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Industry 5.0 & Sustainability – Panel Discussion (World Engineering Day)

Friday, 4 March 2022 | Panel Discussion, Technical Topic Webinar

Presented By

A range of **EIT Lecturers** - Schools of Civil, Electrical, Mechanical and Industrial Automation Engineering

Common Questions/FAQs

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Agenda

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1	Welcome and Introduction
2	Society 5.0 and Sustainability in Industrial Revolution
3	Smart Grids and Sustainability
4	Sustainability for Mechanical Engineers
5	Sustainable Manufacturing Processes and Products
6	SDGs and Civil Engineers
7	Tyre Recycling Case Study
8	Conclusion and Q&A

Introduction - Presenter

Dr. Akhlaqur Rahman

Akhlaqur is an academic with almost 10 years of experience in teaching various Industrial Automation and Electrical Engineering courses at Australian and overseas universities.

Akhlaqur is a member of Engineers Australia and a Senior member of IEEE. He has been involved in industry funded projects with several top universities and government institutes. His PhD project was mainly focused on developing task offloading algorithms for Cloud Robotics applications of Industry 4.0.

As the current Secretary for IEEE Victoria, his current research interests lie in the area of Industrial IoT, Cloud Robotics and Virtual Manufacturing System with a focus on improving efficiency through network optimization.

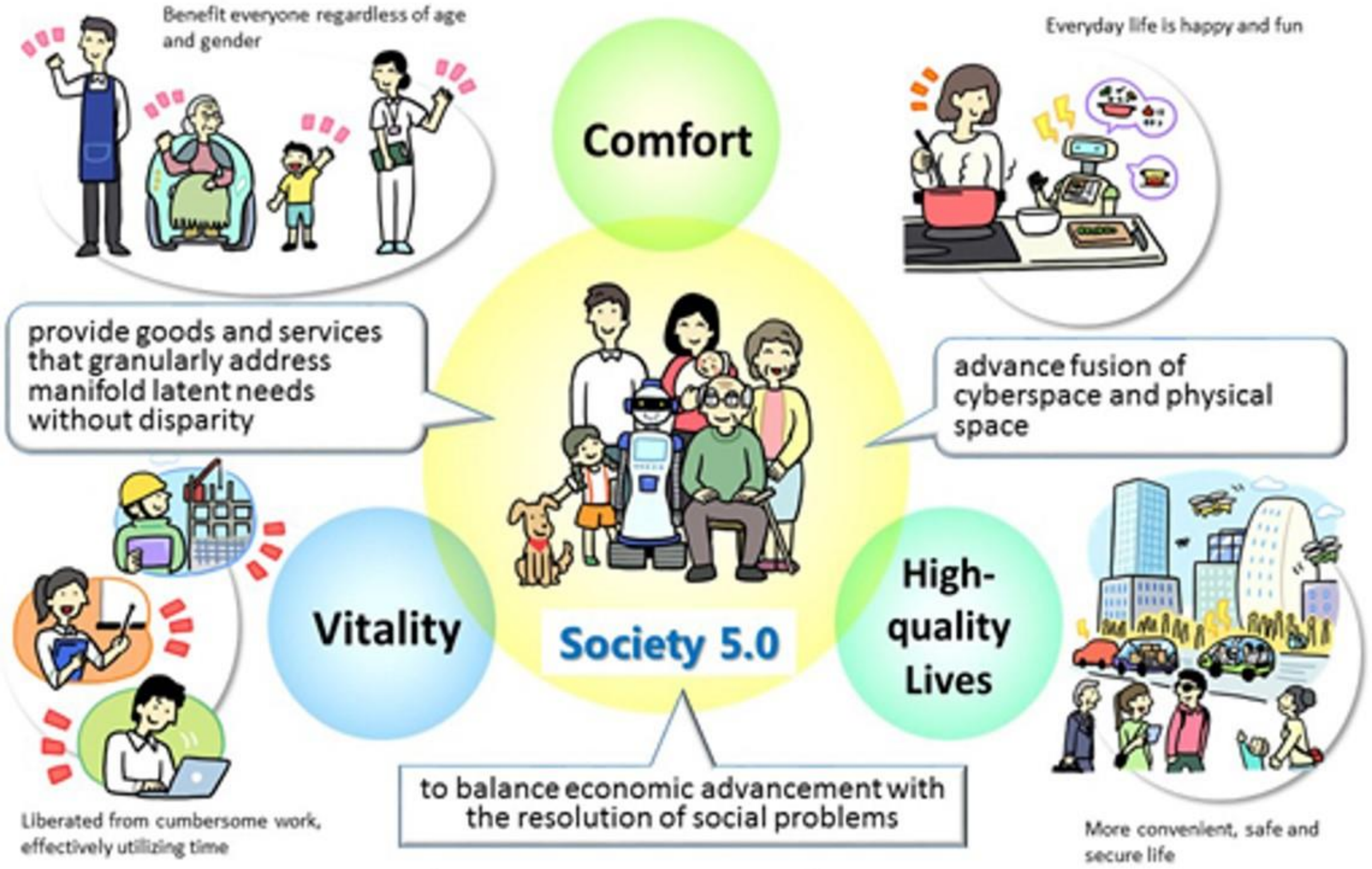
Society 5.0

Society 5.0 (cao.go.jp)

Society 5.0

As Professor Harayama Yuko said: *"Society 5.0 aims to resolve various modern social challenges by incorporating game-changing innovations such as the Internet of things (IoT), robotics, AI and big data into all industries and social activities. Rather than a future controlled and monitored by AI and robots, technology is harnessed to achieve a human-centred society in which each and every person can lead an active and enjoyable life. Within the context of ever-growing digitalization and connectivity and expanding use of Artificial Intelligence (AI) technologies, several actions have been initiated under this flagship concept by the Japanese government as well as by the private sector."*

A balanced Society?

