



EPSRC Centre
for Innovative
Manufacturing in
**INDUSTRIAL
SUSTAINABILITY**



Industrial Sustainability research at IfM & Introduction to the Centre



PRESENTED TO
IfM Open Day

PRESENTED BY
SE

15/05/2012





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SUSTAINABILITY**

Purpose of presentation

- To briefly explain the topic of Industrial Sustainability
- To explain our plans
 - What we are doing
 - How we are doing it
 - Who with
- To present some early results





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SUSTAINABILITY**

Manufacturing & Efficiency

- 300% improvement in productivity since 1979
- We make more today than ever

- We believe that sustainability – environmental, social and economic – will be at the heart of our next change





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What is Industrial Sustainability?





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*“Manufacturing’s
contribution to a more
sustainable society”*



The Challenge:

- To quadruple output,
- To emit 80% less GHGs,
- To halve resource use

All by 2050

- The challenge requires new approaches and a new understanding that we term ***Industrial Sustainability***, which is nothing less than a new industrial revolution



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Case Study:

- Who is this?





TMM Europe Targets

1. Energy usage
2. Water usage
3. Volatile Organic Compounds (VOCs) released from painting operations
4. Waste to landfill
5. Degree of compliance with environmental regulations
6. Number of complaints from external (neighbourhood) parties

Actual (2001-2006)

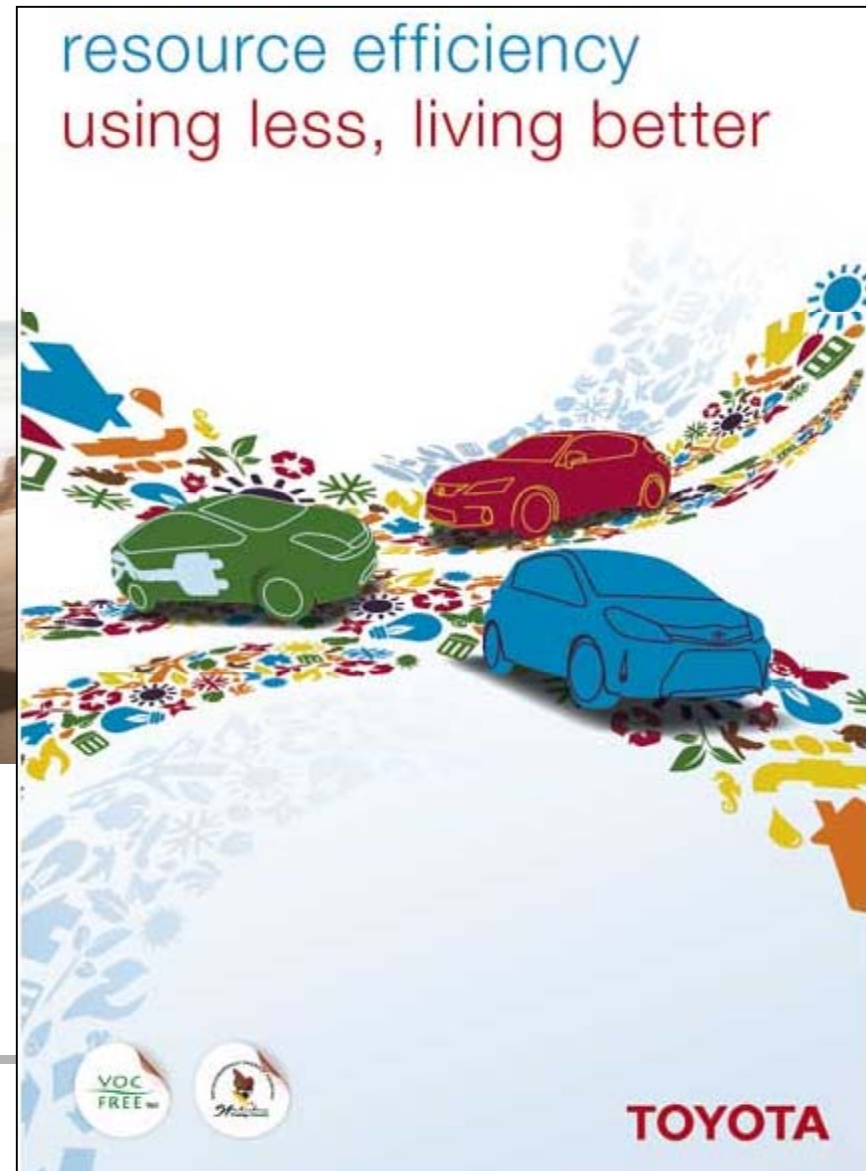
1. - 44%
2. - 37%
3. - 32%
4. - 99%
5. All plants ISO14001

