed =3m/s** ***Belt loading 50%*** ***Actual Belt Air Speed =6m/s*** ***Retention time = 40 mins*** **Ave. Air temp =-7C** **Absorbed Fan Power = 36kW** **Absorbed Comp. P = 40kW** **Run duration = 5*16hrs/week** **Cost per Kg = £0.0076/Kg** **Production per week =80T** **Cost per week = £608** **Moisture loss = 4% = 3200Kg**	**Spiral A:** **Open trays of Mash potato** **Capacity = 1000Kg/hr** **Vertical Air Up** **Open Belt Air Speed =3m/s** ***Belt loading 50%*** ***Actual Belt Air Speed =6m/s*** ***Retention time = 40 mins*** **Ave. Air temp =-7.7C** **Absorbed Fan Power = 36kW** **Absorbed Comp. P = 42kW** **Run duration = 5*16hrs/week** **Cost per Kg = £0.0086/Kg** **Production per week =80T** **Cost per week = £624** **Moisture loss = 1.5% = 1200Kg**

Spiral Freezer Heat Recovery

Spiral A:
Open trays of Mash potato

Absorbed Comp. P = 40kW
Heat of Rejection 150kW
Run duration = 5*16hrs/week

Cost of Gas (4p/kWh)= £6/hr

Spiral A:
Open trays of Mash potato

Absorbed Comp. P = 60kW
Heat of Rejection 165kW
Run duration = 5*16hrs/week

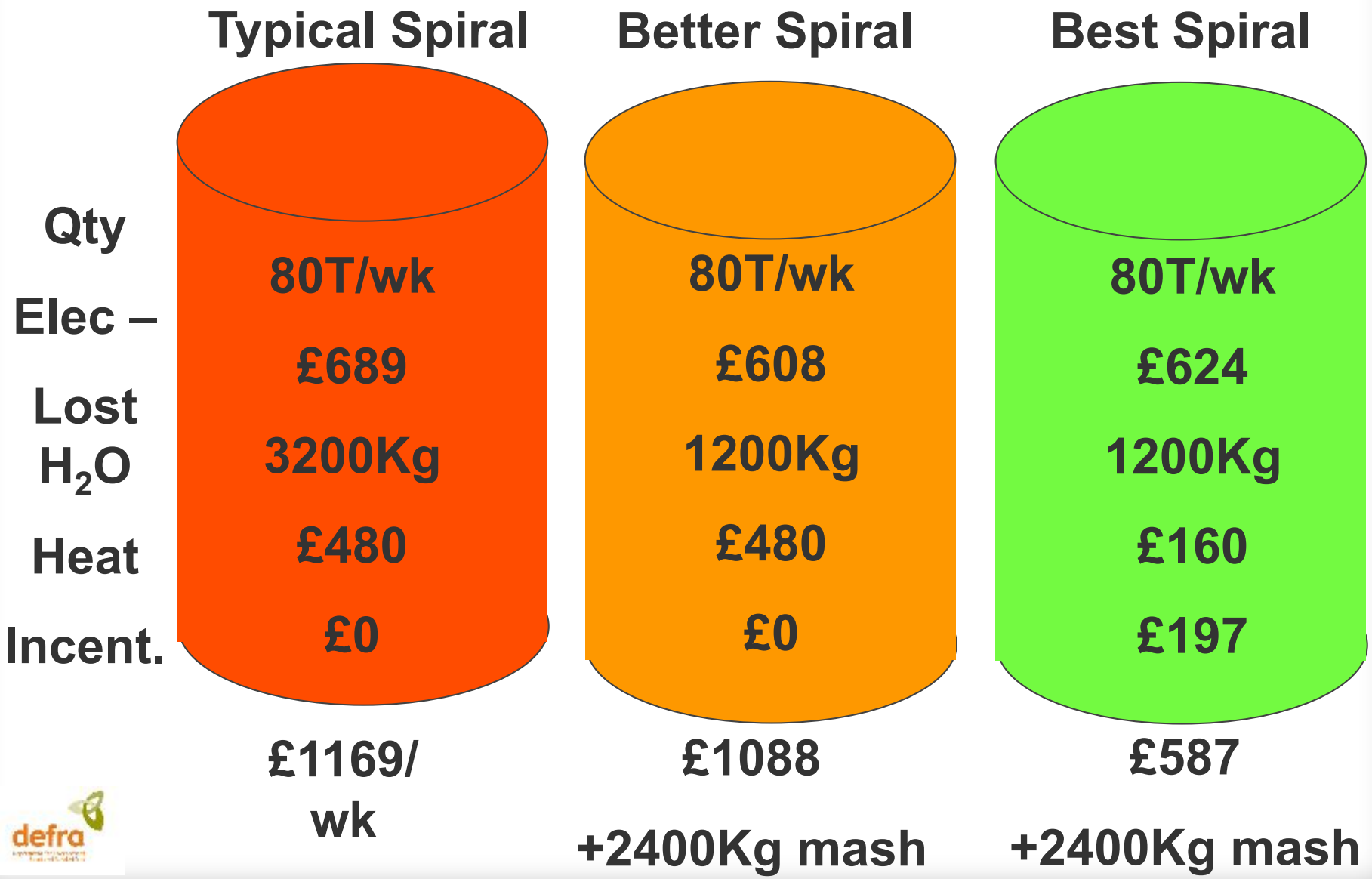
Extra Elect(10p/kWh)= £2/hr

To deliver water at 60°C

Renewable Heat Incentives of 1.5p/kWh = £2.47/hr

Net saving of £6.47/hr
= £518/wk

How to lower £/Kg cost



TC CO_2 Systems

- One to watch……

- Transcritical cycle allows water heating 15°C to 65°C
- Compressors quite small (40kW chill at 12/7°C)
- Danger that COPs are allowed to fall with zero heat recovery (zero gain)
- Very suited to sensitive areas (intolerance of R717)

• Small CO_2 Heat pump,	Typical Chiller
• 46kW Cooling 12/7°C	46kW Cooling 12/7°C
• 14kW Power	7kW Power
• 60kW Heating 15/60°C	53kW Heating 15/20°C

Parting thoughts…….

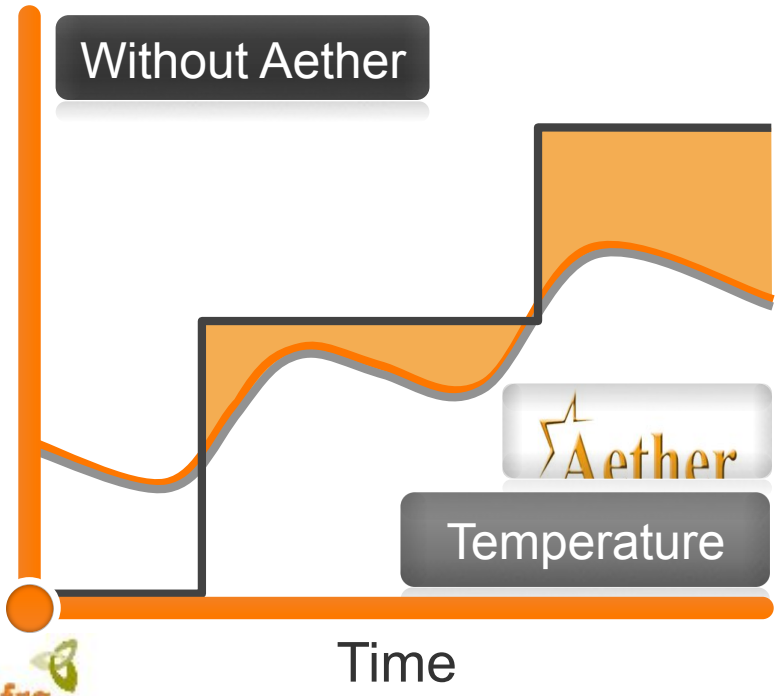
•Whether a large multi-megawatt heat pump like this……..