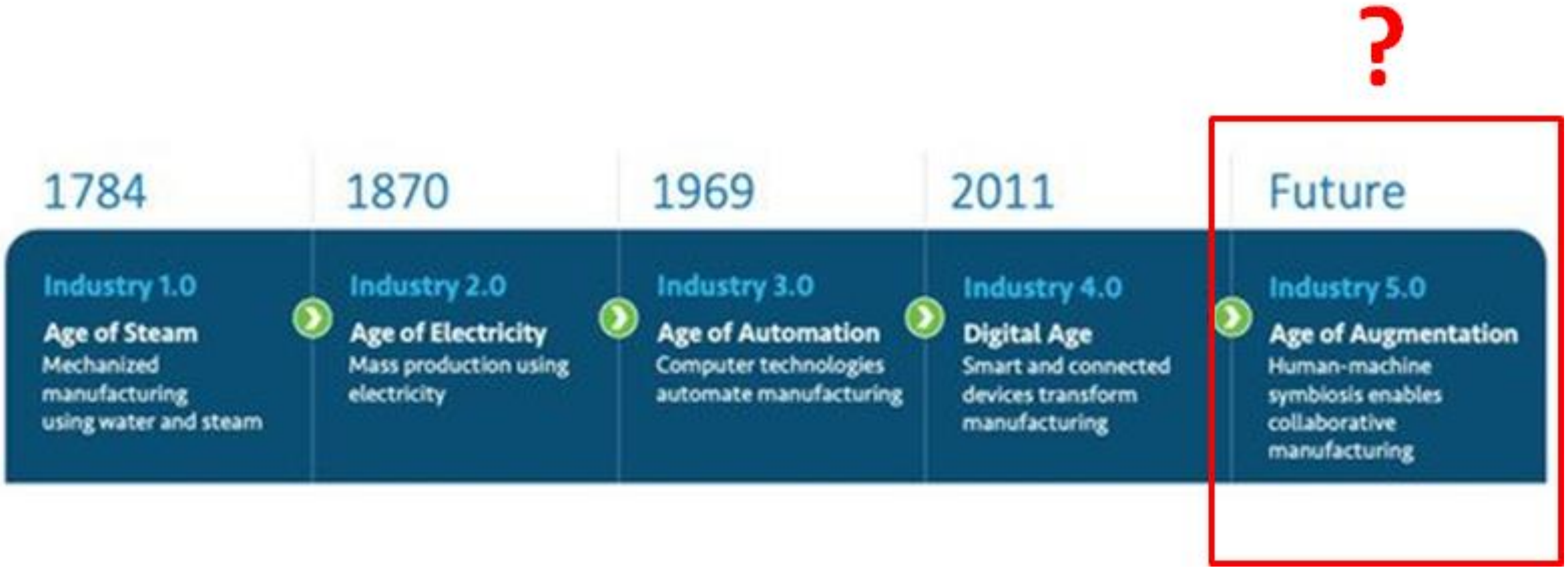


Society 5.0 and Sustainability

https://www.mdpi.com/2071-1050/13/5/2682/htm

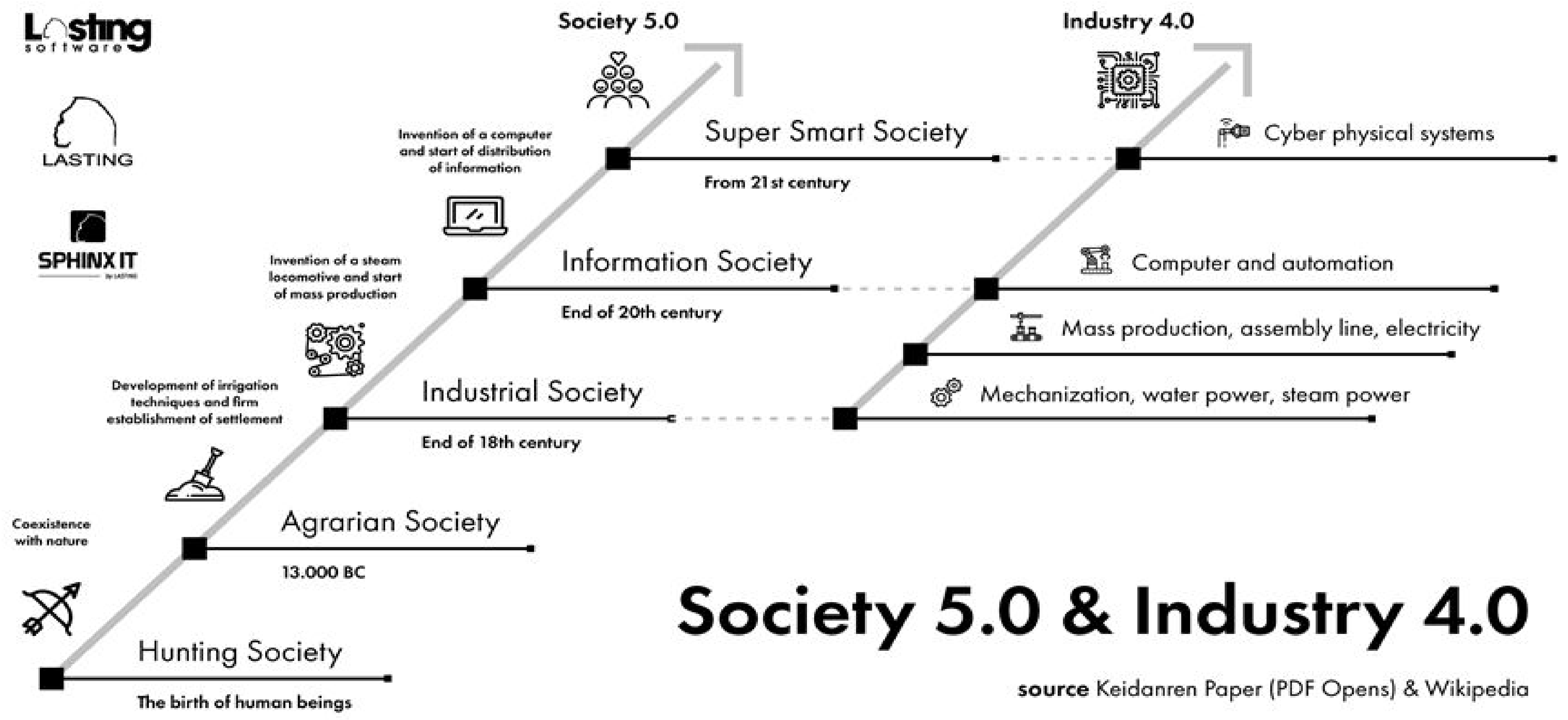
Role of Sustainability in Industrial Revolution

Journey of Industrial Revolution



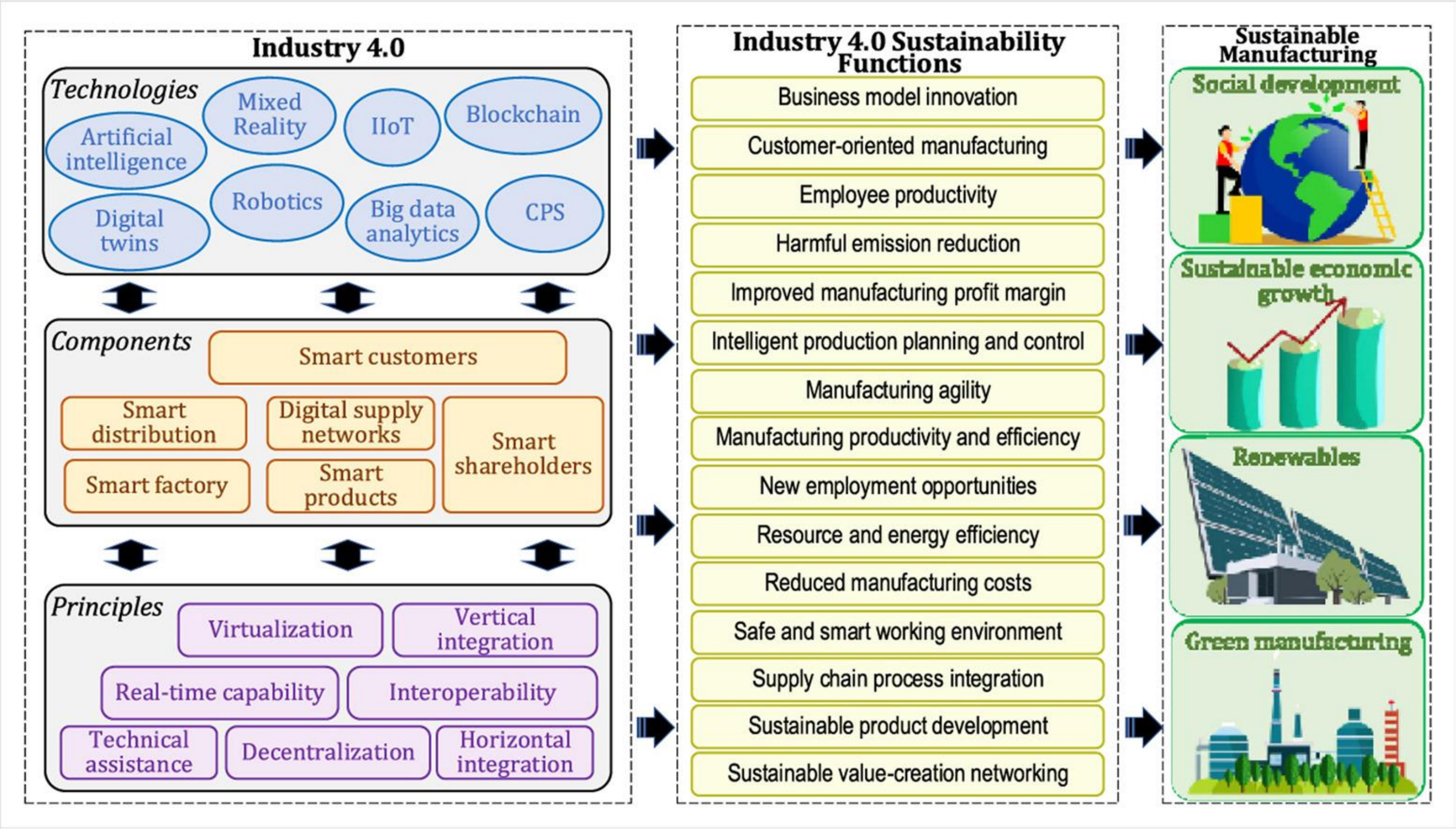
Longo, F.; Padovano, A.; Umbrello, S. Value-Oriented and Ethical Technology Engineering in Industry 5.0: A Human-Centric Perspective for the Design of the Factory of the Future. *Appl. Sci.* **2020**, *10*, 4182.

Society 5.0 meets Industry 4.0



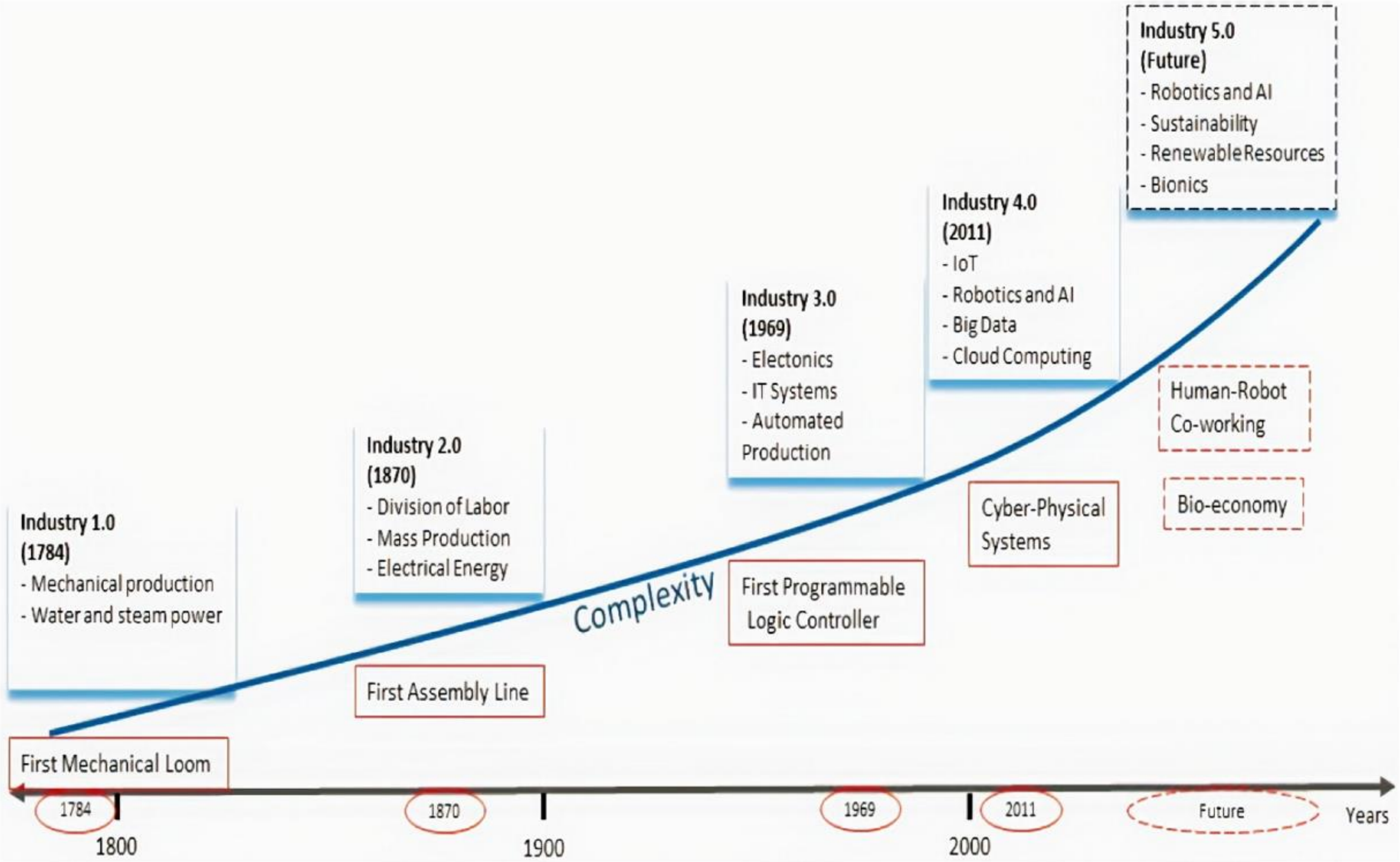
https://www.japanindustrynews.com/2017/08/japans-society-5-0-going-beyond-industry-4-0/