Sustainability in Manufacturing

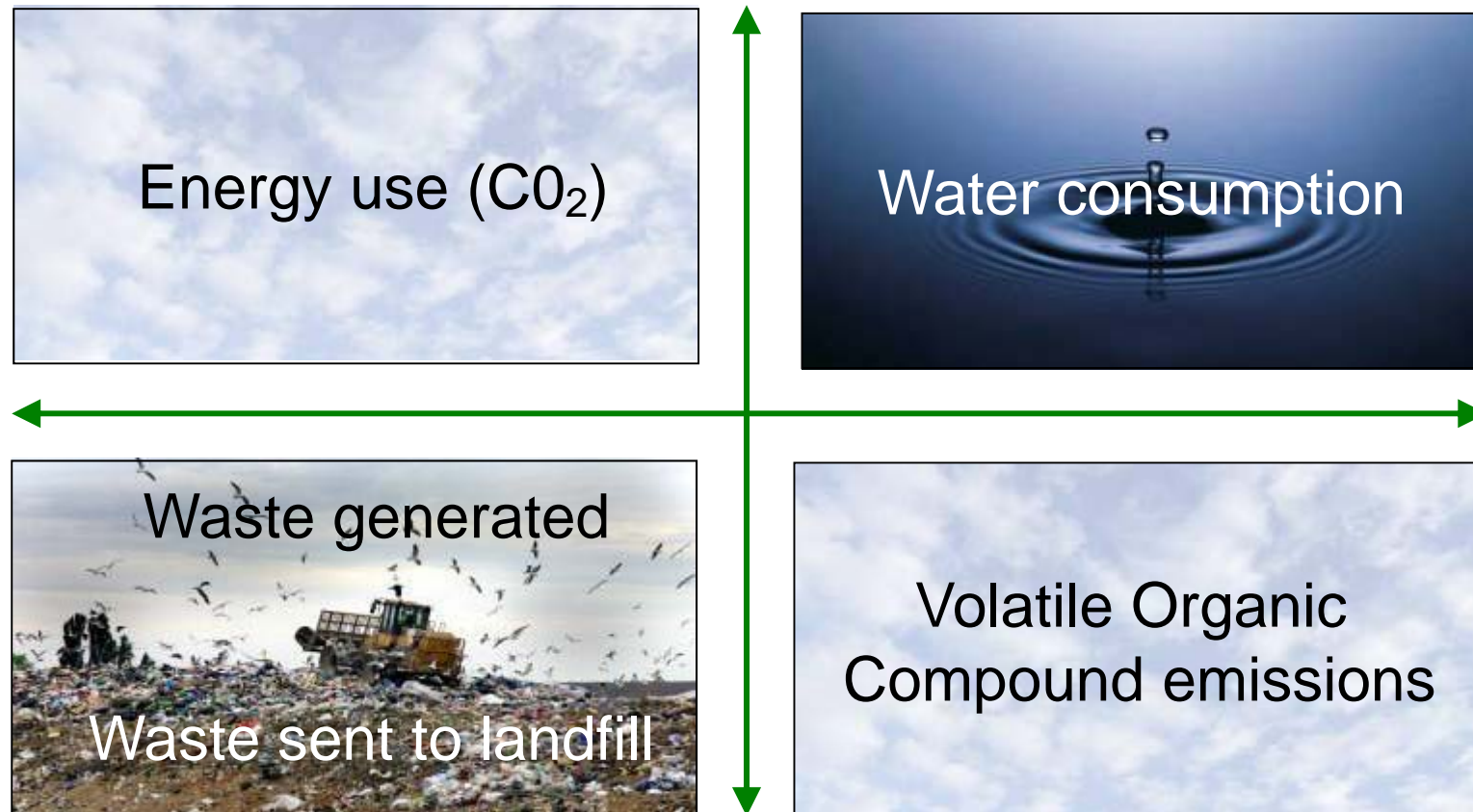
- Towards Zero Emissions



Steve Hope
General Manager
Plant Engineering and Safety
Toyota Motor Europe



Key environmental priorities

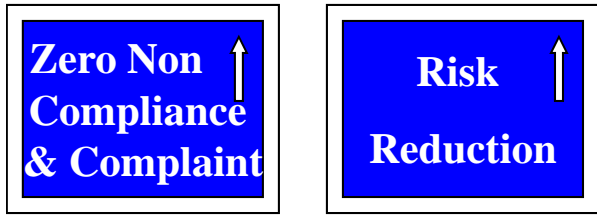
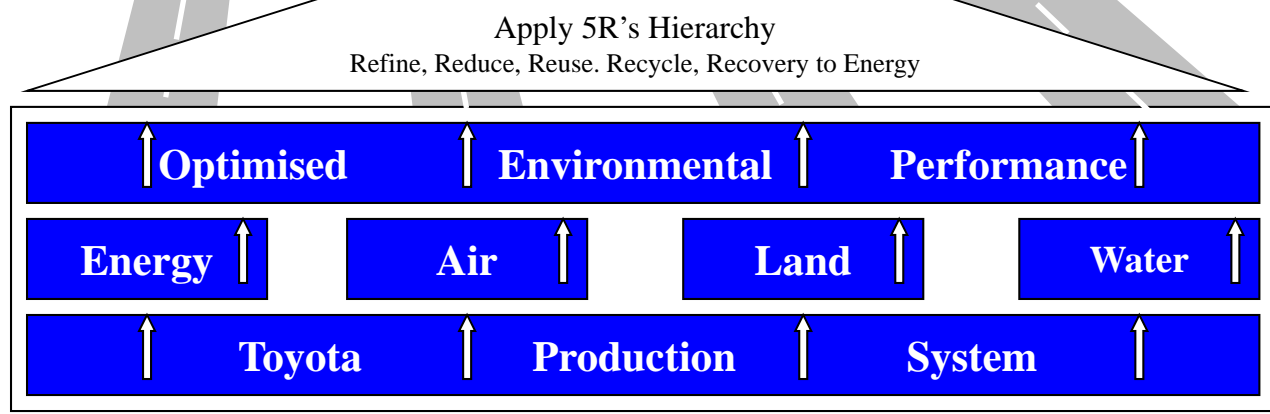
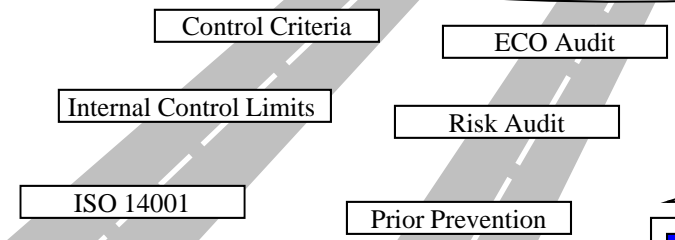
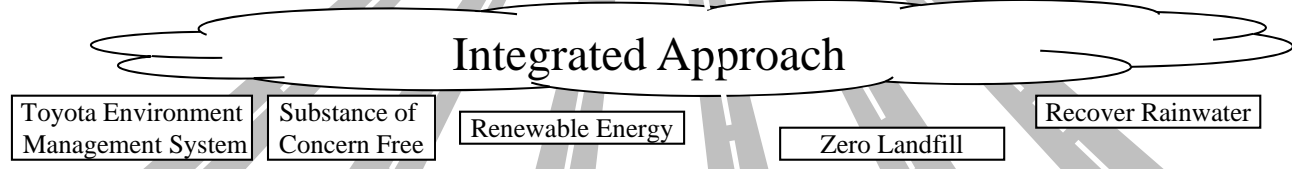
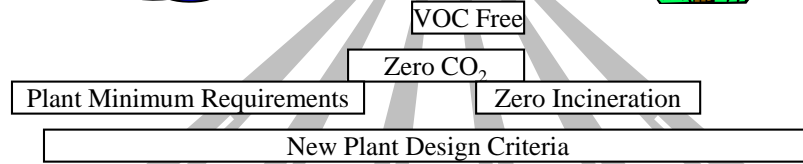
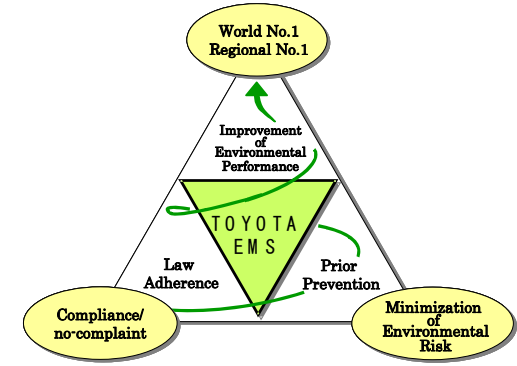


Toyota Motor Europe

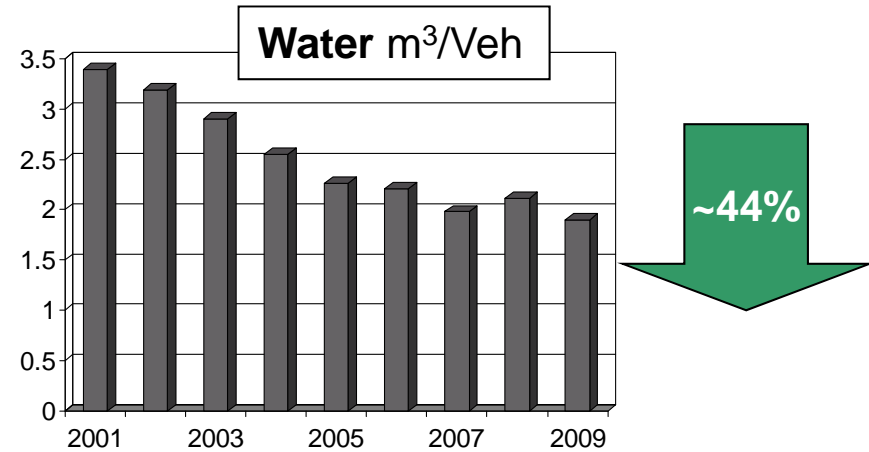
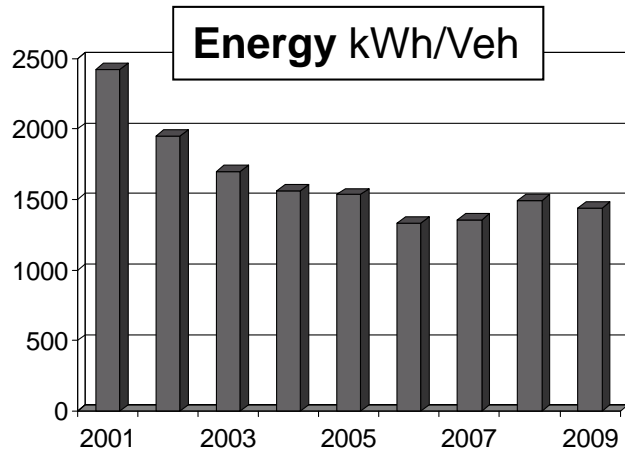
Green, Lean and Clean Towards the Ultimate ECO Factory



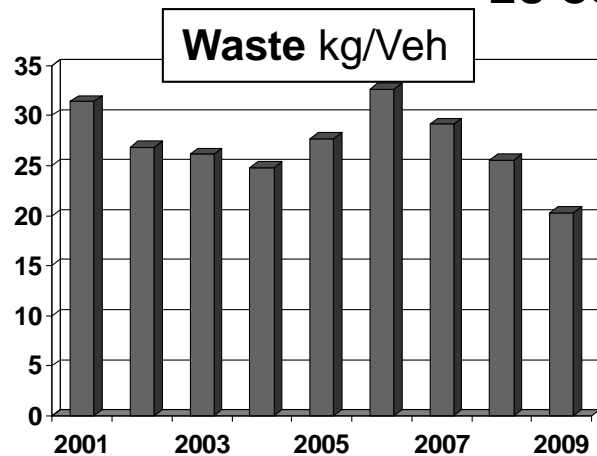
Toyota Motor Europe
Environment and Facility
Plant Engineering Division



