



#### Tim Patterson CEO Fuel Economy Solution (International) Limited



## Biofuels and Biological Fuel Systems for the Green Economy

#### February 17<sup>th</sup> 2022



THEME: Sustainable Future Fuel for Global Green Climate







## **Presentation Summary and Key Questions**

Fuel Economy Solution & Economy Solution Group intro then:

- 1. What are the biofuel types, biomass sources and their uses?
- 2. Biofuels benefits, key technical and market challenges
- 3. Should we be using biomass in the first place this way?
- 4. Combustion vs Pyrolysis of biofuels the new pathway?
- 5. Alternative use of ICEs to release biofuels elsewhere
- 6. ESG Forecast trends to impact the global biofuels sector.



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#### **Fuel Economy Solution**



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## **Fuel Economy Solution**

- Fuel Economy Solution founding brand of ESG
- The core FES technology is combustion efficiency
- Ultimate System Integrator (USI) product range
- Combustion chamber catalysts refinery and secondary
- Refinery end bespoke biofuels stability additive packages
- Private label supply also available
- Reshape the burn of fossil fuels, biomass and biofuels
- Improve thermal efficiency (= savings) and lowers GHGs



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## **Fuel Economy Solution**

- 2018 launch: USI- combustion catalyst range.
- To 2020 fuel tech only COVID changed all that
- Health Economy Solution launched in May 2020.
- Green ECOnomy Solution launched in June 2020.
- Common focus: Green Economy Transformation.
- FES = *founder* of the **Economy Solution** Group.



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- Group entity legally formed 11<sup>th</sup> November 2021
- 4 Economy Solution core subsidiaries formed Jan 2022:
- **Fuel** Decarbonizing Energy
- **Green** Bio-restoration of the Environment
- Health Increasing Biological Resilience in Society
- Finance brown transition and green tech financing (



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# **Green Economy Solution Consulting**

- Fuel and Energy use audit across operations
- Identify potential fuel efficiency OPEX savings
- Propose potential emissions reduction plan
- Validate entire project lifecycle benefits
- Underpinned by fuel efficiency testing
- Investors welcome to inquire re. current raises









#### **Finance Economy Solution**

- Seeking finance currently for >12 ventures total value >\$5b.
- Ventures range from <\$500k TRL 2/3 up to 1\$b+ to TRL7+

9 DEPLOYMENT ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT 8 SYSTEM COMPLETE AND QUALIFIED SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL 7 ENVIRONMENT DEVELOPMENT 6 TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT 5 TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT 4 **TECHNOLOGY VALIDATED IN LAB** 3 EXPERIMENTAL PROOF OF CONCEPT RESEARCH 2 TECHNOLOGY CONCEPT FORMULATED BASIC PRINCIPLES OBSERVED





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Biofuels & Biological Fuel Systems for the Green Economy



**TECHNOLOGY READINESS LEVEL (TRL)** 





#### **Finance Economy Solution**

- Biofuels are included in these key projects for investment
- Various areas across our core ESG brands and eco system
- Specific focus includes transformation (brown tech) projects
- Greening of mining, industrial processes & power is essential
- Green bonds don't cover what is needed
- 78% TCFD fund managers not green economy trained Nov/20
- Seeking financing for clean growth solutions integration
- ESG & our Partners are raising for what is needed not popular



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- 4 other Economy Solution subsidiaries also formed Jan 2022:
- Blue Decarbonizing shipping and restoring the oceans
- Mineral Decarbonizing up mining and mineral processing
- **Coal** improving combustion and carbon capture
- Hydrogen On Board On Demand dual fuel retrofits & RCE H<sub>2</sub>
- A mining and healthcare joint venture in South Africa (Jan 22)
- A joint venture planned in ASEAN 1H/22
- More subsidiaries planned around graphene, nuclear, circular economy, wind, solar, water, food, education and security.



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Behavioural change by Society to improve resilience and reduce brown carbon intensity

Shift from traditional forms of energy to *sustainable* energy from environmentally friendly sources



Restore balance to earth's carbon (Currently c.550Gt deficit) Major progression in State-Citizen Ecosystems for Smart Cities

Improve the Biosphere and increase low carbon high resilience food chains



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### **Economy Solution Group: Strong Management Team**

- 3 directors
- Over 120 years of experience in business
- ServCo OpCo business model
- >63,000 employees worldwide to call on from our partners
- Agile to address fast moving green economy transformation
- Core skill sets in aftermarket automotive, combustion engineering, construction, mining, programme management and business operational excellence.
- Looking for partners *across* the Economy Solution Group



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# **Key ESG Sectors**

- Power Generation
- Marine Transport
- Land Transport
- Mining & Mineral Processing
- Renewable Energy
- Agri Tech
- Materials Technology
- Circular Economy



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#### 2050 FUEL ECONOMY SOLUTION 2020

## **Economy Solution Group**

#### **Economy Solution Group**



ENERGY SECURITY

CLEAN ENERGY

CLEAN WATER





THEME Sustainable Future Fuel for Global Green Climate Biofuels & Biological Fuel Systems for the Green Economy