Sustainability Roadmap in Industry 4.0

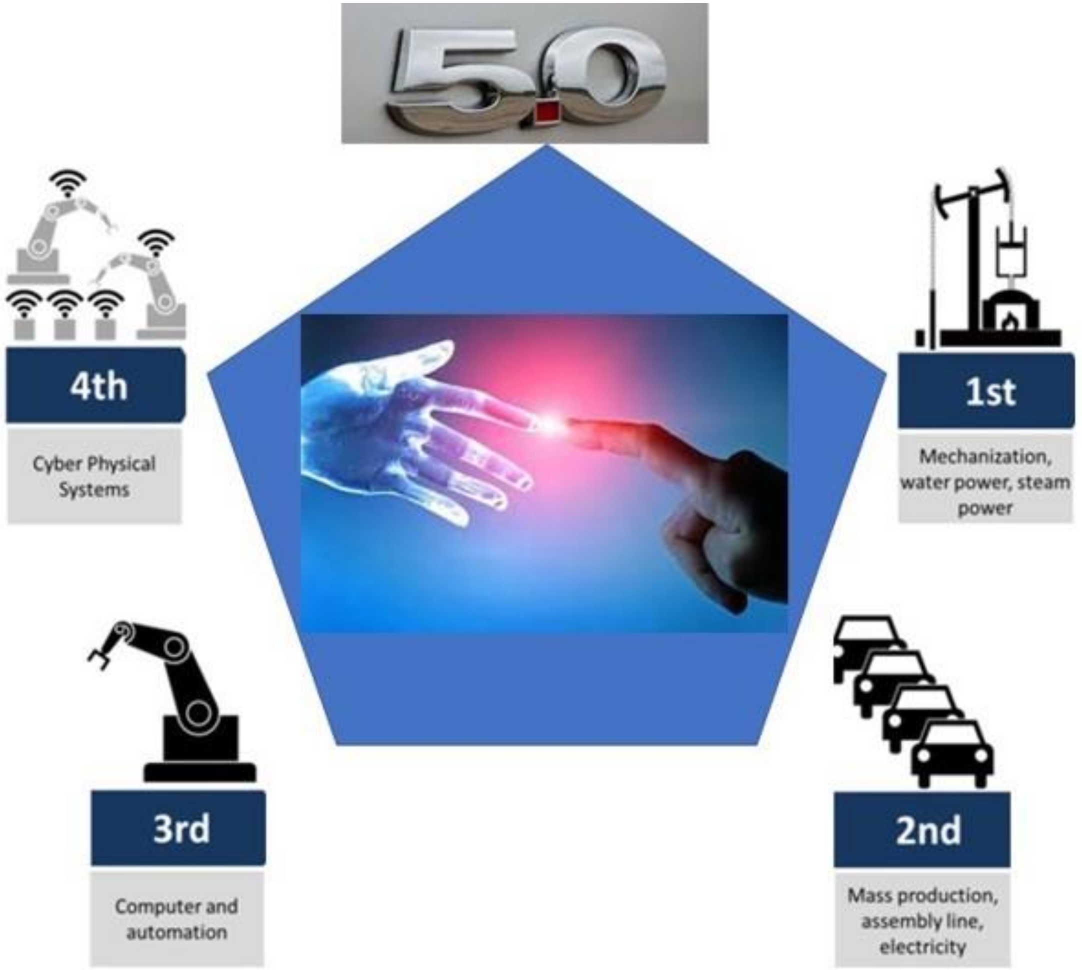


https://www.sciencedirect.com/science/article/abs/pii/S0959652621042992

Vision for Industry 5.0



Vision for Industry 5.0



https://michael-rada.medium.com/industry-5-0-definition-6a2f9922dc48

Vision for Industry 5.0

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Table 1. A Comparison of Industry 4.0 and Industry 5.0 Visions

	Industry 4.0	Industry 5.0 (Vision 1)	Industry 5.0 (Vision 2)
Motto	Smart Manufacturing	Human-Robot Co-working	Bioeconomy
Motivation	Mass Production	Smart Society	Sustainability
Power Source	Electrical power Fossil-based fuels Renewable power sources	Electrical power Renewable power sources	Electrical power Renewable power sources
Involved Technologies	Internet of Things (IoT) Cloud Computing Big Data Robotics and Artificial Intelligence (AI)	Human-Robot Collaboration Renewable Resources	Sustainable Agricultural Production Bionics Renewable Resources
Involved Research Areas	Organizational Research Process Improvement and Innovation Business Administration	Smart Environments Organizational Research Process Improvement and Innovation Business Administration	Agriculture Biology Waste Prevention Process Improvement and Innovation Business Administration Economy

Vision for Industry 5.0

Role of Sustainability in Industry 5.0

https://medium.com/tdk-ventures/the-emergence-of-industry-5-0-the-fifth-revolution-adds-sustainability-ac22bbec701b

Role of Sustainability in Industry 5.0

https://www.futurebridge.com/industry/perspectives-mobility/industry-4-0-and-sustainable-manufacturing/

Summary

Industry 1.0
Industry 2.0
Industry 3.0
Industry 4.0
Industry 5.0

Human-centric
Industry 5.0
Resilient
Sustainable

Vision for Industry 5.0

Table 1. A Comparison of Industry 4.0 and Industry 5.0 Visions

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Introduction - Presenter

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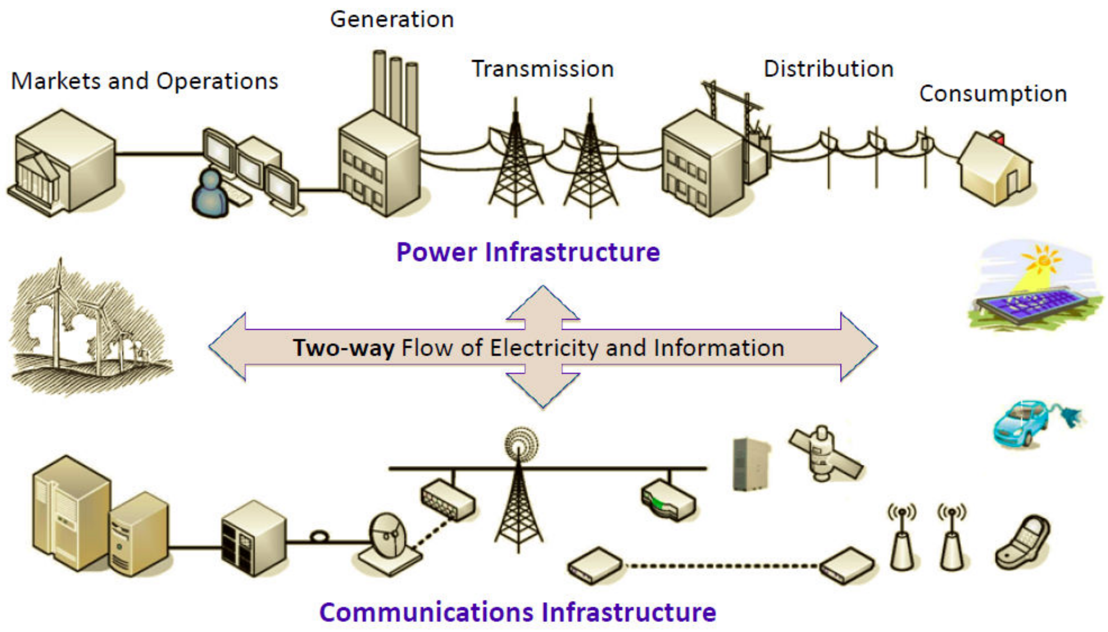
Dr. Yuanyuan Fan

Coming from an electrical background, Dr. Yuanyuan Fan has always attached significance to social and environmental impacts in her everyday work and research. She believes the future lies in the efficient utilization and management of renewable energy sources, from where smart grids incorporating technologies such as green hydrogen production and usage will then become practical and cost-effective. With extensive teaching experience to engineering students and continued pursuing of applied research, Dr. Yuanyuan Fan has publications from power system analysis to machine learning based engineering practices and education. For a sustainable energy future, she believes electrical engineers should take initiatives to broaden their knowledge in multiple engineering and science fields, and in the meanwhile to collaborate with data communication engineers, automation engineers, data scientists and policy makers.