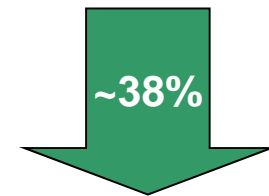
.....dramatic reductions achieved in EU



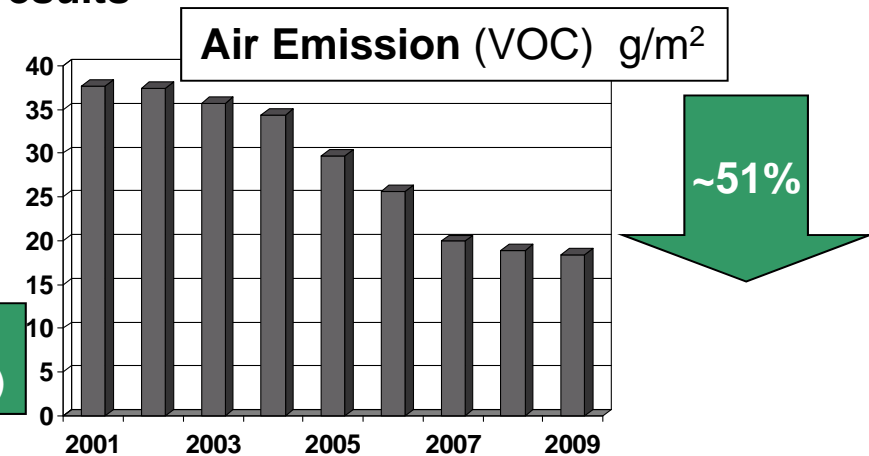
EU Consolidated KPI results



- 2001 - 2009



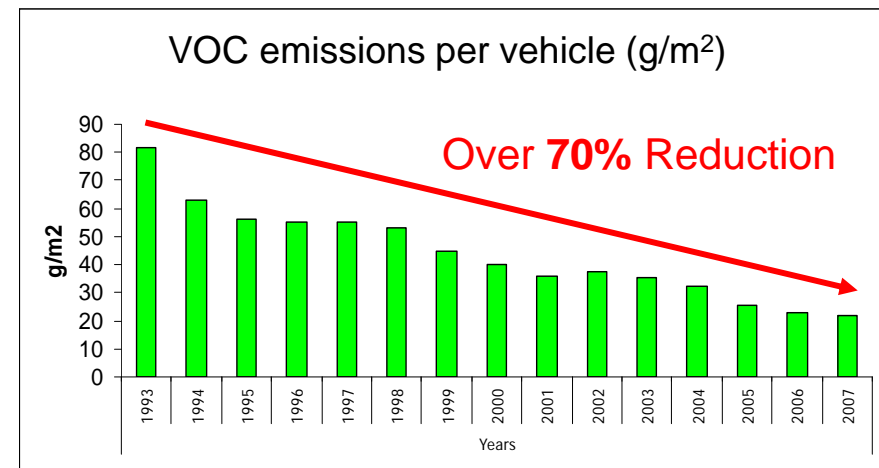
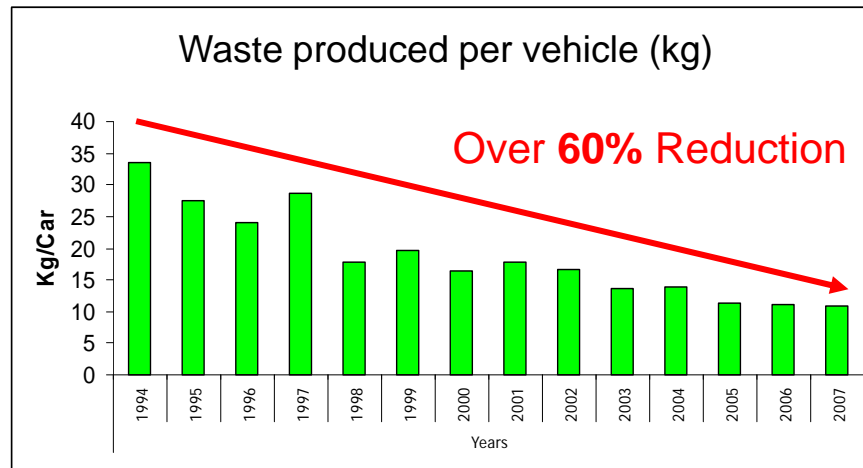
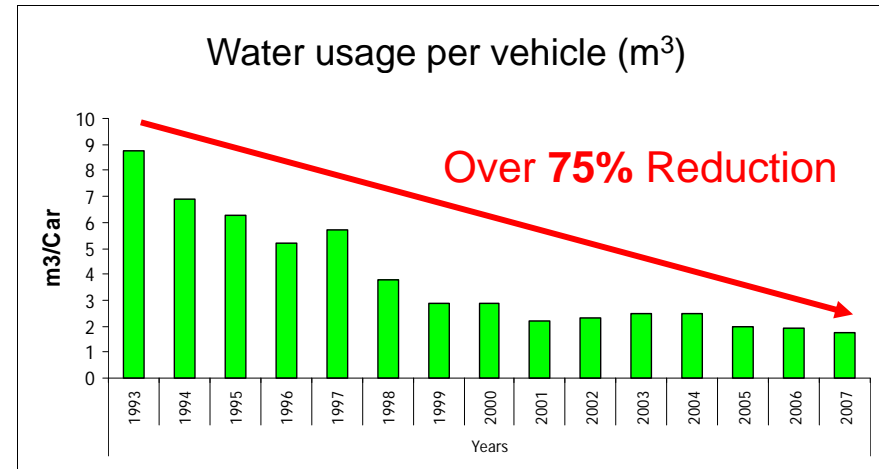
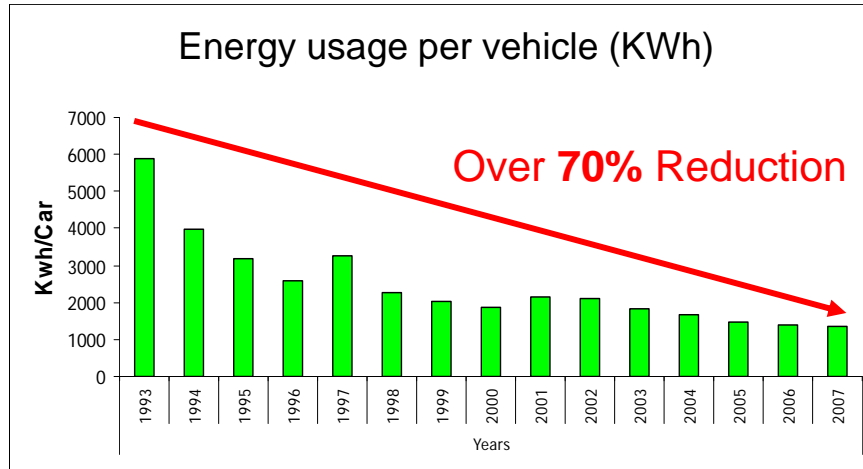
Zero Waste to Landfill (8/9 sites)



+ VE factor - Increasing vehicle production volume

-VE factor - Increasing vertical integration (2 x engine / transmission plant introduced)

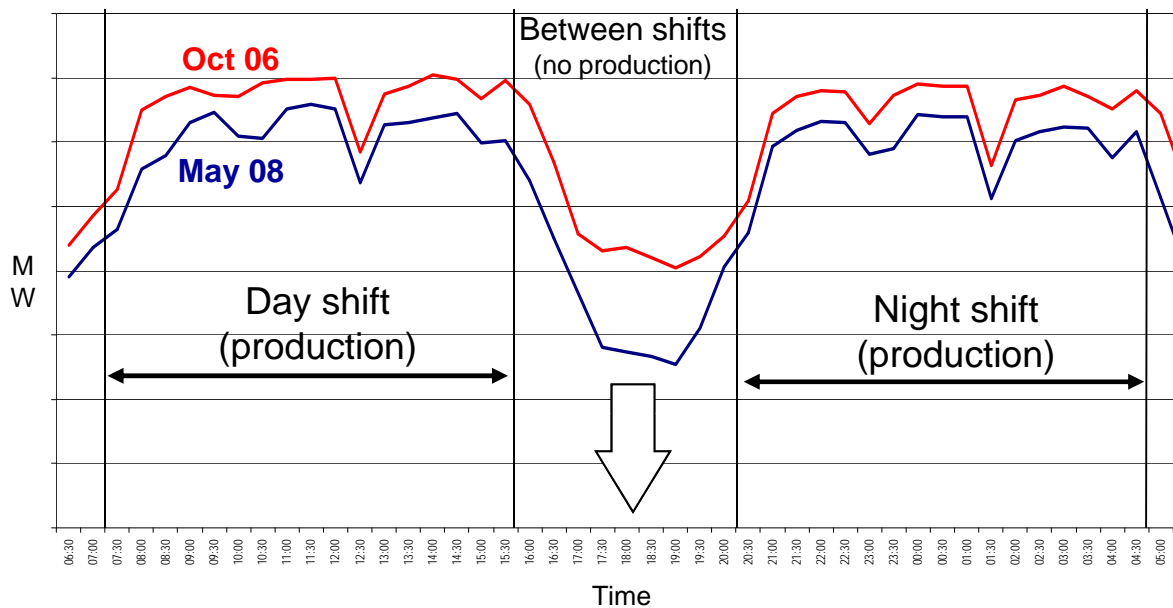
Environmental KPI Results (TMUK)



Examples of Leadership Energy reduction

Inter-shift shutdown focus

Burnaston Plant site electrical loading



Target: no production = no energy use

Weld Shop energy focus

ENERGY SWITCH OBSERVATION POINT

FROM THIS POINT CAN BE SEEN :-

- LIGHT SWITCHES
- FAN SWITCHES
- PORTABLE FAN SWITCHES

VIEWING AREA

DASH

RESPONSIBLE GROUP : 022

THIS SWITCH CONTROLS QUALITY 2 (MILL 8001 15.00.000 (1000 10000))

SWITCH TO BE TURNED OFF AT :	1 ST BREAK	<input checked="" type="checkbox"/>
	LUNCH	<input checked="" type="checkbox"/>
	2 ND BREAK	<input checked="" type="checkbox"/>
	End Of Shift	<input checked="" type="checkbox"/>