•Or a small CO_2 freezing system like this …….. optimise the freezing costs, remember the product value and don't forget the waste <u>heat- it is valuable stuff</u>

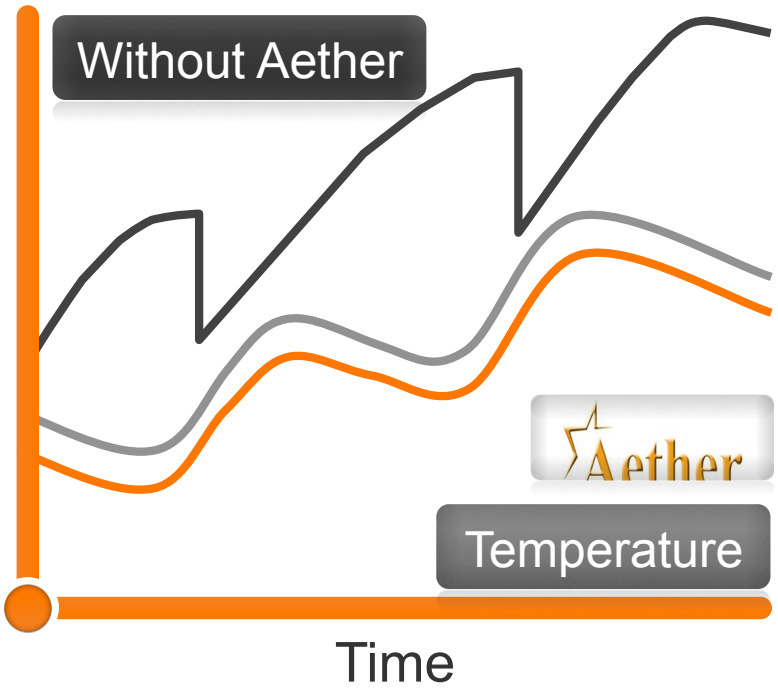
Condenser Fans

36.6kW

