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Organic Waste Treatment in urgent need for Innovation

EWGCFM 2013

ESCP Europe London campus

guo – Business Development

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BUSINESS from TECHNOLOGY

- 25 years track record in building added value from **Technological Core Competence** in the field of **Materials Technology** for **Thermal Management** Applications
- **Development** of Carbon Composite Materials enabled by "**DRY THERMO-CATALYTIC METHANE SPLITTING**" **C**arbon **C**apture for **U**se [CCU] at 55% thermal energy/mol Hydrogen than SMR
- **CCU** unlocks MARKETABLE VALUE from ANTHROPOGENIC METHANE by **recycling CO_2** with Waste Heat energy into Synthesis-Gas
- **Economy from Ecology** unlocked by **Resource Efficiency** through combination of elsewhere existing states of art into **CCU Bio-Refinery Concept** for organic waste utilization

“DRY THERMO-CATALYTIC METHANE SPLITTING”

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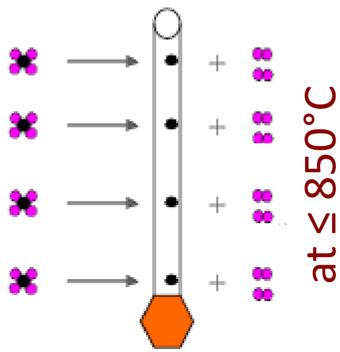
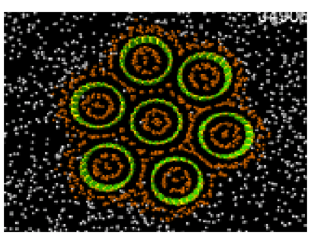
Hydrogen production by CVD Carbon Capture from CH_4

$CH_4 \rightarrow C + 2H_2$



group VIII
transition
metal catalyst

our prototype reactor developed under
EU-FP5 factory of the future program



co-produces “highly surface active **CARBON**” and **“HYDROGEN”**, together enabling to upgrade “energy rich decomposition gas” from abundant organic input materials into so called Synthesis gas (a combination of H_2 and CO).

Energy Efficiency State of Art from Organics

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Accelerated Decomposition into ENERGY-RICH GAS

By solid Biomass Gasification or Anaerobic Digestion of putrescible Biomass

ph & temperature-controlled digester in Strem /Guessing District, at European Centre of Renewable Energy (Future Energy Technologies)