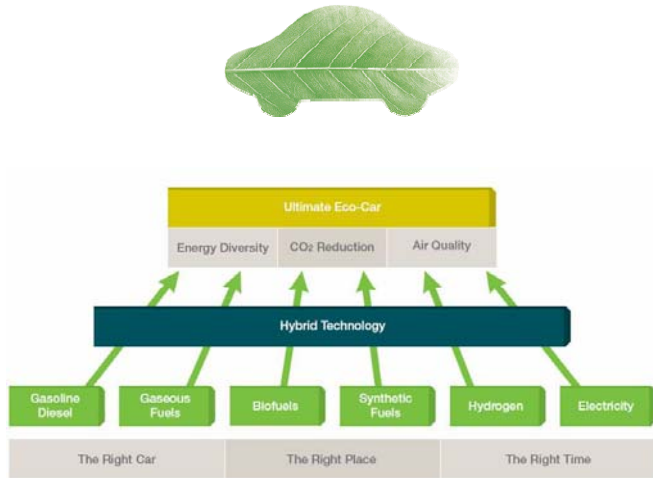
A NUMBER - NOT A CLASS - HAS BEEN RESPONSIBLE FOR THIS TASK

TOYOTA

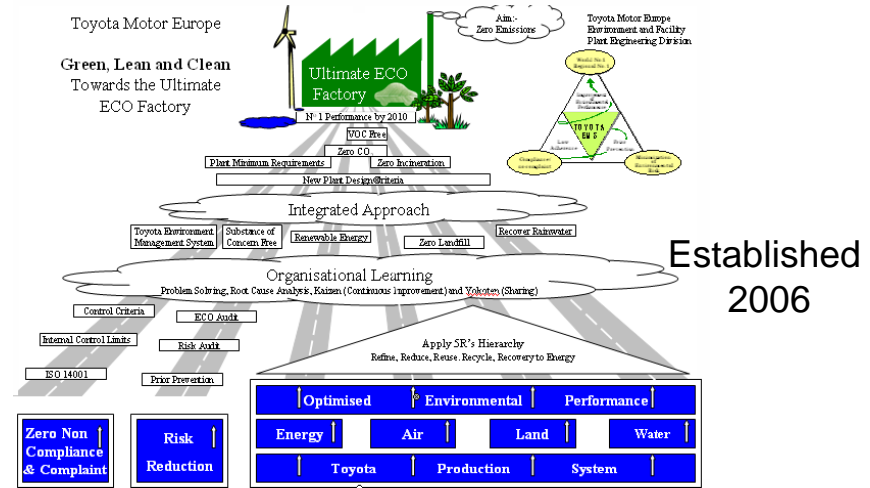
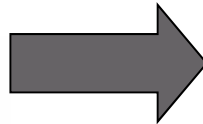


- Employees responsible for switch off
- Energy switch observation points
- Clear instructions for switch off times
- Local ownership of energy control

Further Develop the Manufacturing "Vision"

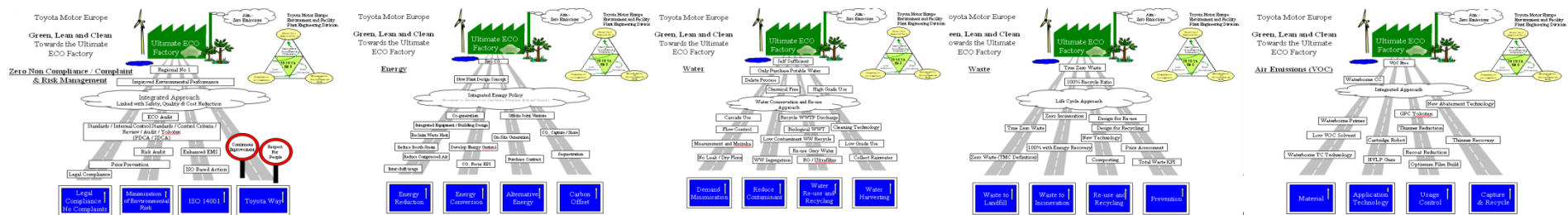


Ultimate ECO Car



Ultimate ECO Factory

Compliance Energy (CO₂) Water Waste Air Emissions

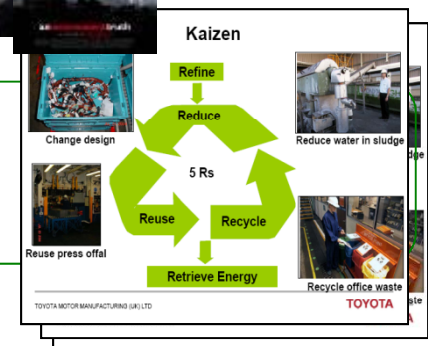


Equipping & inspiring our members (employees)

Consistent & Strong Leadership
eg Board-led environmental forums



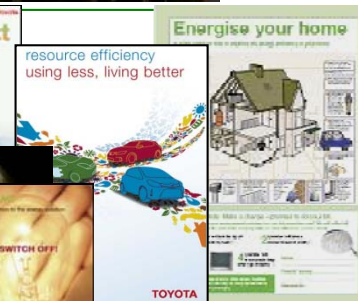
Environment training
eg general awareness, technical skills



Member involvement
eg – “window” role, quality circles



Consistent / Frequent Communications
eg – Green Month, Open days, shop level events



Develop Specialised Energy Saving Teams

In House Training - The 6 Attitudes

Approach 1 ELIMINATE Focus point: Why is this equipment needed?

Work Conveyor Power: 30 Kw

Work Roller rail

Cut out electricity use!

Approach 2 REPAIR Focus point: Are we losing energy as a result of the breakdown?

Hose Heat flow

Air leak from damaged hose!

Repair the damage!

Approach 3 STOP Focus point: Just because it's operating doesn't mean it's working!

Load equipment Too High Pressure gauge Release valve Water flow Pump Stop

More water is being pumped in than necessary for the load equipment.

Stop one pump to supply required water flow.

Approach 4 REDUCE Focus point: Why do we need so much?

Compressor 300 Kpa Pressure gauge Pressure-reducing valve Power: 11 Kw

Reducing valve is being used to reduce pressure

Remove pressure reducing valve and reduce the set point of compressor output!!

Approach 5 PICK UP Focus point: Don't throw it away. Can't you use it somewhere?

Steam Chloroalks heater 100°C Exhaust gas 300°C Work heated 300°C

High-temperature exhaust gas emission

Pick up waste heat to heat up chemicals by using heat exchanger.

Approach 6 CHANGE Focus point: Is there any cheaper source of energy?

Panel heater Steam for heating Radiated heat Drain Other energy

Steam drain at 100°C is being wasted!

Change to low-waste, low-cost system.

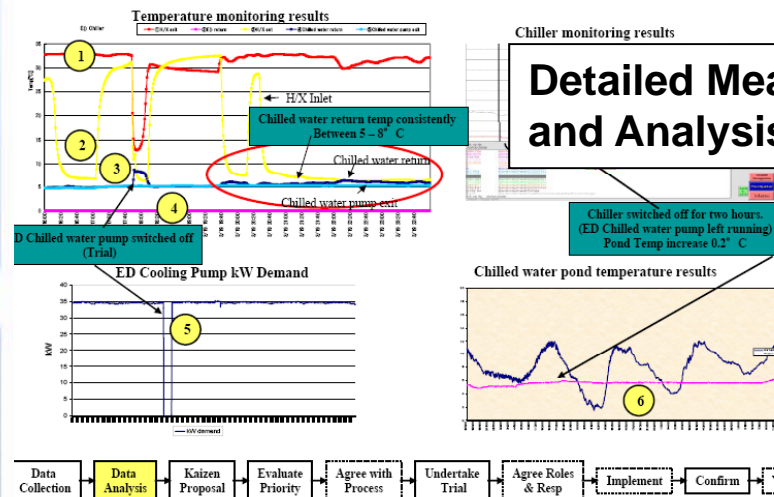
Train the Trainers



Then develop EU Wide Teams



① Assessment of current state of energy usage in process



Beyond benchmarking – Determine concepts of “Minimum Requirement”



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Eco-Efficiency at Toyota Europe

- Energy in manufacturing (kWh/vehicle)
 - 2001 - 2006 = 44% reduction
 - 2006 - on = new programmes
 - 2010 = investigation of paint plant refrigeration?
 - 2011 = investigation of paint drying?