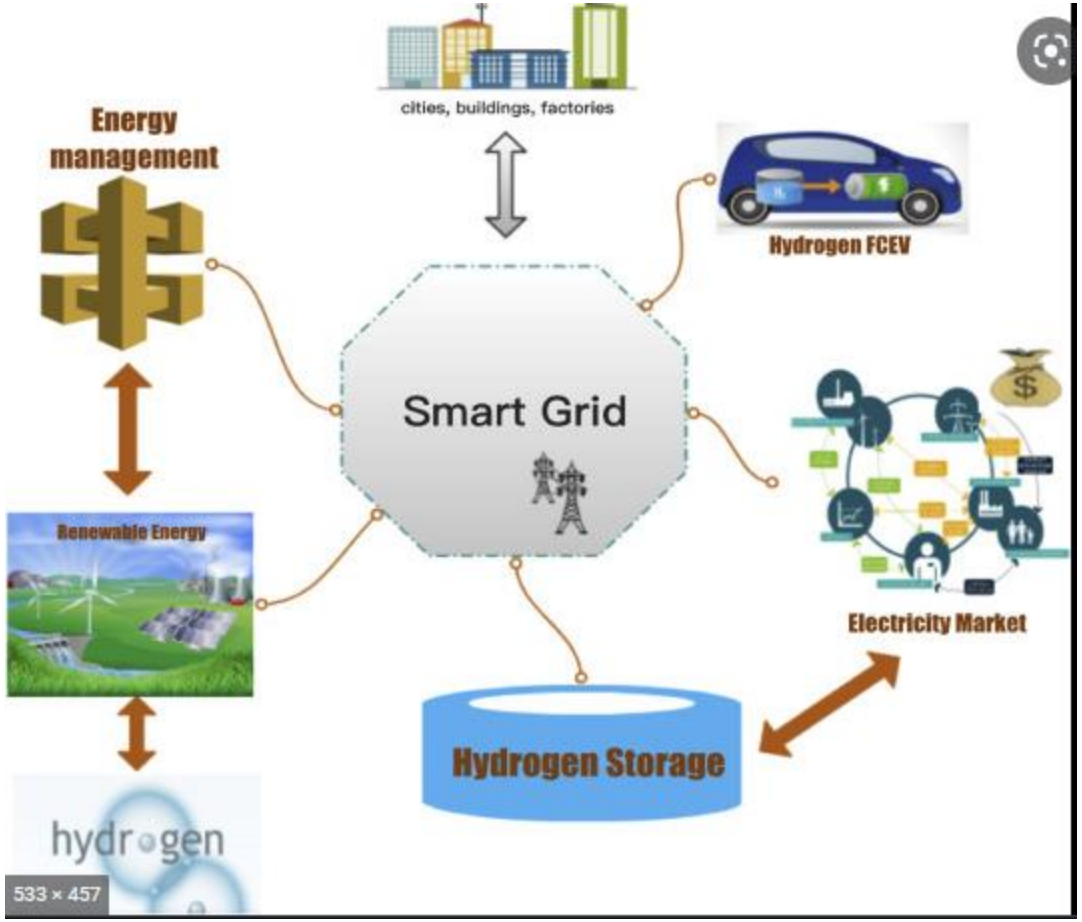
Smart Grids and Sustainability

A smart grid is an electricity network that uses digital and other advanced technologies, such as cyber-secure communication technologies, automated and computer control systems, in an integrated fashion to be able to monitor and intelligently and securely manage the transport of electricity from all generation sources to economically meet the varying electricity demands of end-users.



Smart Grids and Sustainability

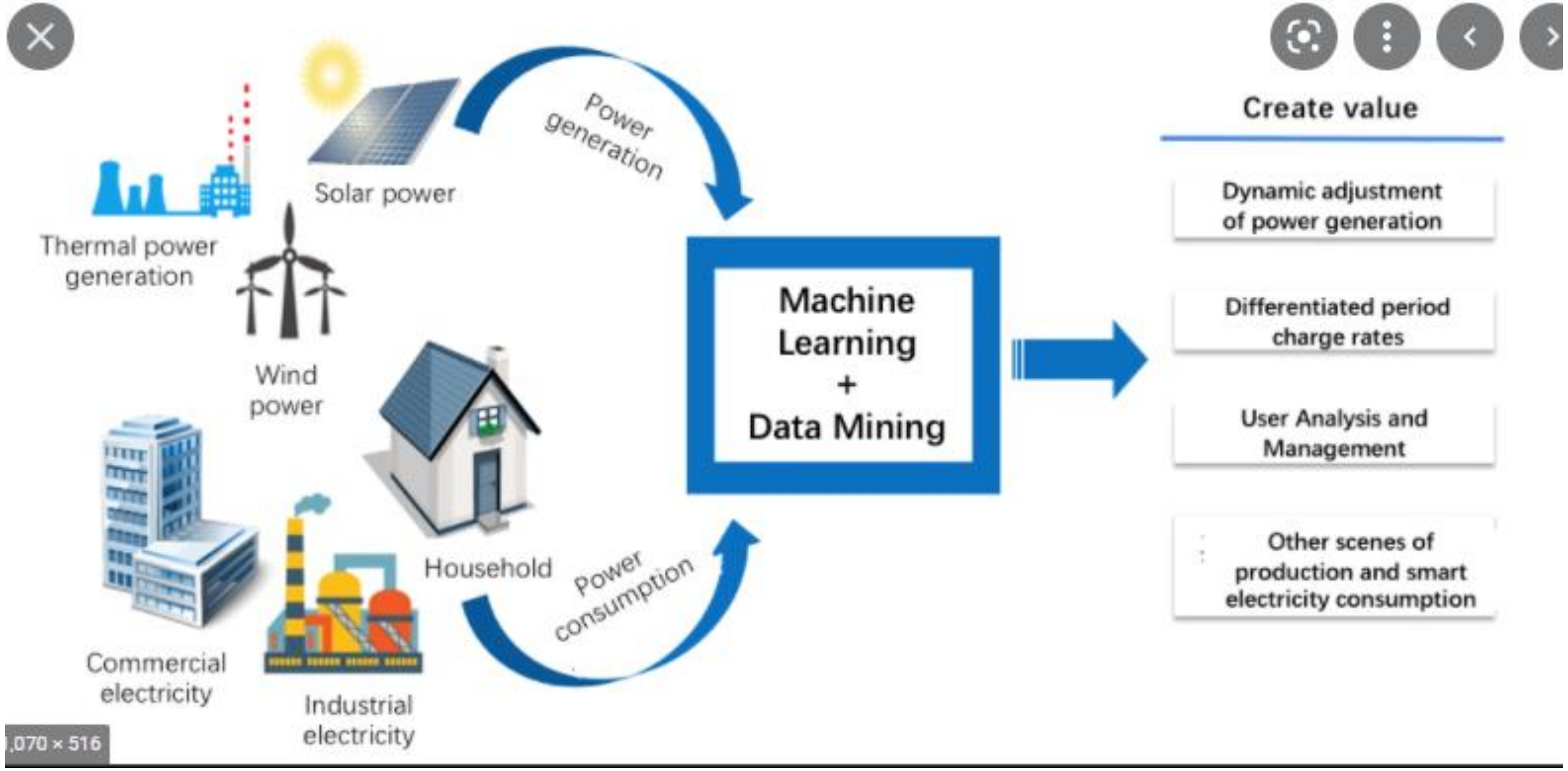
- Smart grid values
  - More reliable -- More economic -- More efficient
  - More secure -- More environmentally friendly -- Safer
- Smart grid principal characteristics
  - Enable active participation by consumers **- demand response**
  - accommodate all generation and storage options **– distributed generation**
  - enable new products, services, and markets – **peer to peer energy trading**
  - optimize asset utilization and operate efficiently - **VPP**
  - anticipate and respond to system disturbances – **outage prediction and self-healing**



Source: *https://doi.org/10.1016/j.ijhydene.2020.01.047*

Smart Grids and Sustainability

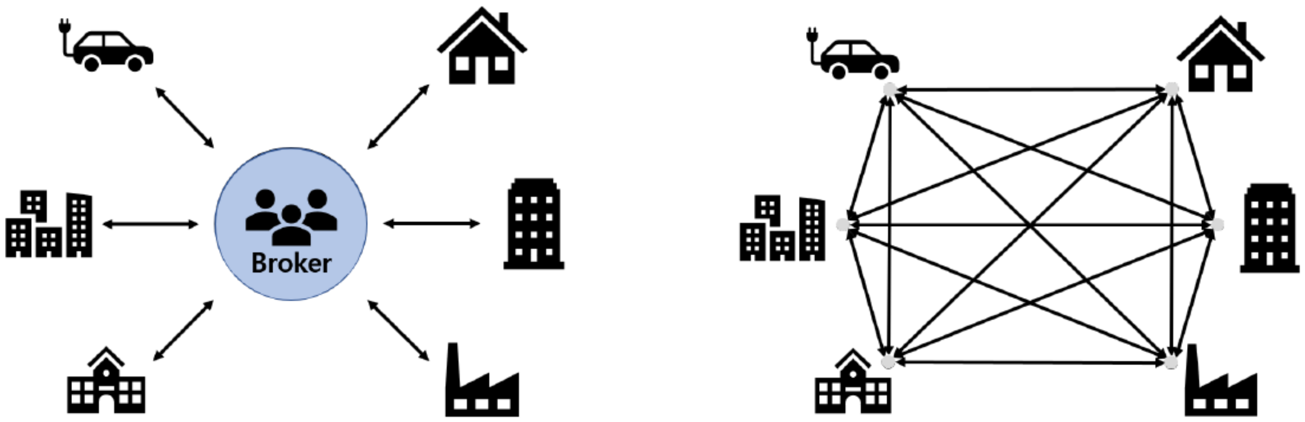
- Failure prediction
- Power outage prediction
- Dynamic energy management – demand response; peer-to-peer electricity trading etc
- Demand side management
- Theft detection
- Predictive maintenance
- Real-time customer billing
- Optimising asset management
- Enhancing customer experience
- Demand and renewable forecasting
- Condition monitoring



Source: *https://wanglab.sjtu.edu.cn/en/Pictrueleft.aspx?info_lb=501&flag=503*

Smart Grids and Sustainability

- Some customers have installed Distributed Generation (DG) and energy storage. Such customers do not only consume electricity, but also can supply power to the grid.
- In P2P energy trading, the main agent is the prosumer, who produces and consumes energy and exchanges with other prosumers for surplus electricity that is overproduced after consumption.