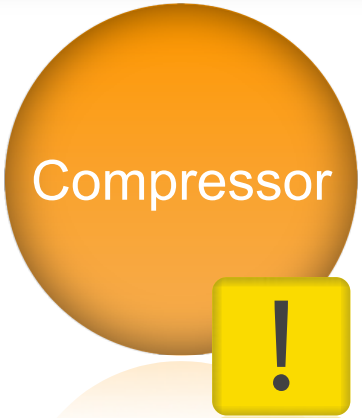
Fan speed

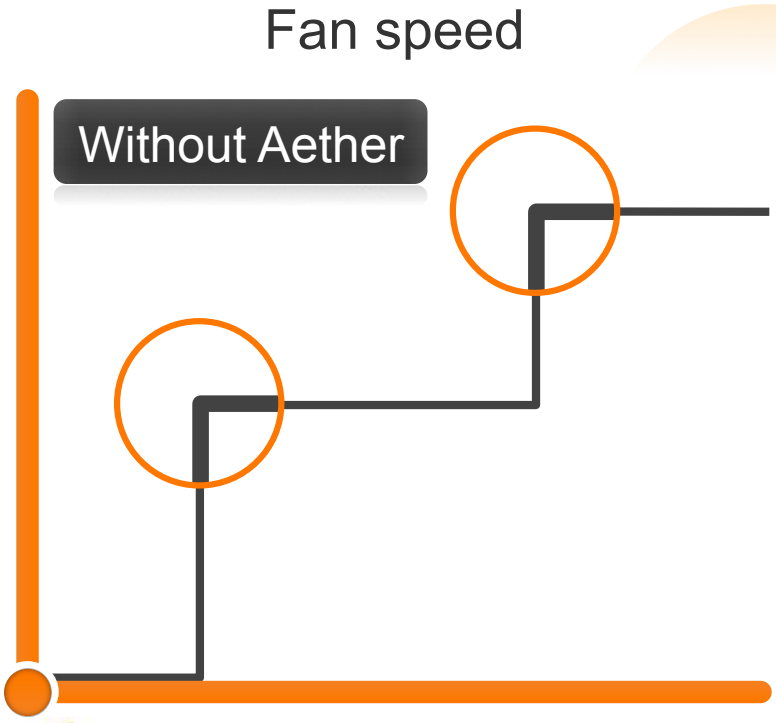


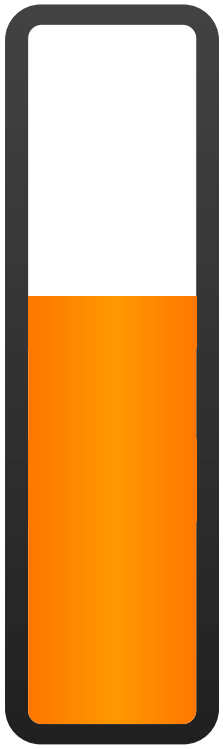
Compressor head pressure



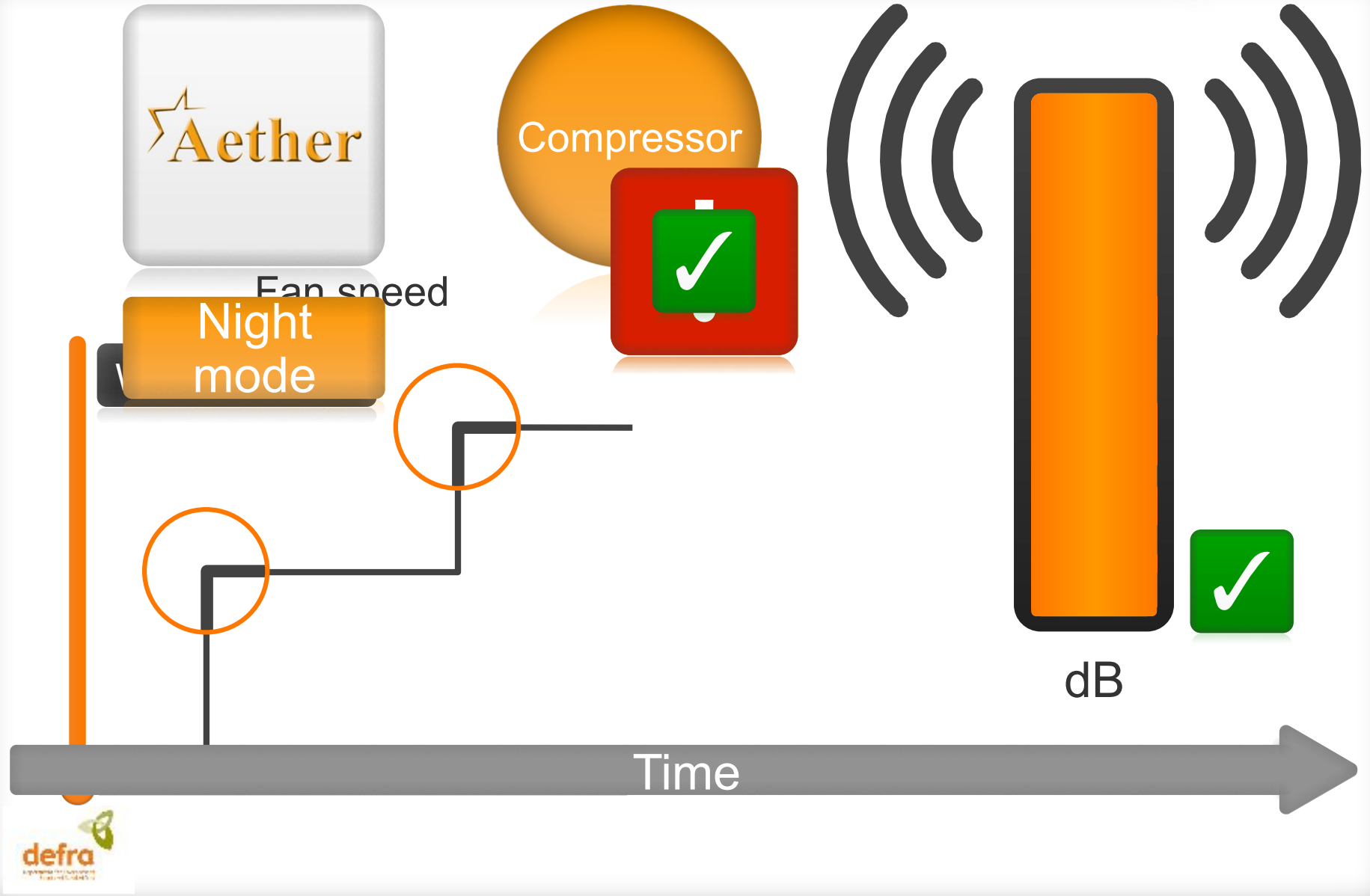
Condenser Noise