*What is your upper
limit & how close are
you?*



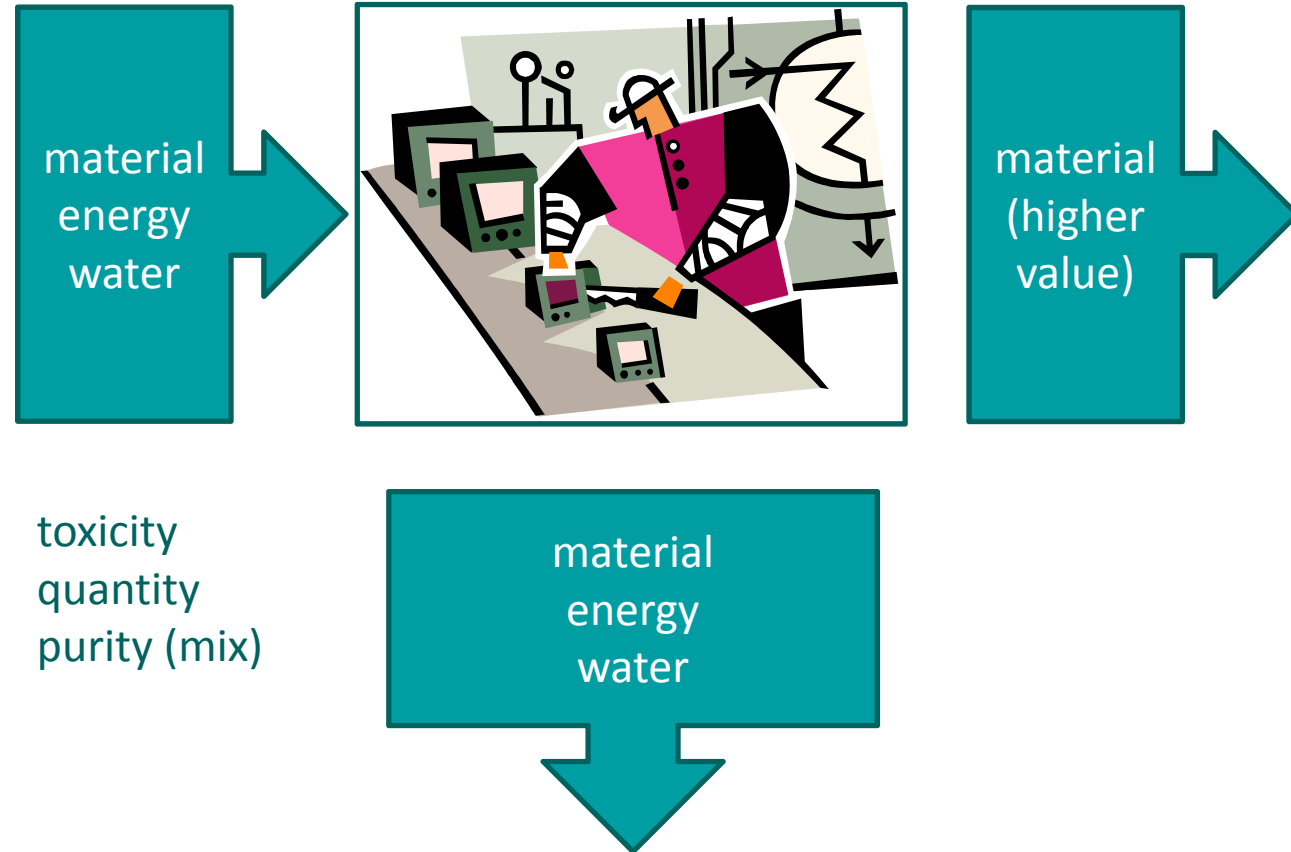


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Areas of activity in manufacturing

*Use best practice
Use best technology
Use best systems*

*Includes:
monitoring,
measurement,
modelling,
process technology,
control technology,
waste processing,
energy harvesting,
energy creation,
material substitution,
etc*





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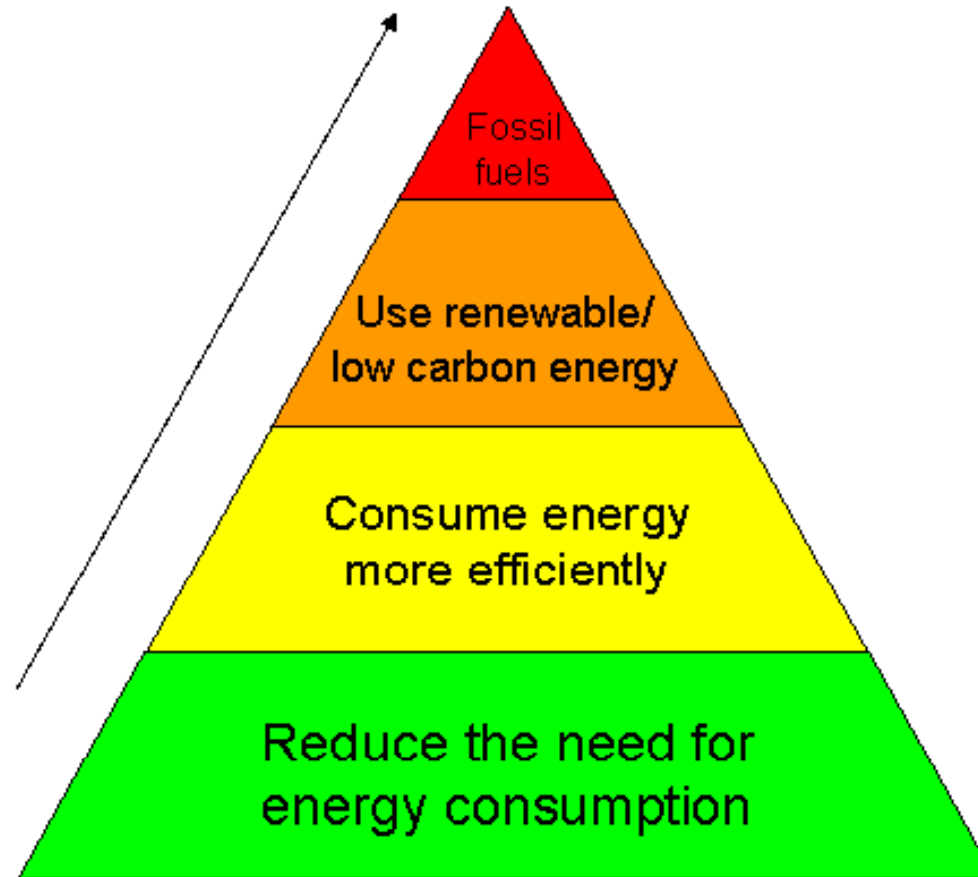
Material Hierarchy (aka waste hierarchy)





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Energy Hierarchy

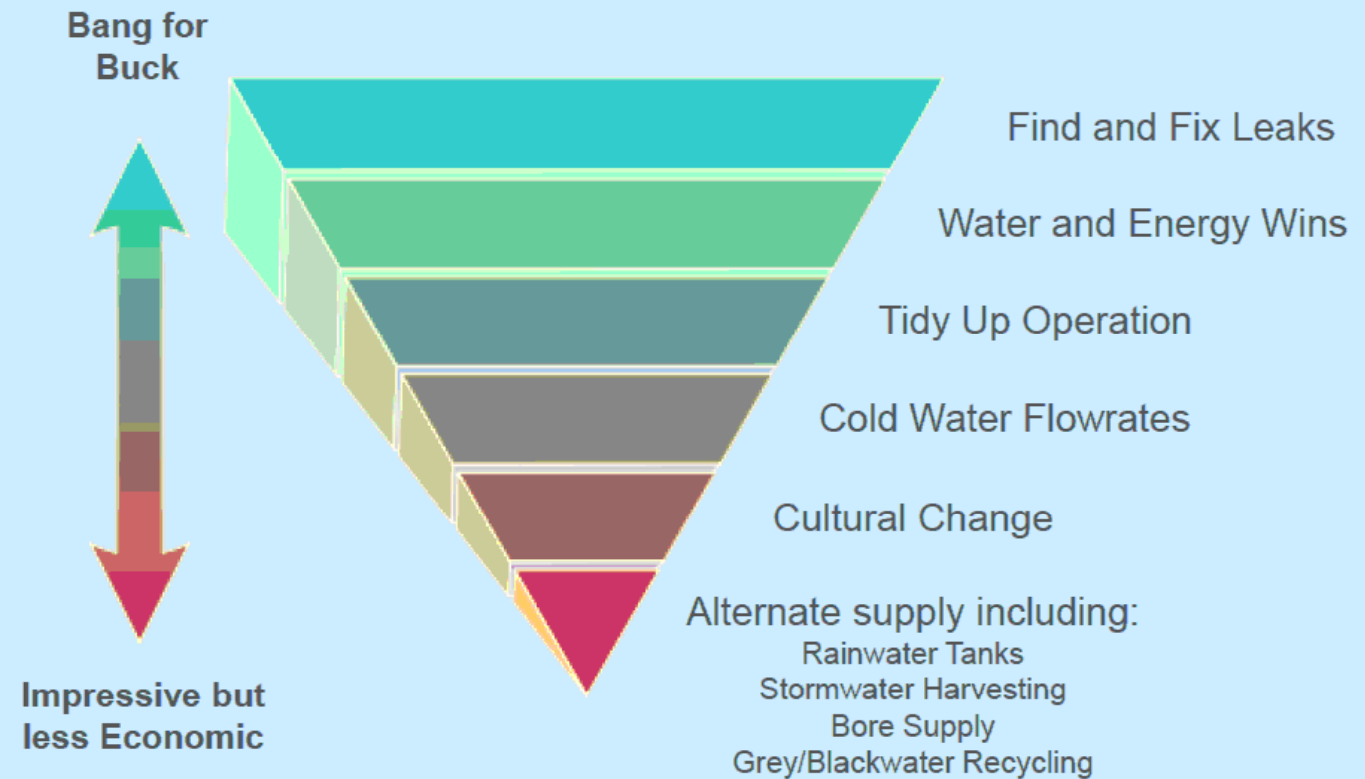




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Water Hierarchy

Efficient Targeting in Water – Short Version





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Research Themes

Use best practice



How to make current products
in a low-carbon, resource efficient
manner.

Use best technology



How to transform our factories
and products.

Use best systems



Explore how the entire
industrial system might change



Cranfield
UNIVERSITY



Imperial College
London





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What are we planning to
do about it?



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A new national research centre





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Challenge-led
20 Grand Challenges
200+ manufacturers
88 PhDs
*International co-
operation*



Vision

- We are creating a transparent, collaborative community for practical research into ways to enable industry to become more sustainable.
- We are global in outlook, open & pro-active in working with others, and transparent about our successes & failures.