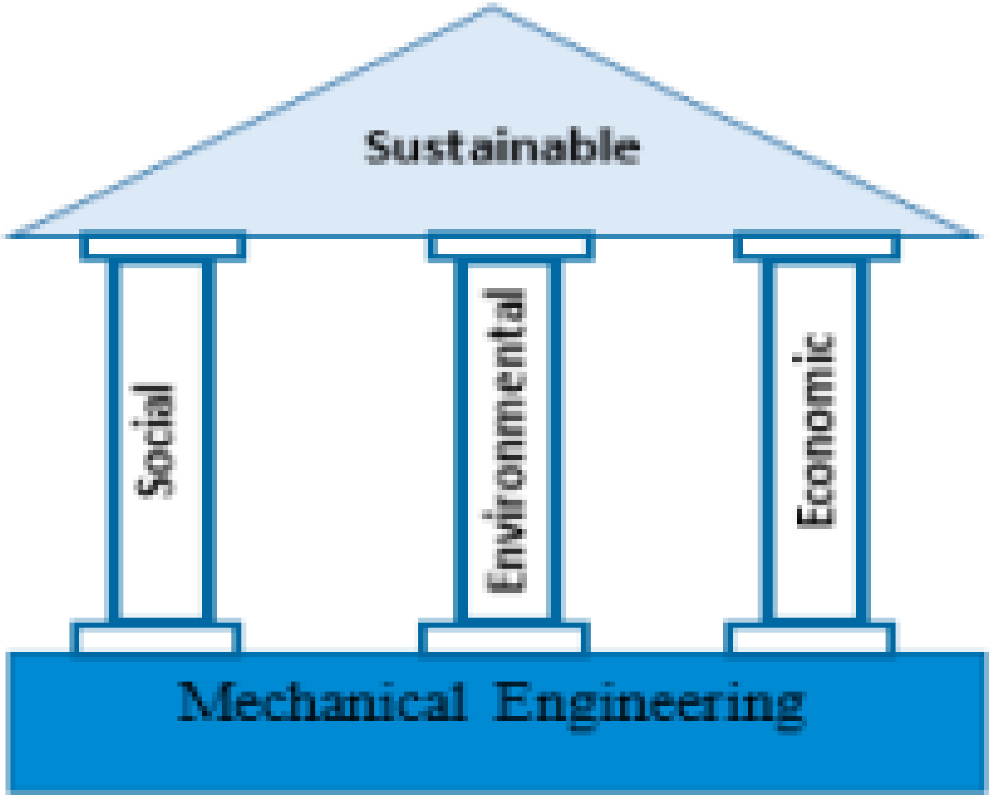


Introduction - Presenter

Dr. Arti Siddhpura

- 16+ years of experience as an academic in top Australian and overseas universities.
- PhD in Mechanical Engineering from UWA.
- Received prestigious awards from the Australian government and published in high-ranking international journals and conferences.
- Lecturer in Mechanical Engineering, RPL and PD coordinator at EIT.
- Research interests: Condition monitoring of machine tools, diagnosis and prognosis of tool life, smart manufacturing

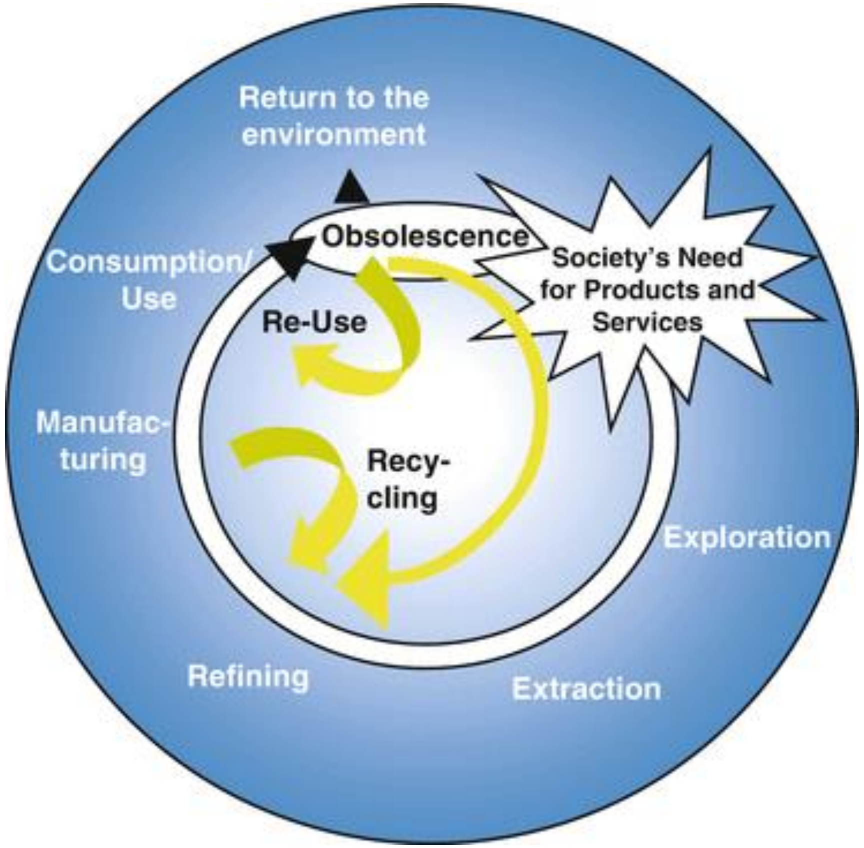
Sustainability for Mechanical Engineers



- Sustainability – Earth Charter
- Sustainable Engineering - UNESCO
- 3BL or 3Ps

M.E. Abu-Goukh, G.M. Ibraheem, H.M. Goukh. Engineering education for sustainability and economic growth in developing countries (the Sudanese Case). Procedia-Social and Behavioral Sciences. 2013 Nov 22; 102:421-31.

Sustainability through PLM (Product Lifecycle Management) – a holistic approach



Sonnemann G., Gemechu E.D., Remmen A., Frydendal J., Jensen A.A. (2015) Life Cycle Management: Implementing Sustainability in Business Practice. In: Sonnemann G., Margni M. (eds) Life Cycle Management. LCA Compendium – The Complete World of Life Cycle Assessment. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-7221-1_2

Sustainability for Mechanical Engineers

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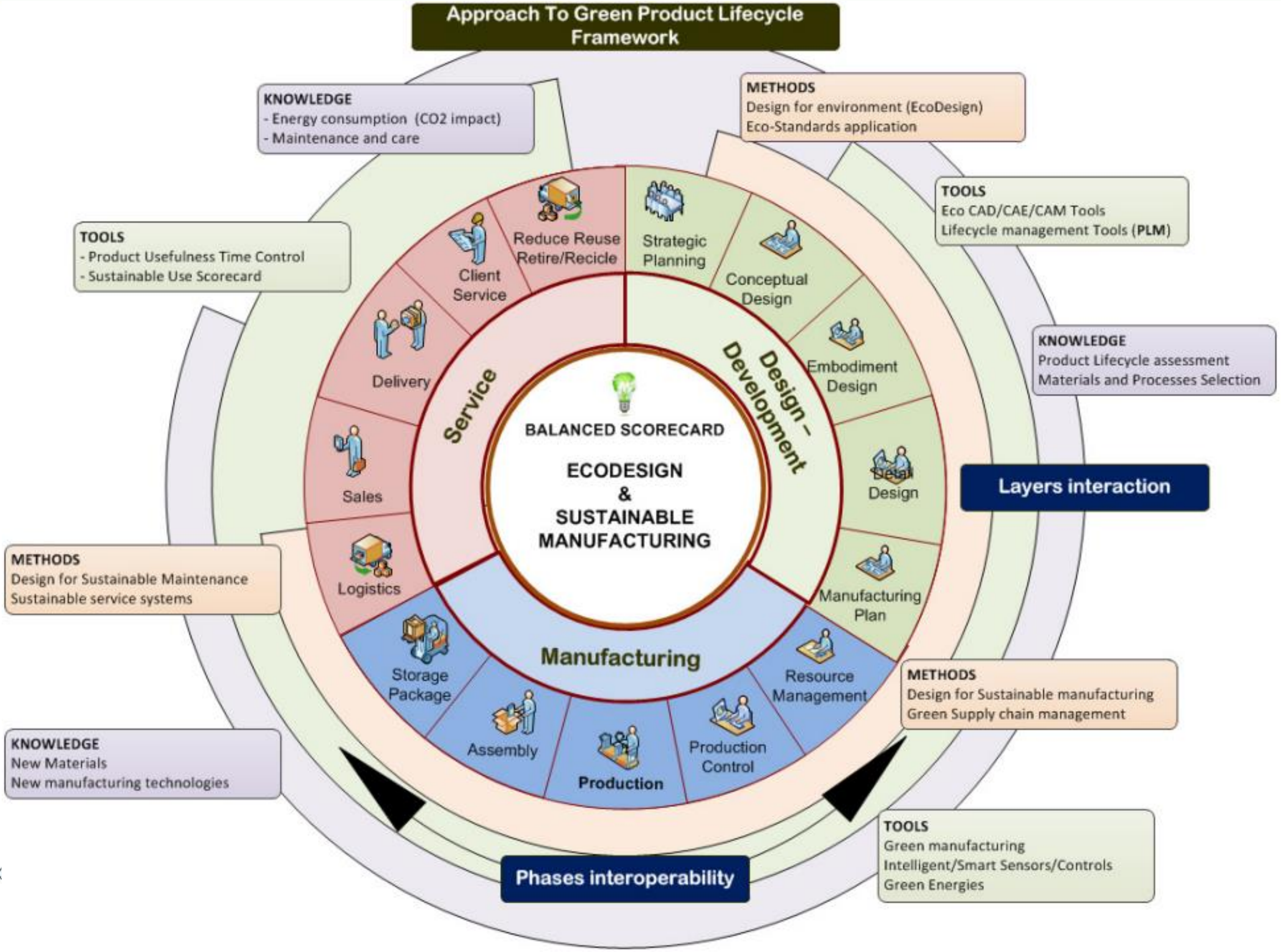
Sustainability through PLCM (Product Life Cycle Management) – a holistic approach