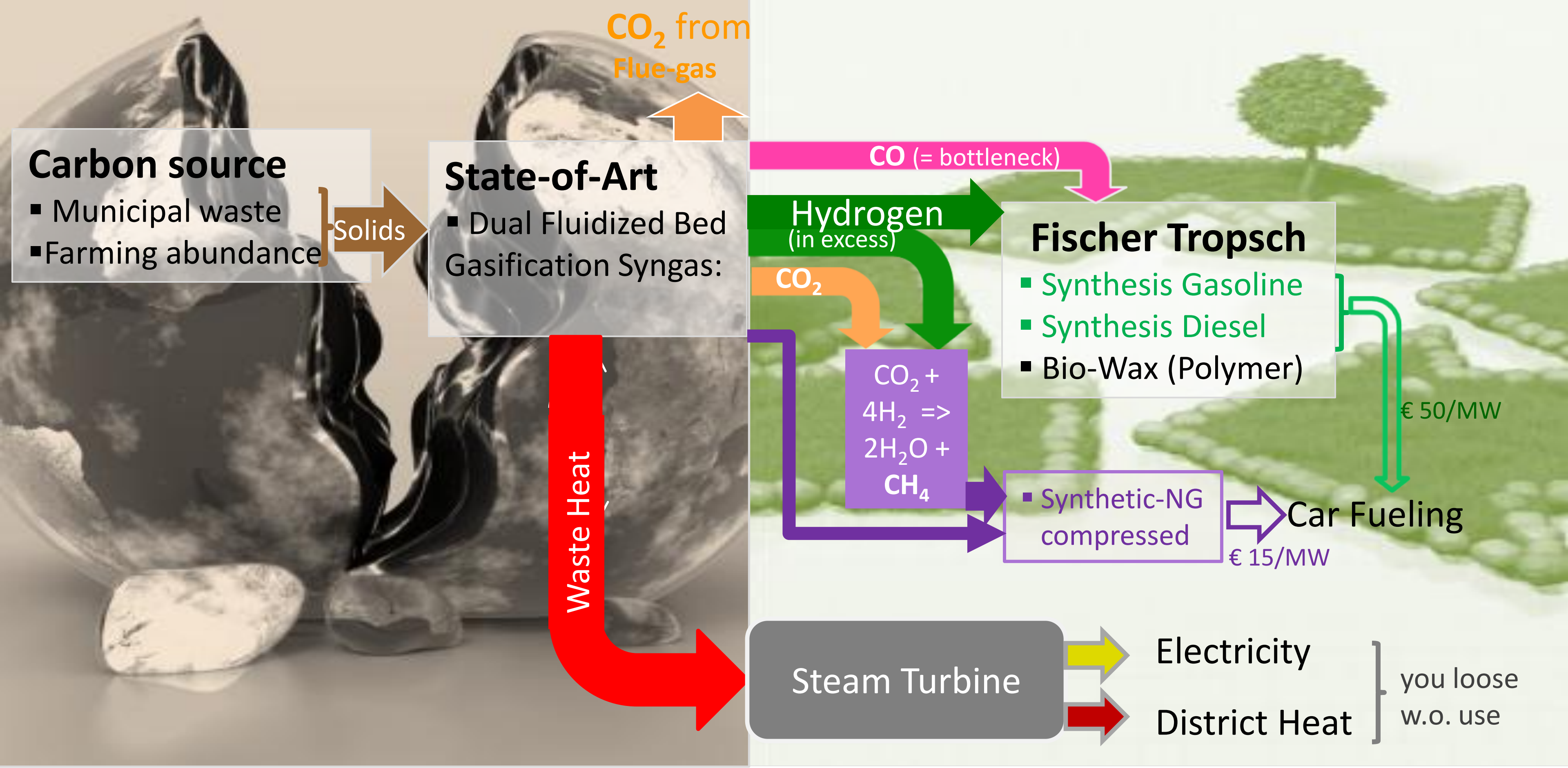
Delivering

50% Hydrogen, 20% CO, 20%CO_2, 7% CH_4 45-60% CH_4 + mostly CO_2 for the rest

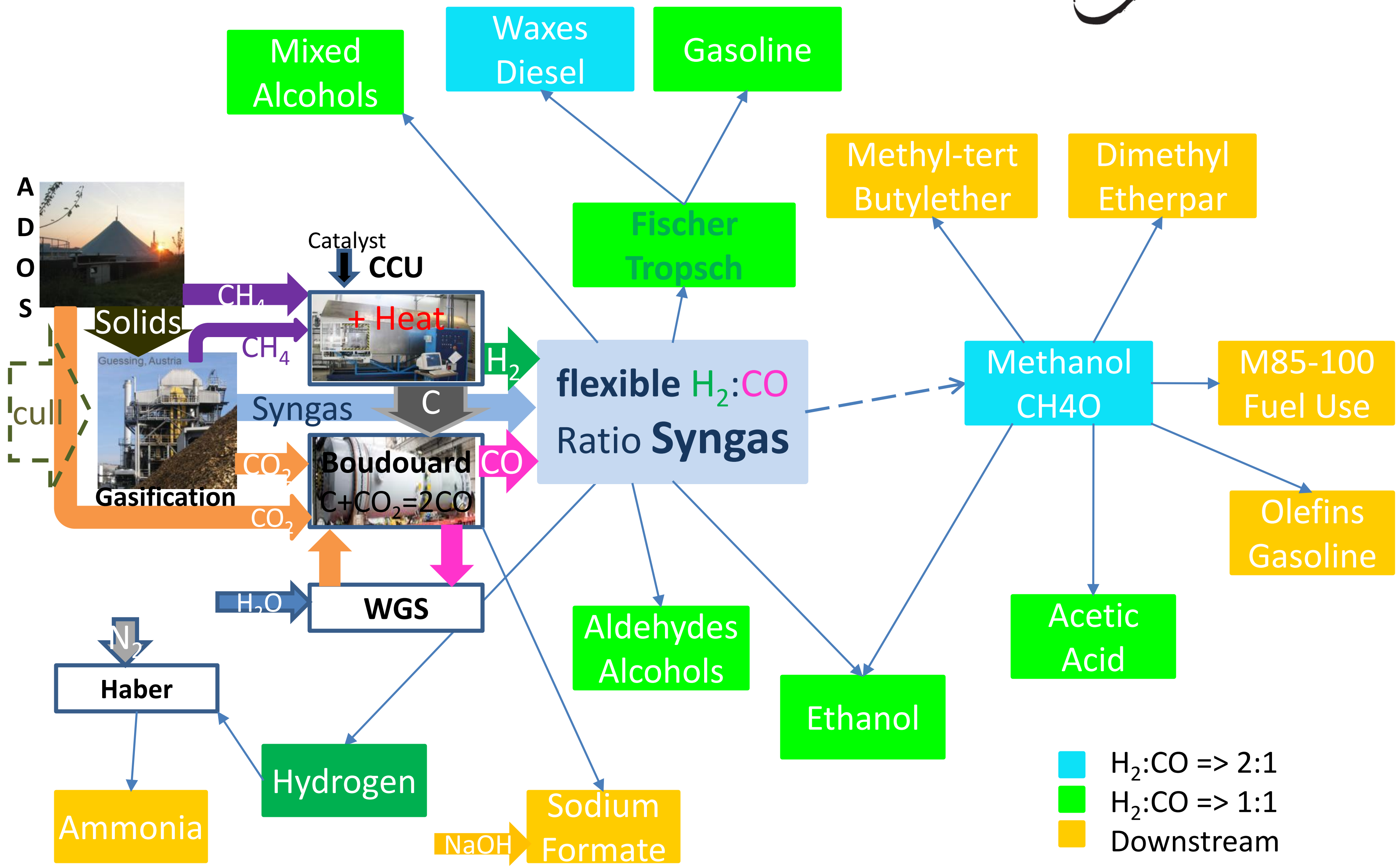
Poly-Generation (separate gas stream use)