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Our Purpose

To support and encourage the transformation toward a sustainable industrial system the Centre delivers:

- Knowledge
- Tools & methods
- Leaders
- Policy support

By 2016:

*20 Grand Challenge
Projects*

200+ manufacturers

88 PhDs

by being collaborative, transparent, grounded in practice and challenging & innovative.



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Outputs

Large cohort of
future industry
and research
leaders

Tools and
techniques that
improve current
performance

A strong
membership
that uses results

Direct policy
influence

Envision the
potential future
shape of the
industrial system

20 Grand Challenges
200+ manufacturers
88 PhDs





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Centre Investigators

Professor Steve Evans

Centre Director, Institute for Manufacturing (fM),
University of Cambridge.

Professor Sir Mike Gregory

Head of the IfM, University of Cambridge.

Professor Shahin Rahimifard

Deputy Director, Professor of Sustainable Engineering,
Loughborough University.

Dr Peter Ball

Senior Lecturer in Manufacturing Operations,
Cranfield University

Dr Mike Tennant

Lecturer in Business and Environment,
Imperial College London

Executive Group are:

Toyota

GM

Riversimple

Unilever

ES-KTN



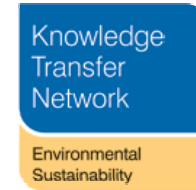


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Current Members



TOYOTA



**MARKS &
SPENCER**

Unilever

VITSOE™



iema

Institute of Environmental
Management & Assessment

*Across sectors,
large to small,
& network members*





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Member interactions

Join webinars,
member days,
annual
conference,
QuickGuides

Use our tools
and techniques
before others

Join specific
research
projects

Get involved in
policy influence

Share ideas on
the future shape
of the industrial
system





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Research Themes

WHAT ARE TODAY'S KEY CHALLENGES?



How to make current products
in a low-carbon, resource efficient
manner.



How to transform our factories
and products.



Explore how the entire
industrial system might change

*3 themes align with
short, medium and
long term changes to
the industrial system*



**UNIVERSITY OF
CAMBRIDGE**



Cranfield
UNIVERSITY



Imperial College
London



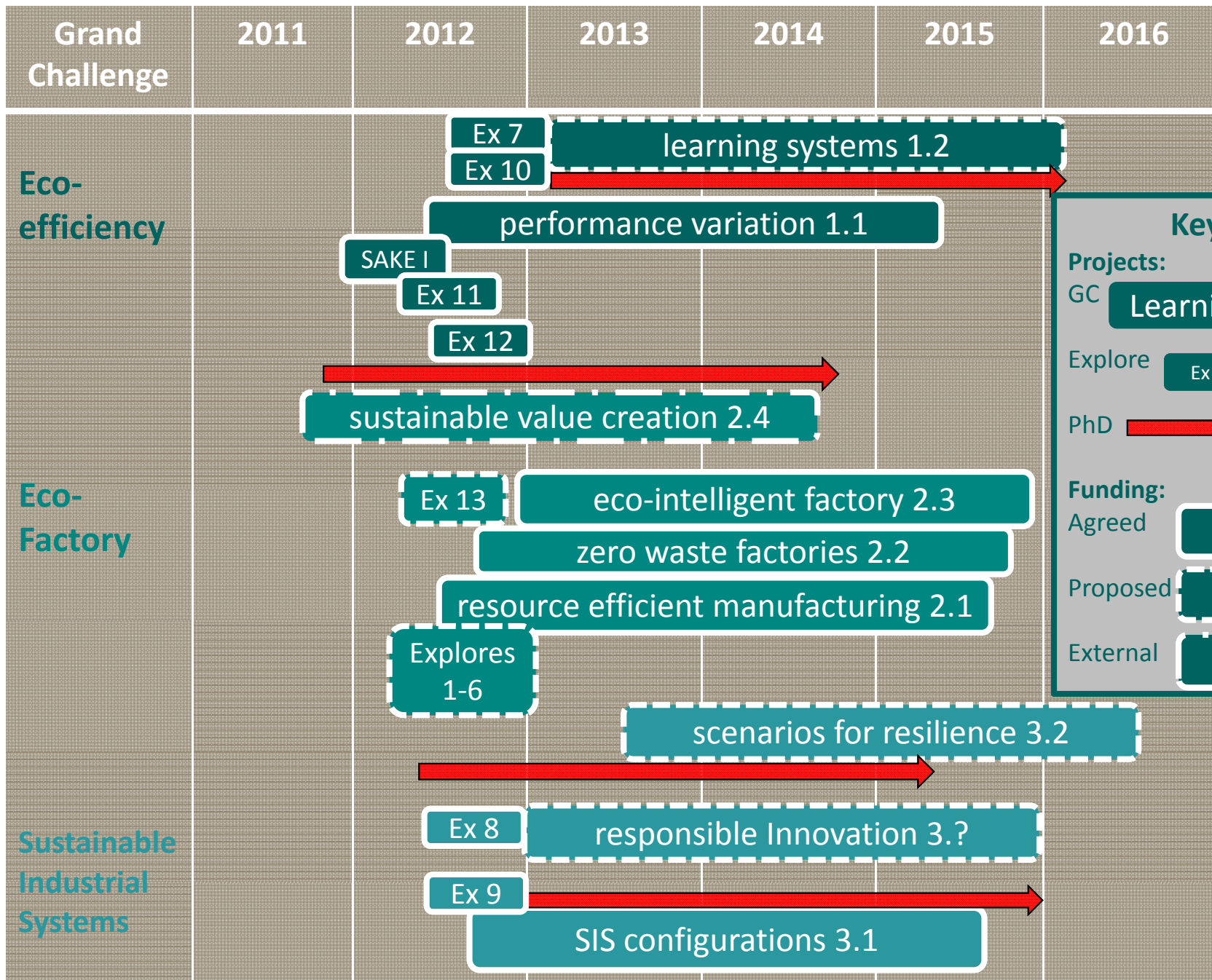


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PRESENTED TO

PRESENTED BY





Key

Projects:

GC **Learning 1.2**

Explore **Ex 11**

PhD

Funding:

Agreed

Proposed

External



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Year 1 priorities

Recruit best
staff &
researchers

Set up admin &
back office
Key resources
Start projects
Member start

Projects active
with members
Cohort building
Public Launch
Governance
operating

Policy plan
International
development
External UK
Other Centres

Explore new
project ideas
New members

*Progress on plan
except for:*

*Delayed
administration*





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Progress & achievement





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Year 1 priorities & overall progress

*Started July 2011
20 months into 60
month funding*

*Progress on plan
except for:
Delayed
administration,
International
Development.*

Recruit best
staff &
researchers
Governance
operating

Set up admin &
back office
Select projects
Member start

Projects active
with members
Cohort building
Public Launch

Policy plan
International
development
Other Centres

Explore new
project ideas
New members





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*Very strong team,
Cohort programme,
Winning bids,
Active projects,
Active Members*



Outputs to date





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Stop:

*Wasted effort on
admin & legal*

Start:

China plan

India plan

Clear policy plan

Continue:

Project progress,

Cohort programme,

Winning bids,

Active projects,

Active Members,

Papers, etc.



Plans for 2013/14

Tools and
techniques

(being used, having
impact)

Research leaders

Over 60 people

Shaping the
industrial system

papers,
road-mapping

Membership

Excellent & regular
communications

Policy

Foresight, UNIDO,
APPMG, UNESCAP

Being
sustainable

People & funding



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Early results





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Sustainability Assessment & Knowledge Exchange (SAKE)

- Investigate sustainability metrics and KPIs, and how these may be used
- Help members address areas of concern and identify future research directions
- Encourage knowledge exchange between members

*An example Explore
project driven by
Members short term
needs*





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SAKE: OUTCOMES (1)

1. Members are not sure whether KPIs are leading to the right behaviour or to desired performance.

Setting the boundaries, and choosing metrics (absolute or per product) will greatly influence improvement.

2. How can we make trade-offs between social, economic and environmental metrics, because all are important?

Should we consider one metric more than the others and how do we go about this? Social metrics are not widely used yet, but are of increasing interest to governments and some companies.

3. Measurement and control of impacts outside of direct scope (customer, suppliers) are of concern.

How can we best engage our suppliers and downstream stakeholders?





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SAKE: OUTCOMES (2)

4. Leaders are finding ways to move beyond the metrics they have used in the past

What are these and how do we prove they are good metrics?

5. There may be tension between internal and external sustainability reporting

Are we measuring what we want and need, and are we broadcasting what we do well?

6. Learning within the company is important but challenging

Learning within a company - between different sites - is important but may be difficult.

7. Emissions to air in factories are not regularly measured and are of concern to some members.

Some companies do measure emissions to air but not on a regular basis. Others do not know exactly how to measure this.