Abellán-Nebota, J. V. et al. "An approach to Sustainable Product Lifecycle Management (Green PLM)." (2015).

Sustainability for Mechanical Engineers

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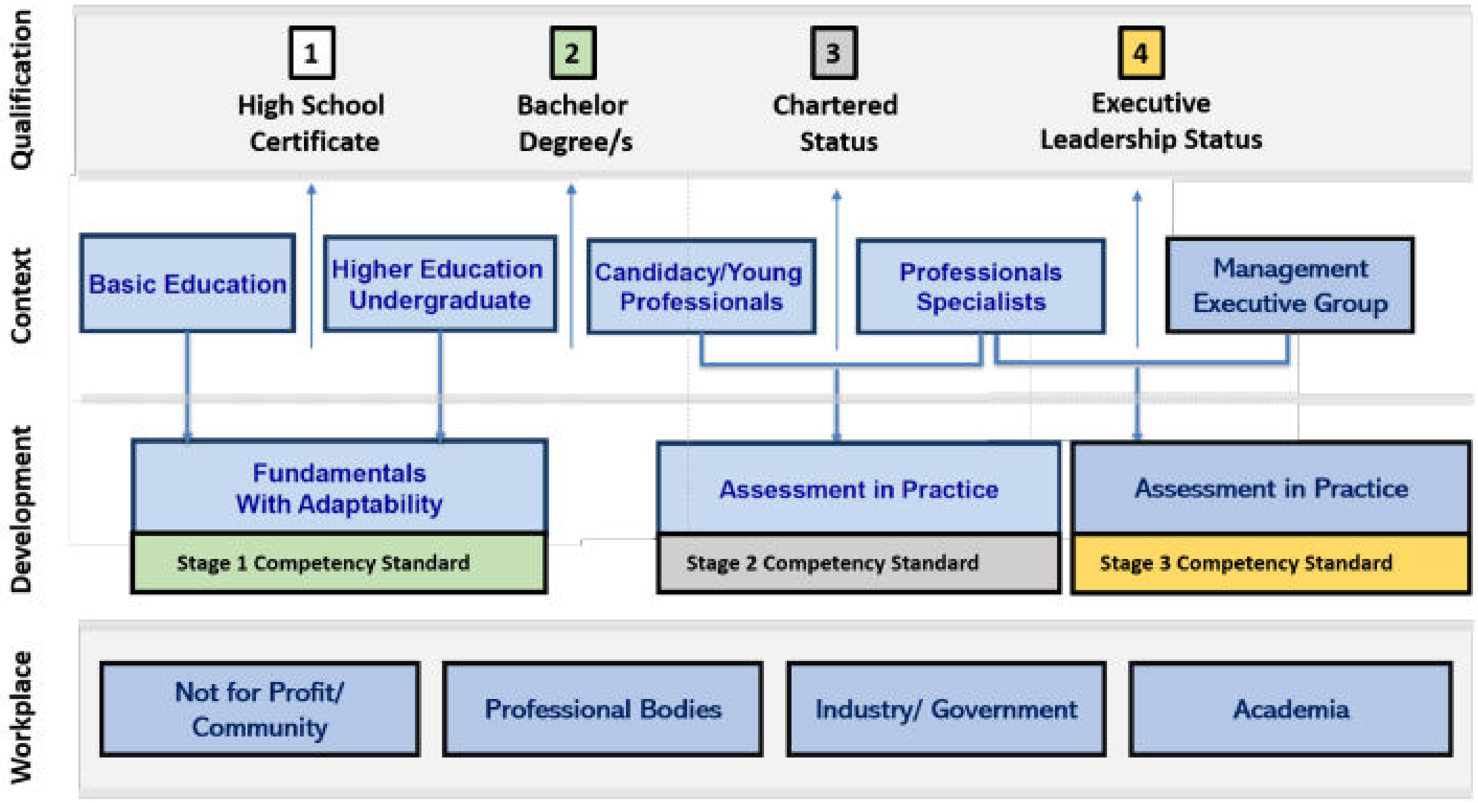
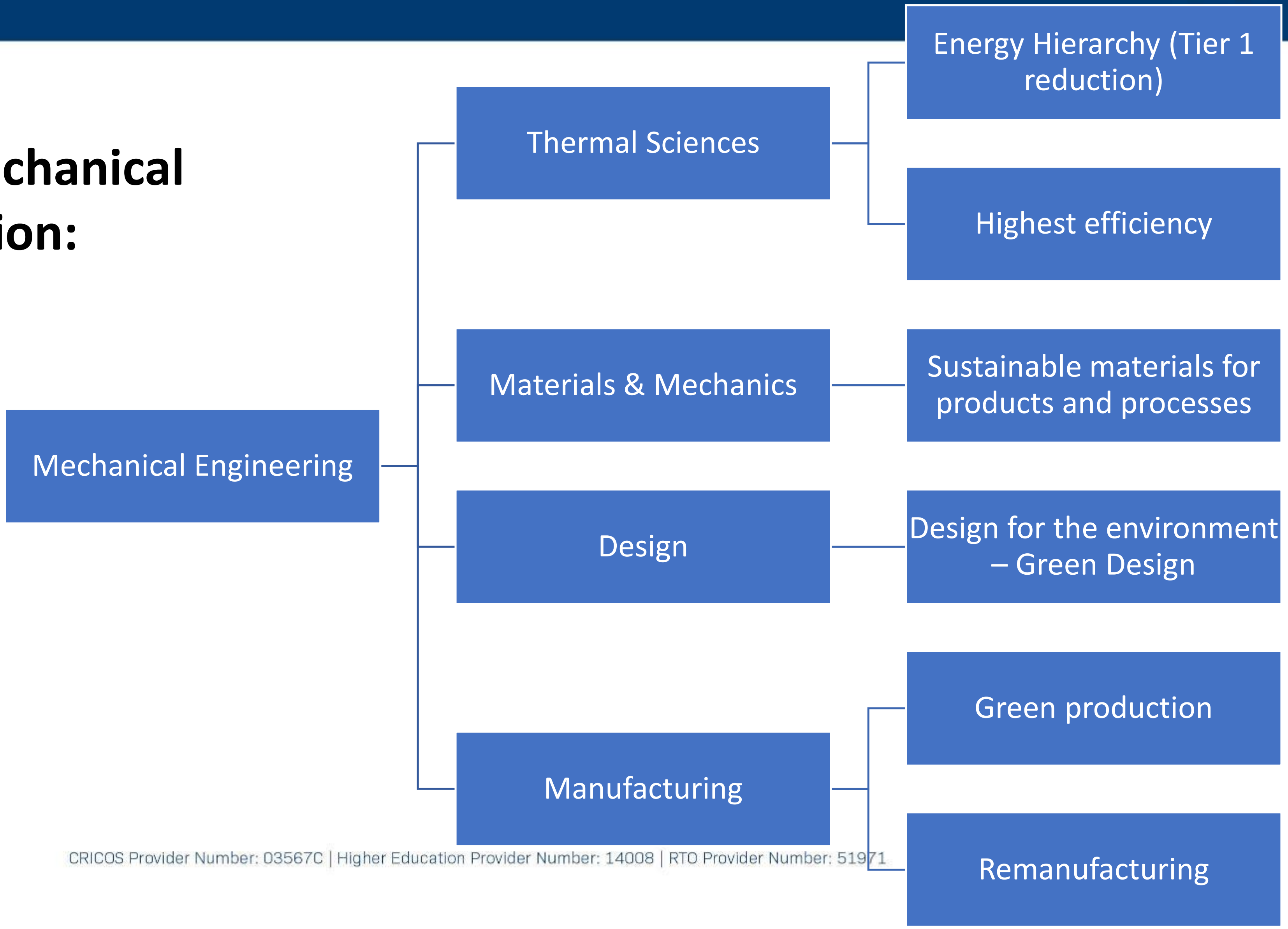
Sustainability in education:



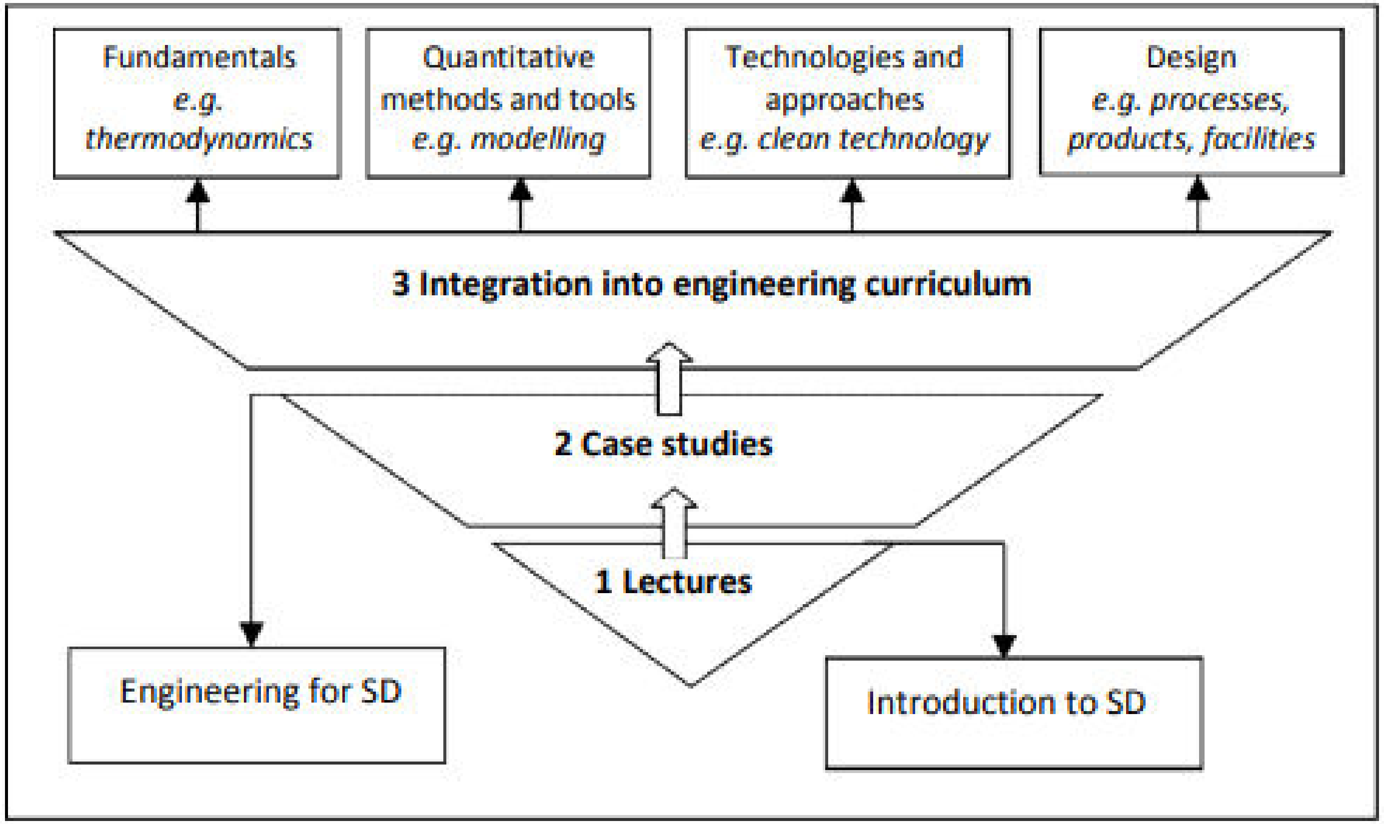
Desha, Cheryl, Debra Rowe, and Doug Hargreaves. "A review of progress and opportunities to foster development of sustainability-related competencies in engineering education." Australasian Journal of Engineering Education 24.2 (2019): 61-73.

Sustainability for Mechanical Engineers

Sustainability in mechanical engineering education:



Sustainability in mechanical engineering education:



Azapagic, A., Perdan S. & Clift, R. (2004). Sustainable Development in Practice: Case Studies for Engineers and Scientists. JohnWiley: Chichester.

Introduction - Presenter

Dr. Milind Siddhpura

- Over 18 years of experience as an academic in top Australian and overseas universities.
- PhD in Mechanical Engineering from UWA.
- Received prestigious awards from the Australian government and published in high-ranking international journals and conferences.
- Course Coordinator in Mechanical Engineering at EIT.
- Responsible for developing and maintaining highest quality in the Bachelor’s, Master’s and Doctorate of Engineering courses.

Sustainable Manufacturing Processes and Products

Sustainable Manufacturing Processes:

1. Microwave Material Processing: A clean, green and sustainable approach

2. Thixoforming of Light-weight Alloys and Composites: An approach towards Sustainable Manufacturing

3. Experimental and Numerical Analysis of Al-Cu Sheets using Hydraulic Bulging Process

https://www.researchandmarkets.com/reports/4759485/sustainable-engineering-products-and

Sustainable Manufacturing Processes and Products

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Sustainable Engineering Products:

1. Hybrid Welding of 304 Austenitic Stainless Steel
2. Design and Construction of Helical Anchors in Soils
3. CFD Design/Analysis of Heat Exchanger
4. CFD Design/Analysis of ‘Cross-Flow Turbine’ for Tidal Energy Extraction
5. Parameter Optimization Using the Surface Response Technique in Automated Guided Vehicles (AGVs)
6. Evolution of Material Selection in Commercial Aviation Industry

https://www.researchandmarkets.com/reports/4759485/sustainable-engineering-products-and

Introduction - Presenter

Dr. Ana Evangelista

Ana is a passionate Civil Engineer and is currently a Lecturer and Work Integrated Learning Coordinator at EIT. Her research in Australia has been focused on sustainability in construction and engineering materials and her PhD research was mostly concentrated on non-destructive tests to evaluate concrete structures.

Why Sustainability in Engineering ?

- Sustainable engineering is the process of using resources in a way that does not compromise the environment or deplete the materials for future generations.
- Sustainable engineering requires an interdisciplinary approach in all aspects of engineering and it should not be designated as a sole responsibility of environmental engineering.

Why Sustainability in Civil Engineering ?

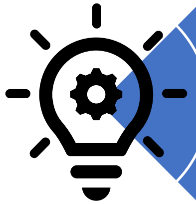
‘that a healthy economy is underpinned by a healthy environment and respect for all life on earth’
(Engineers Australia)

How can we reduce the environmental impacts in AEC sector ?

Using materials with low(er) embodied energy

Reducing transport of materials and associated fuel, emissions and road congestion

Preventing waste going to landfill



Designing and constructing for ease of reuse and recycling at end-of-life (design for deconstruction).

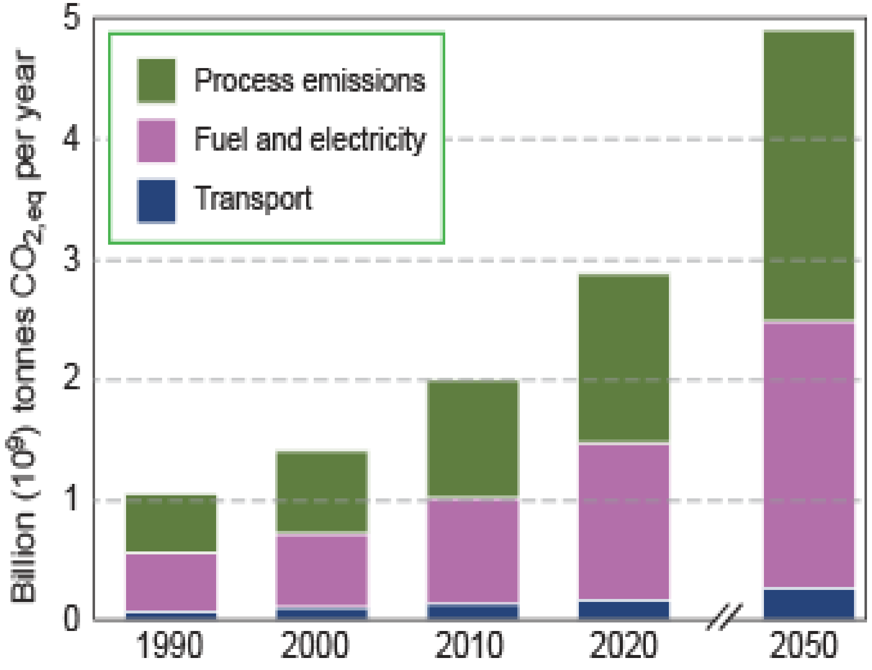
Cementitious Materials & Carbon Emissions

Carbon emissions arise from fossil fuel combustion and from the **calcining reaction**

$$(CaCO_3 \rightarrow CaO + CO_2)$$

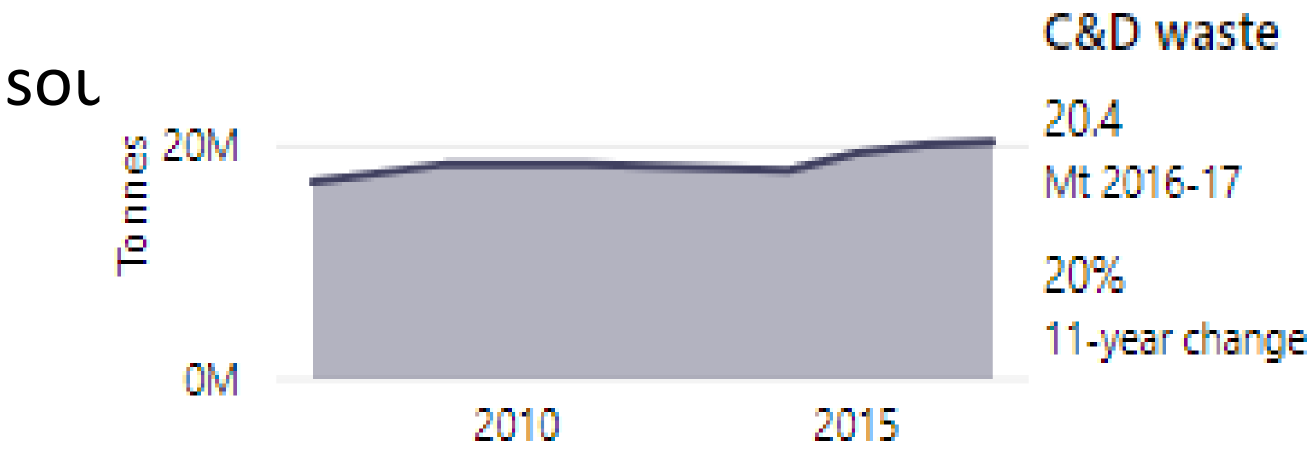
1 tonne of cement releases around 1 tonne of CO_{2eq}

Globally 5% of all greenhouse gas emissions are from making **cement**; expected emissions of 5 billion tonnes/year by 2050 (grantadesign.com)



Waste Minimisation

Australia generated **75.8 million tonnes** of solid waste in 2018-19, which was a 10% increase over the last two years (since 2016-17).