Extending the Value Adding Hierarchy beyond Electricity

Utilization of Organic Residue State of the art at Guessing



Syngas Chemistry Opportunities



Modeling integration of CCU & $MSW_{organics}$

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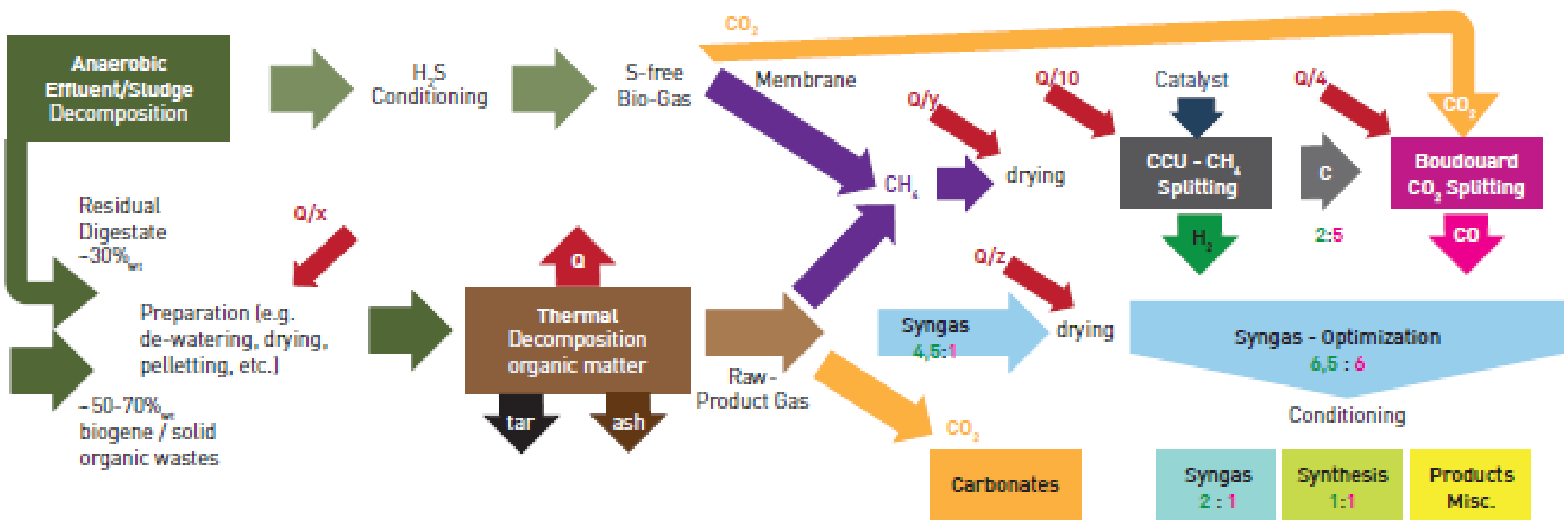
Energy-Mass Balances by IPSE-Pro for 80,000 capita

INPUT/hr	Mass	Chemical Energy	OUTPUT/hr	Volume	Chemical Energy
sewage sludge	6,250 kg	$2{,}6MW_{chem}$	CO_2	$120m^3$	-
F & K waste	625 kg	$1{,}6MW_{chem}$	CO	$1{,}050m^3$	$3{,}7MW_{chem}$
RDF waste	1,275 kg	$6{,}1MW_{chem}$	H_2	$1{,}350m^3$	$4{,}0MW_{chem}$



Revenues/hr	Electricity	+ Heat	Synthetic Fuel	+ Polymer	or Hydrogen only
in £	84	28	240	+ 120	410
unsubsidized market	at £ 37/MWh^{-1}	at £ 13/MWh^{-1}	at £ 67/barrel	at £ 0,93/kg	at £ 2,95/kg

Competitive Analysis (worldwide averages)

Technology comparison based on MSW (organic fractions)

		Biorefinery	ADOS	Incinerations	Landfills
Waste collected	fermentable	✓	✓	with auxiliary fuel	✓
	combustibles	✓	with extra treatment	✓	✓
Cost/ ton of waste handled		38£	11£	30£	13£
Main deliverables		Carbon & Hydrogen for synthetic gasoline	biogas	waste heat	landfill gas
Application of deliverables		advanced green clean fuel for ICE vehicles & aviation	$400kW_{el}$	$230kW_{el}$	$250kW_{el}$*)
CO_2 reductions / million tons of waste handled		1,170,000 tons	300,000tons	400,000 tons	150,000 tons*)
Revenue/ton waste handled (sludges @ $40\%_{water}$ ratio)		160£ @ £ 0.49/ltr. Gasoil & £ 0.93/kg Bio Wax	23£ @ £ 0,06/kWh CHP	13£ @ £ 0,06/kWh CHP	15£ *) if captured
EBIT %		15 - 20%	8%	<5%	10%
Payback time		<6 years	>7 years	12 years	?infrastructure?