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*Providing
manufacturers with a
business modelling
process and
accompanying tools to
embed sustainability
into everyday
business operations*



SustainValue Grand Challenge Project

BUSINESS MODEL INNOVATION – FINDINGS TO DATE

- Business model innovation is seen to offer the opportunity for fundamental shift
- A good conceptual understanding in the literature but limited practical
- Our Industrial case studies demonstrate:
 - Leading firms are exploring business model innovation successfully
 - The business modelling process is ad-hoc and largely dependent on visionary leadership
- There is a lack of systematic tools and methods to help manufacturers innovate their business models for sustainability



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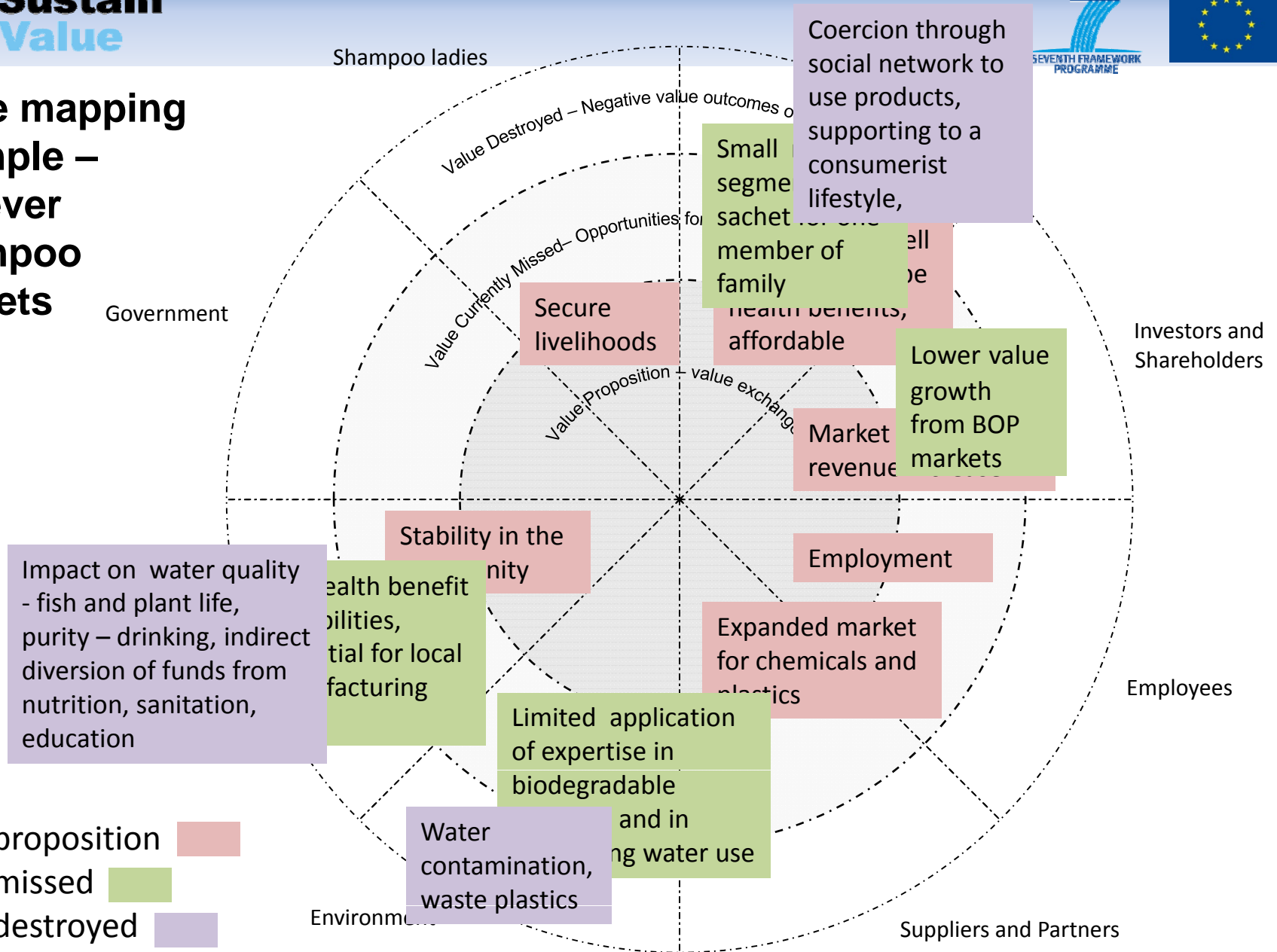
*Systematic and
practical process for
reconceptualising the
business model for
sustainability*



Better Business Modelling needs:

- A Multiple stakeholder view of value
 - current tools focus largely on customers
- A Comprehensive view of value:
 - Value proposition is not just value exchanges
 - Existing value opportunities are being missed in the current model
 - value is being actively destroyed
- A systematic approach to shifting value is needed:
 - using existing industrial knowledge on business model innovation

Value mapping example – Unilever shampoo sachets



Value proposition ■
 Value missed ■
 Value destroyed ■



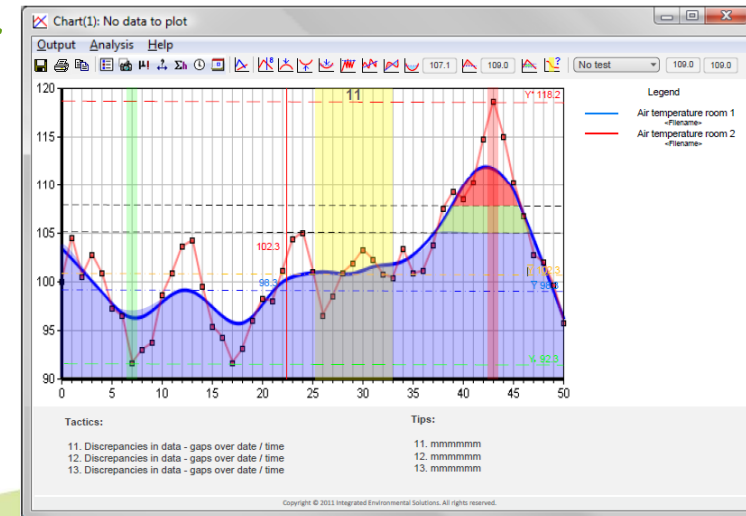
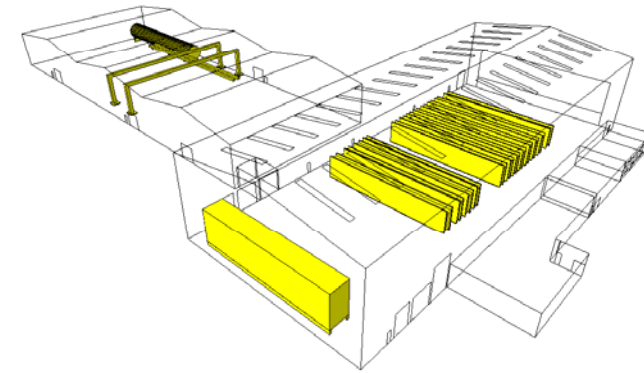
Business model archetype	Examples from practice
Maximise material and energy efficiency (<i>Do more with less resources, generating less waste, emissions and pollution</i>)	Lean Manufacturing, Low-carbon solutions, Dematerialisation, Packaging reduction, Bio-mimicry, Green Chemistry
Create value from waste (<i>Turn waste streams, emissions and discarded products into feed stocks for other products and processes</i>)	Closed-loop production, Circular economy, Cradle-to-Cradle, Industrial symbiosis, Take-back Management
Deliver functionality, rather than ownership (<i>Provide services that satisfy users' needs without having to own physical products</i>)	Product service systems - Product Orientated, Use Orientated, Result-orientated, PFI (Private Finance Initiative)/DBFO (Design, Build, Finance, Operate)
Encourage sufficiency (<i>Solutions that actively seek to reduce consumption and production</i>)	Consumer/User Education, Demand Management, Cap and Trade, Ethical product promotion, Slow Fashion, Responsible product/distribution – Health, wellbeing, Product Longevity
Adopt a stewardship role (<i>Proactively engaging with all stakeholders to ensure their long-term health and well-being</i>)	Ethical Trade (fair trade), Resource Stewardship, Bio-diversity protection, Choice editing to promote consumer health
Re-purpose the business for society/environment (<i>Focusing the business on delivering social and environmental benefits, rather than economic profit maximization</i>)	Not-for-profit, Hybrid businesses, Social Enterprise (for profit), Entrepreneur/ Business Support models, Base of Pyramid Solutions
Integrate the business more fully with other stakeholders (<i>Including community, employees, partners, etc. through more collaborative approaches</i>)	Alternative ownership structures – Employee ownership, Collectives, Partnerships, Cooperatives, Crowd-funding, Localisation
Develop scale-up solutions (<i>Delivering sustainable solutions at a large scale to maximise benefits for society and the environment</i>)	Licensing, Franchising, Open-innovation, Standardisation of the process – business practices and legal/law
Radical Innovation (<i>Introduce system change through introduction of new technologies to facilitate a greener economy</i>)	Technology & network reconfiguration, (process innovation, e-learning) Step-change technology solutions – Including renewable energy solutions

www.therm-project.org

Through-life Energy and Resource Modelling



- Systems view of the factory
 - Model buildings and manufacturing processes
 - Import process data
 - Create “profiles” (inputs/outputs)
- Improve using *Toyota attitudes*
 - STOP
 - ELIMINATE
 - REPAIR
 - REDUCE
 - TRADE
 - CHANGE





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*There are many
approaches to
planning – how do we
prepare for a step
change?*



Grand Challenge Project Sustainable Industrial Systems

HOW DO WE PREPARE FOR A CHANGING FUTURE?