URBAN MINING LANDFILL MINING R WASTE TO ENERGY **PYROLYSIS SOLUTIONS** RECYCLABLE COMPOSITES

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CRITICAL MINERALS TAILINGS PROCESSING

OFF/MICRO GRID STANDALONE CLEAN ENERGY SYSTEMS

#### **Green ECOnomy Solution** H,ydreGEN Economy Solution

ICE RETROFITS & H2 SUPPLY TO ALL EQUIPMENT (2023 TO 2040) RCE H2 ELECTROLYZERS GIGA FACTORY PRODUCTION (ELECTRICITY) RCE H2 FUEL STATION SLED UNIT SUPPLY (TRANSPORT)

SUPERCAPACITORS STORAGE OF RCE H2 GENERATED ENERGY (fuel & electricity)





#### 1. Biofuels types, Biomass sources and their uses



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## **Biofuel types**

- Gaseous
  - Biogas and biomethane (e.g. Produced from AD)
  - Syngas (partial combustion to form CO, H<sub>2</sub> + HCs)
- Liquid
  - Most common are bioethanol and biodiesel



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## **Biofuels: 4 Generations of Biofuel Production**

- 1G: Food crops grown on arable land.
- 2G: Lignocellulosic, woody biomass or agricultural waste.
- 3G: Algae formed in ponds or tanks on land or out at sea.
- 4G: includes electro fuels and solar fuels.
- Electro fuels are produced by storing electrical energy
- Solar fuel is made from solar energy.



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#### **Biofuels: 4 Generations of Biofuel Production**



Different generations of biofuels (Reference: sciencedirect.com)



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## **Biofuel & Biological Energy Systems**

- This could be deemed a new category
- Involves creation of energy systems from biomass/fuel
- Further re-use of a by product from biomass processing
- This could include circular economy in food production
- Even better it could be new sustainable food practices
- The biomass by-product is critical energy related output
- For example bio-refining using sugar beet waste for power
- However sugar beet can be used to produce graphene
- Low cost graphene will be needed for scaling supercaps



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#### **Biofuels: 4 Generations of Biofuel Production**



Different generations of biofuels (Reference: sciencedirect.com)



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**Biofuels: 4 Generations of Biofuel Production** 



Different generations of biofuels (Reference: sciencedirect.com)



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**Biofuels: 4 Generations of Biofuel Production** 



Combustion catalysis (biofuel combustion efficiency & stabilization additive packages)



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## 2. Biofuels: Benefits and Key Market Challenges



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## **Biofuels – benefits**

- Combustion efficiency of transport fuels
- Cost
- Durability
- Easy access to resources
- Renewable resources
- Reduction in GHGs
- Economy security
- Less pollution









## **Biofuels – key technical challenges**

- Sustainability of feedstock production e.g. Palm oil
- Additional use of land urgently needed for agriculture
- Consistency of product quality from plantations
- Stability in transport from plantation to refinery
- Oxidation stability affects quality and shelf life
- Raised total acid numbers corrosion?



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## **Biofuels – key market challenges**

- Carbon debt & payback times for biomass units
- Carbon payback time varies by supply chain
- Wood particularly challenging
- Better carbon accounting case to use waste only
- Is combustion the best method?
- Is combustion catalysis cost effective and helpful?



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#### 3. Biofuels: Should we be using/combusting biomass?



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#### **Biofuels: Should we be using/combusting biomass?**

• Some crops have high water consumption



Water footprint of biofuels from different crops [litre/litre]

Water use to product biofuele (Reference: slideplayer.com)



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#### **Biofuels: Should we be using/combusting biomass?**

- Food shortages caused by occupying crops' agri space
- Biofuel crop growth raises fertilizer-watercourse risks
- Biofuels are limited in use (CFPP in cold weather)
- BioLNG from biomass waste? No! Biochar CCUS



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## **Biomass & Biofuels Catalysis Research**

- Palm oil biodiesel
- Algae fuels from harvesting parasitic knotweed
- Cleaner burning biomass e.g. Olive pomace
- Additive for more improved recycling in pyrolysis



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# **Biomass & Biofuels Catalysis Research**

- Palm oil biodiesel Indonesia going from B20 up to B50 (Issues with oxidation stability and acid numbers)
  Benefit: Massively collapse transport CO<sub>2</sub> footprint
- Algae fuels from harvesting parasitic knotweeds (173 invasive alien plants recently studied in India)
  Benefit 1: Restore cleaner water bodies
  Benefit 2: Clean energy (algae fuel or pyrolysis + biochar)



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## **FES Proposition: For Sustainable Biofuels**

#### **Refinery end additive package proposals:**

- Look in details at each feed stock and application
- This will vary by market
- Finance for R&D will need to be raised
- We offer bespoke fuel stability additive packages
- Help to maximise production volume
- But also minimize emissions of volatiles combustion
- Improved product performance for all sector customers
- 2022 ASEAN JV: Biofuels proposal to a national refiner