INNOVATION looking for its IMPLEMENTATION

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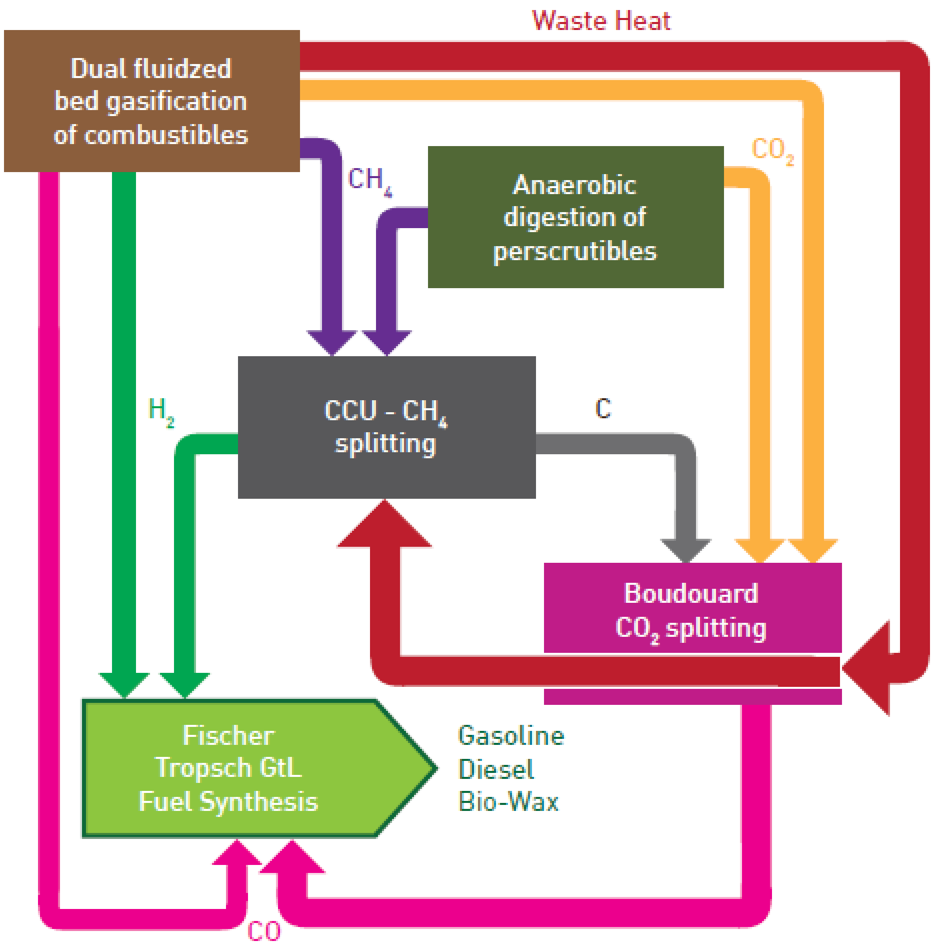
Scoping of a CCU Bio-Refinery for 250,000 capita MSW



- **Capital cost** per plant — £ 50 – 60mio
- **Operating cost** excluding feedstock — 13 – 15% of capex
- Number of **jobs per plant** — 30 – 35
- **Revenue** per plant — £ 20 – 25mio
- CO_2 equivalent CH_4 emission mitigation per plant — 158,500 t/yr
- CO_2 recycling effect per plant — 1,500 t/yr

Multi – Impact Dependences/Benefits

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obvious Public Private Partnership Opportunities

to increase local purchase power through energy supply from regional **closed loop circular economy**

Equipment Suppliers
a) DFB Reactors
b) Coal Gasifiers
c) Backend Refineries

Feedstock Provider
MSW Management, Small Holder Cull, wasteland grass, sludge residues from sewage, or COD Industries

Investment- Funds
Private Equity, RE – Funds, Contract Forfeiting, Clean Energy Commodity Futures, IFI-Development Funds, Islamic Financing, etc.

Plant Operator
Communities, Waste-Mgmt. contractors, (COD Effluent) Industries, Refinery Operators, etc.