- There are a number of weak signals for future changes to the industrial system:
 - Pressures from energy cost, resource availability, policies...
 - Suggested solutions from Cradle to Cradle, The Natural Step, Industrial Ecology, Industrial Symbiosis, Product Service Systems, Green Chemistry, Bio-mimicry...
- How will we make decisions about what gets made where and how?
 - There are a number of tools and techniques
 - Road-mapping, foresight, scenario planning , PEST, forecasting, backcasting, systems modeling. . . .
- These techniques do not deal with the growing challenge of coping with uncertainty, resilience, unintended system consequences, etc
 - We would like to understand the shaping forces and cope with weak signals, black swans, interconnectedness, etc.



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Project aims

Help manufacturers understand how to plan for futures, that may need to be radically different, from today's business as usual trajectory. . .

- What gets made where
- What needs to change
 - System parameters
 - Governance, business models
 - Relationships
 - At the system level (policy, conditions)

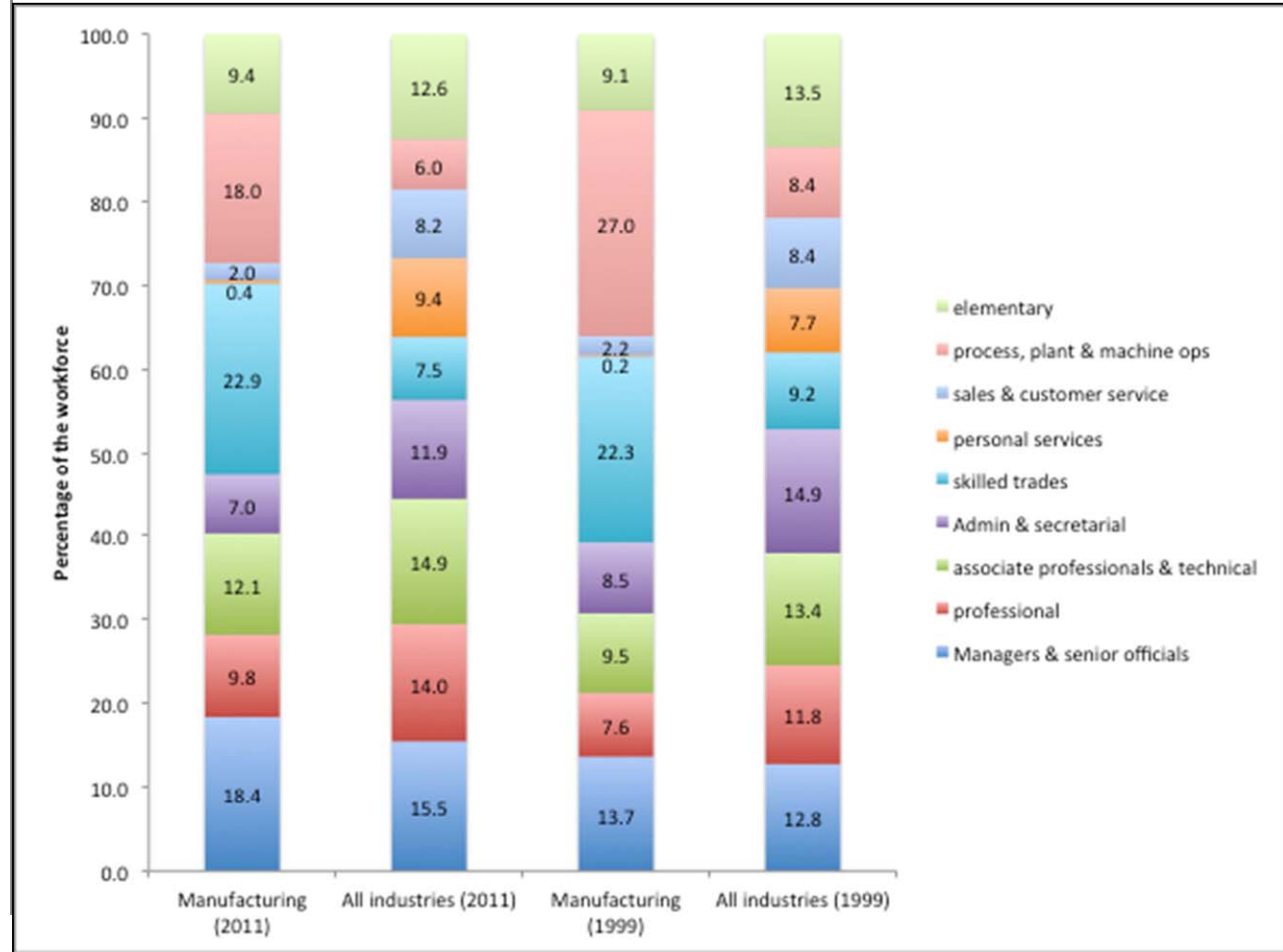
What is different about planning for sustainability at the system level?





Future of Manufacturing in the UK

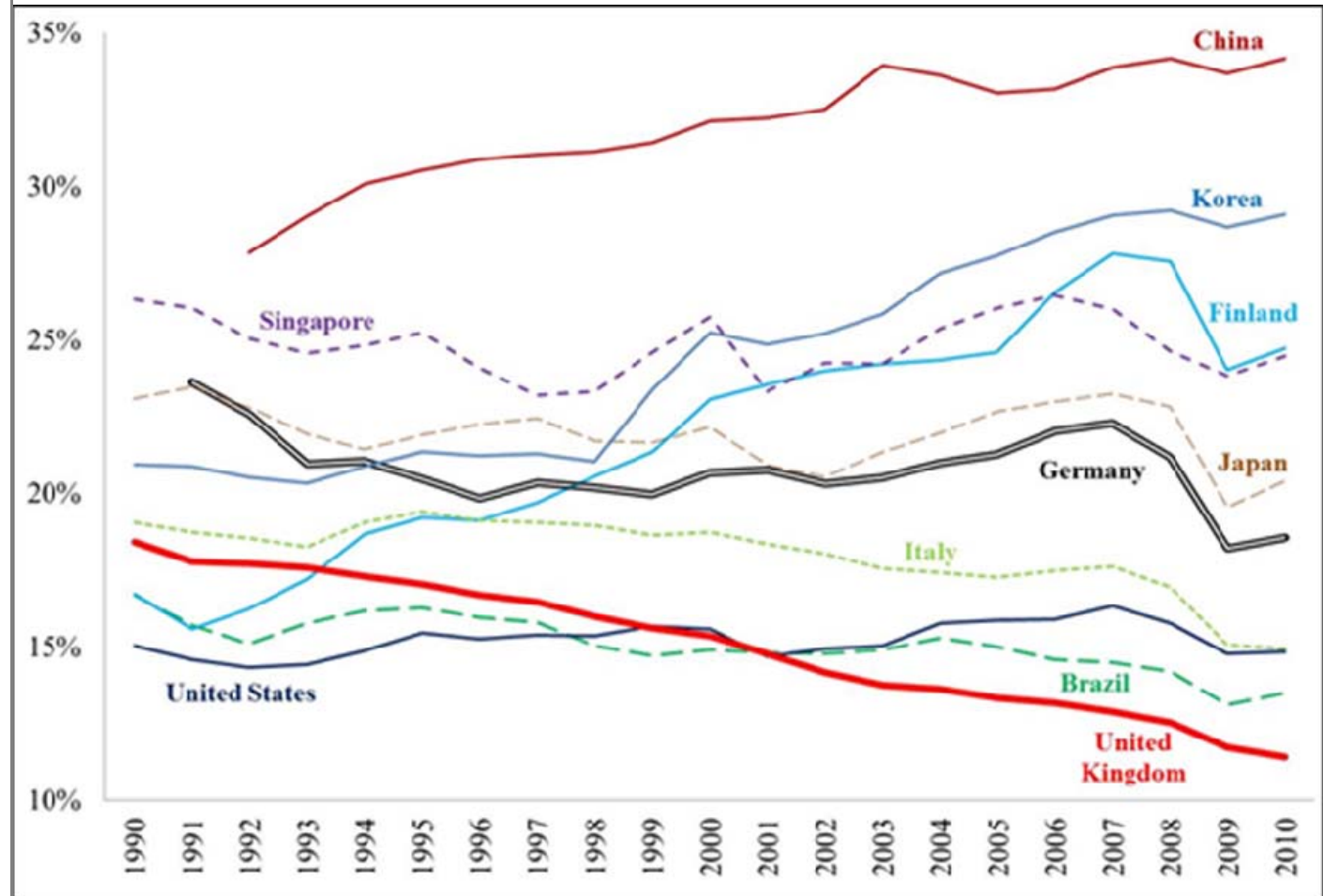
THE WORKFORCE





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'Re-balancing the economy'





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Things will
change:

Lean & Clean,
Never saying
goodbye,
Making it
everywhere,
Keeping in touch,
Kissing frogs,
Slow local
manufacturing.



Future of manufacturing?

*Growing vs subtracting, sensors, data, services,
global & local, disruptions/shocks...*

eco-efficiency,
closed-loop,
local making,
selling service,
new collaborations,
& high-value.



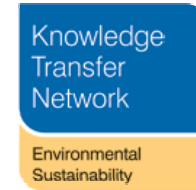


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Join us!



TOYOTA



*Thank
you*



**MARKS &
SPENCER**

Unilever

VITSOE™





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Thank you