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### 4. Biofuels: Combustion vs Pyrolysis



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## **Combustion vs Pyrolysis**

- If combustion can be avoided this is preferable
- However in transition this is not always possible
- Catalysis can help optimize combustion and lower GHGs
- Heating by pyrolysis for complex waste streams is better
- Simplifies and separates complex molecular structures
- Outputs yielded are the simple core elements









# **Pyrolysis Benefits**

- Significant reduction of waste volume by up to 85%
- Release of energy (i.e. generation of heat)
- Retrieval of metals oils and by products









• 7<sup>th</sup> August 2021 – 42 pg summary of findings AR06 report





#### FUEL ECONOMY SOLUTION POST



## **IPCC Report – 7<sup>th</sup> August 2021**

Approved Version

Summary for Policymakers

IPCC AR6 WGI

#### Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling





Figure SPM.2: Assessed contributions to observed warming in 2010-2019 relative to 1850-1900.







# **IPCC Report Summary Report:Figure SPM02**

- The SO<sub>2</sub> indicated as one of few factors slowing CC
- This has come from coal and other fossil fuels (transport)
- 100% fossil fuel cessation now would increase warming
- Due to less SO<sub>2</sub> reflected light and heat
- Before coal phase out we need massive bio-restoration
- Biochar production and re-sequestration into soils







# Advanced Thermal Carbon Recycling: Technology

Pyrolysis is the thermal decomposition of matter into:

- Gas
- Bio oil
- Carbon solids

In the absence of oxygen at temperatures between 600 and 900 degrees C.







- Good Waste to Energy solution for various feed stocks
- But greatest bio-restoration opportunity is with *biomass*
- FES preparing a framework agreement with an IP owner
- Using recent tech developments in pyrolysis (Aug21)
- Technology is being deployed now in sub-Saharan Africa
- Also in use as part of carbon capture in Latin America
- Plan in 2022 is to develop finance and roll out projects
- Market focus for FES is India, ASEAN, N Africa & Europe















## Advanced Thermal Carbon Recycling: Process









## **FUEL ECONOMY SOLUTION Advanced Thermal Carbon Recycling: Addressable Markets**

2050



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2020



#### In Solid Waste Recycling:

- Diverts biomass, municipal waste & plastics from landfills
- This avoids GHG emissions
- Creates energy and valuable products

#### **Other Applications:**

- Renewable Energy Generation
- Bio Carbon Production





- Renewable electricity & bio fuels (including green H<sub>2</sub>)
- Biochar
- Activated carbon







Biochar is a carbon-rich, stable solid derived by pyrolysis of agricultural, wood, forest and food waste:

- Carbon sequestration and offset
- Regenerative agriculture
- Remediation
- Livestock







- Sequesters carbon in soil
- Offsets 3 tons CO<sub>2</sub> emissions/tonne of biochar
- Could avoid 4 Gigatons of CO<sub>2</sub> emissions by 2050
- Why is this important to focus on?









#### 7. ESG Forecast Trends to Impact Global Biofuels Sector

- Biofuels will be just a transitionary step for the transport sector
- Fluid oscillation CC in power generation and vertical farming
- Solid state supercapacitors using graphene for battery storage
- Hydrogen (RCE & Fuel Cells) vs Lithium battery EVs -who will win?
- Scaling of retrofitting existing ICEs for on board on demand H<sub>2</sub>
- Graphene economy will explode with many circular opportunities
- Graphene sand composites as low cost water filtration material
- Vertical farming high volume, quality & efficient food production
- Growth in advanced thermal carbon recycling in the South-south
- Sequestration of pyrolised biochar back into the biosphere







## **Resonant Control Electrolysis Hydrogen**

- Significantly reduces the bond strength between H and O
- IP to treat water to re-structure covalent bond strengths
- 3-10x more efficient using existing electrolyzers
- Current R&D phase will take RCE Hydrogen to the next level
- Huge investment opportunity for giga factory H<sub>2</sub> production

# H<sub>2</sub>ydr GEN Economy Solution











## **Supercapacitors**

- Graphene SS energy storage technology
- Could well be a 4G electro fuel system with RCE H<sub>2</sub> charge
- Not really a battery no chemicals involved
- 1 million charges capability unlike Lithium ion
- Lithium ion 10 year max guarantee, cell change 4 years
- Sodium ion SS still electrochemical 800 charges
- Market leaders already in production
- FES & ESG partners can help integrate supercap solutions
- This will transform the future demands of global mining







## **Thank You**

#### **Economy Solution Group Limited**

Fuel Economy Solution (International) Limited. Green Economy Solution (International) Limited.
Health Economy Solution (International) Limited. Finance Economy Solution (Global) Limited
Blue Economy Solution Limited. Coal Economy Solution Limited. Mineral Economy Solution Limited.
Hydrogen Economy Solution Limited.TKEH

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THEME: Sustainable Future Fuel for Global Green Climate New ESG Web sites launch on SiloCloud 22nd February 2022