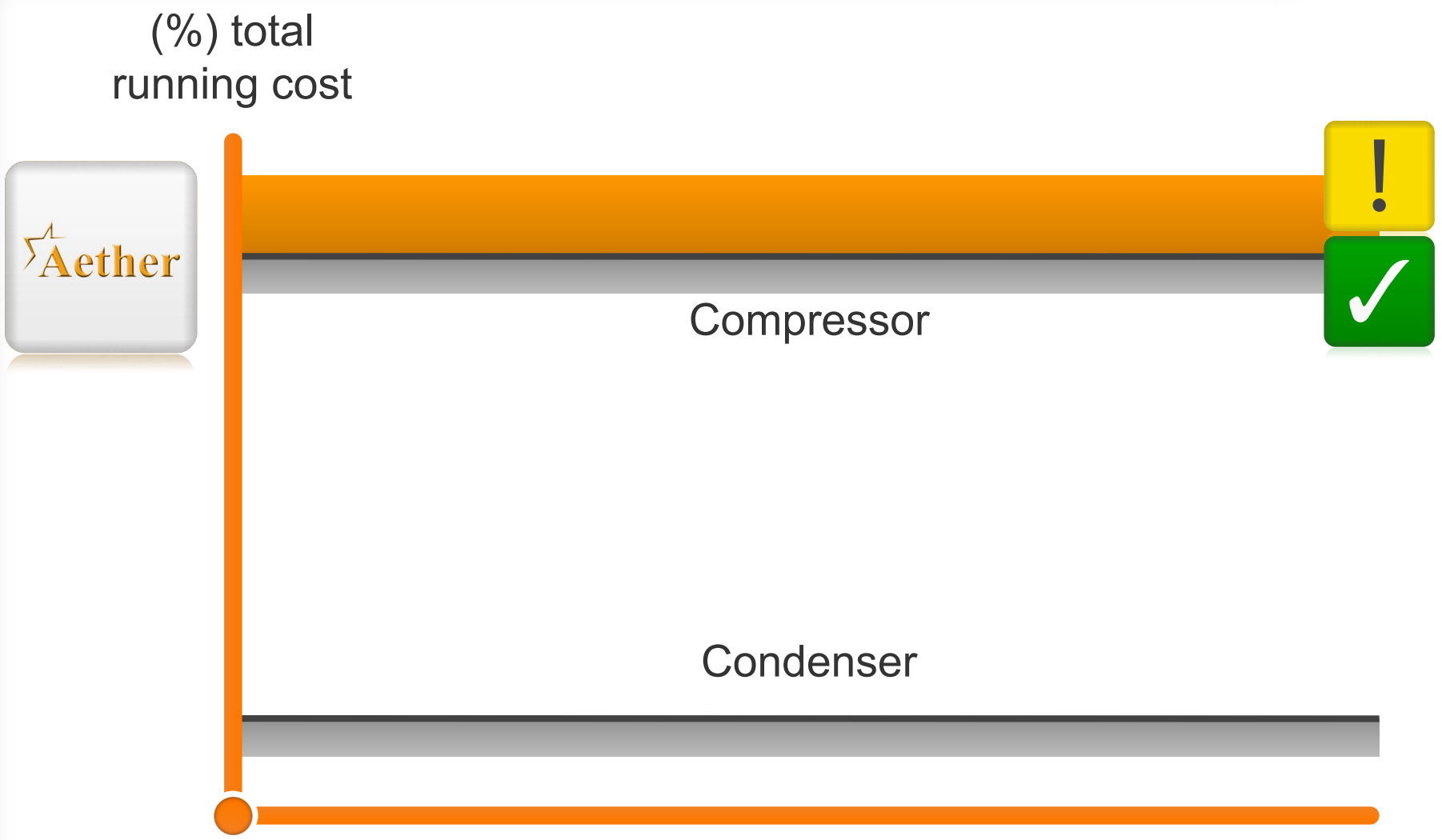




Condenser Noise



Cost of Running Plant

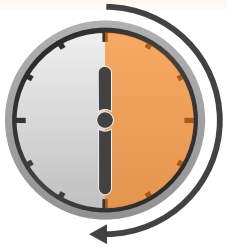


Secondary Pumps

10.6kW max

Without Aether

18.5kWhr



Aether

18.5kWhr

-7.4kWhr per hour

-64,824kWhr per year