Construction

- **16.8% of total waste**
- Largest supply of masonry materials (8 million tonnes)**, 35% of all masonry material waste**
- $2 billion spent on waste services
- Construction waste increased by 22% since 2016-17

Over **200 million tonnes** of **aggregates** are used in the construction of homes, workplaces, public buildings and roads every year. (Source : CCAA,2020)

Recycled concrete – tyre waste

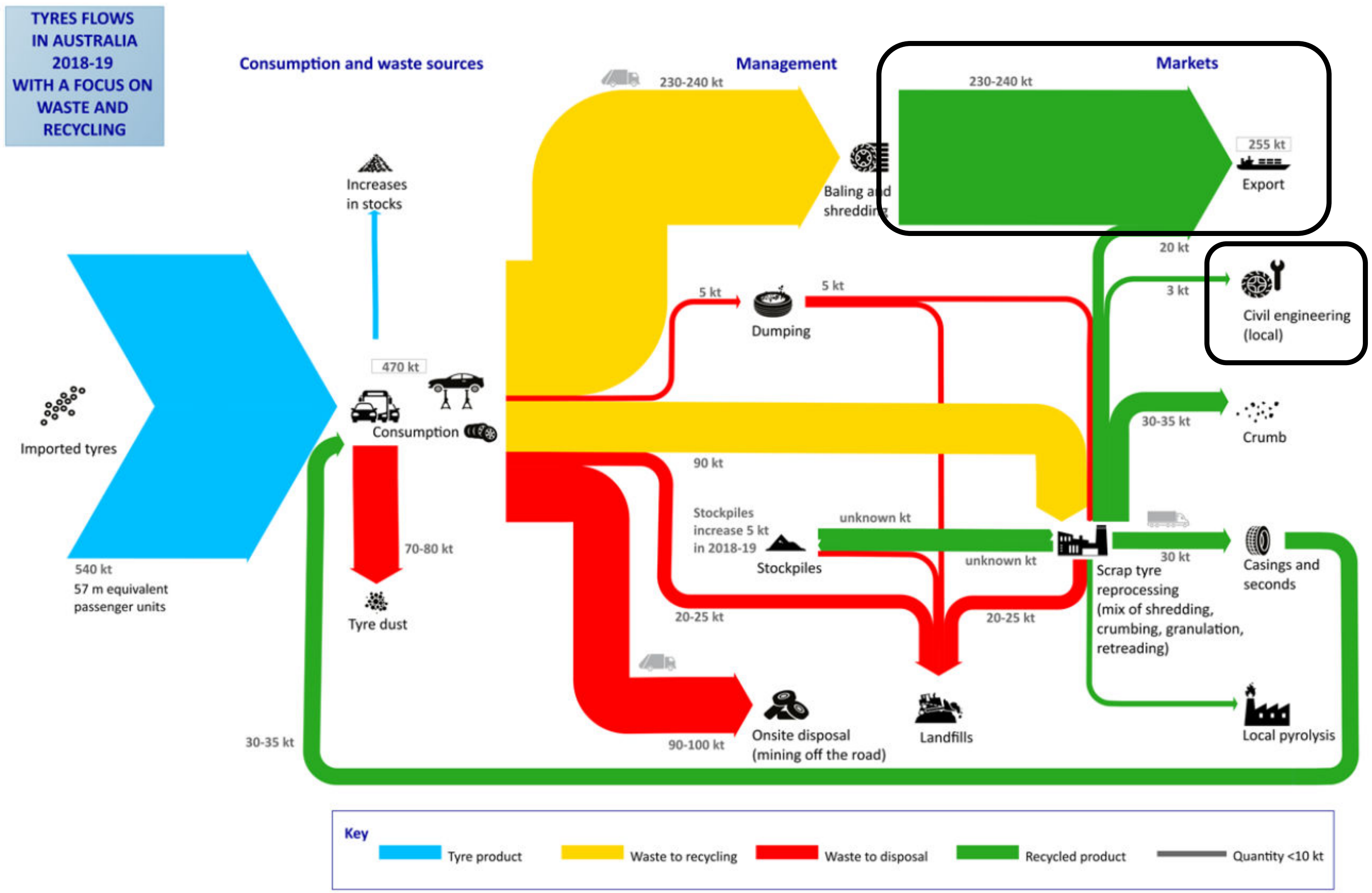
- In the past twenty years, many attempts have been made to utilise recycled waste tyre rubber as an aggregate substitute in concrete and pavements

Introduction - Presenter

Dr. Harisinh Parmar

Chemical engineering professional with extensive experience in industry and in academia. Experience in design of a subsea settling tank, CFD modelling of trickle bed reactor for H_2S removal in LNG plant and multi-scale modelling of biomass pyrolysis. Interested in application of CFD in various industries for process intensification and optimization.

Australian tyre flows in 2018–19



Domestic EoL tyre fates in 2018–19

Fate	Passenger (tonnes)	Truck (tonnes)	OTR (tonnes)	Total (tonnes)
Casings & seconds	2,000	30,000	0	**32,000**
Civil engineering	1,000	1,000	1,000	**3,000**
Crumb, granules and buffings	6,000	27,000	0	**33,000**
Pyrolysis[1]	NR	NR	NR	NR
Stockpiles	-	-	-	**5,000**
Landfill	21,000	8,000	5,000	**34,000**
Onsite disposal (mining OTR)	0	0	96,000	**96,000**
Dumping	1,000	2,000	2,000	**5,000**
Total	**32,000**	**70,000**	**107,000**	**208,000**

Source: REC, et. al. (2017) *analysis (updated).*

1. Local pyrolysis processed tyre data not reported due to commercial confidentiality constraints. Quantity is currently well under 5,000 tonnes/yr.

Feasibility study for ROI

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(ROI) 100 TONS/DAY in USD.		
Particulars	**Unit**	**100 Tons per day**
Raw material feeding/month (steel free Crumb rubber)	Mt	2500
Sale Price of Green oil	d/Mt	450
Sale Price of Raw Carbon	d/Mt	55
Sale price of Uprgraded Carbon	d/Kg	285
Sale Price of Steel Wire	d/Mt	200
Recovery of Oil % from Crumb Rubber feeding	%	**45**
Recovery of Raw Carbon % fromCrumb Rubber feeding	%	35
Monthly Oil production	Mt	**1125**
Monthly Raw carbon production	Mt	**875**
PRODUCTION COST		
RM (Crumb) cost/month(1x3)	USD	**62500**
Cost of Electicity/month(1x6x7)x24 hrs	USD	**7500**
Total USD (Man power cost)		**127000**
Cost of Maintanance approx	d/month	**4000**
Cost of office expance petrol/stationary/ etc.	d/month	**5000**
Total cost of production	d/month	**206000**
REVENUE FROM SALES		
Revenue from sale of Green OIL	USD	**506250**
Revenue from sale of raw carbon	USD	**48125**
Total Income	USD	**554375**
Monthly Gross Profit without interest & depreciation	USD	**348375**
Annually Gross Profit without interest & depreciation	USD	**4180500**

Upcoming Technical Webinars

Carbon Dioxide As Working Fluid for Power Generation and Refrigeration
Date and time: Thursday, 10 March 2022, 3:00pm - 4:00pm AWST
Enabling Digital Transformation of Industry With AI and Big Data
Date and time: Thursday, 17 March 2022, 6:00pm - 7:00pm AWST
Voltage, Stability and Islanding Control in Microgrids
Date and time: Thursday, 31 March 2022, 3:00pm - 4:00pm AWST

Upcoming webinars: https://www.eit.edu.au/news-events/events/

Upcoming EIT Courses

We have a range of courses in Civil, Electrical, Mechanical and Industrial Automation Engineering.

Course Type	Intakes/start date
Professional Certificate of Competency courses (short courses)	Throughout the year
Diploma & Advanced Diploma courses	Throughout the year
Undergraduate Certificates	25 July 2022
Bachelor of Science degrees	25 July 2022
Graduate Certificates	27 June 2022
Master of Engineering degrees	27 June 2022
Doctor of Engineering	25 July 2022
On Campus Bachelor's, Master's and Doctor of Engineering programs	1 August 2022

See our full course schedule here: www.eit.edu.au/schedule/

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SCAN ME

Q&A

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