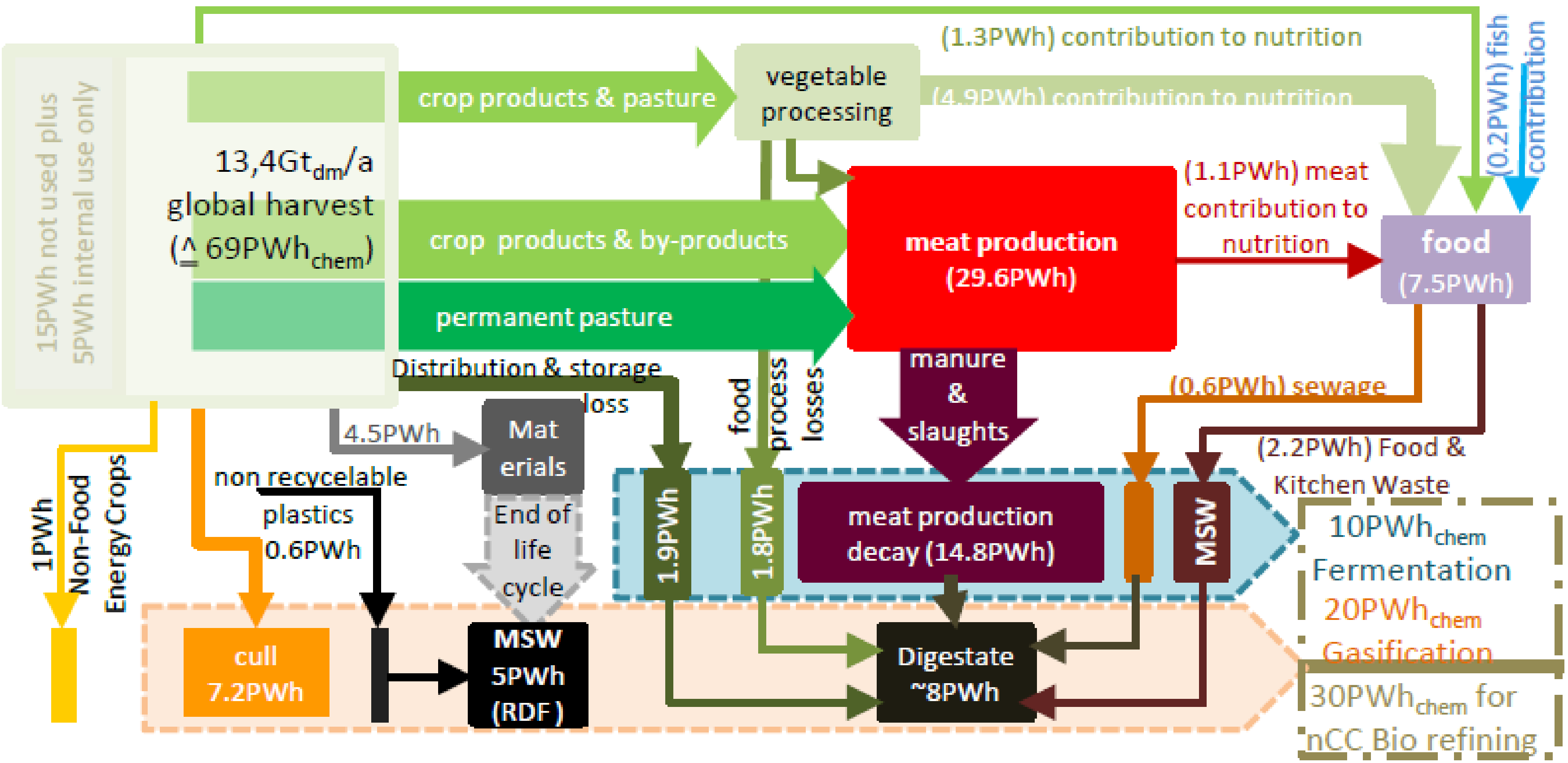
Hydrogen Customers
local supply (pipe) grid, Industry, Wholesalers, Public Transportation

Bio Fuel Users e.g.:
aviation, Bio-husbandry, 20-20-20 EU-goals, Public Transportation

Energy Providers
regional HVAC-CHP-FC Systems‘ on demand electricity concepts

Global Feedstock for Bio-Refineries

Waste from global renewable Organic Matter Use

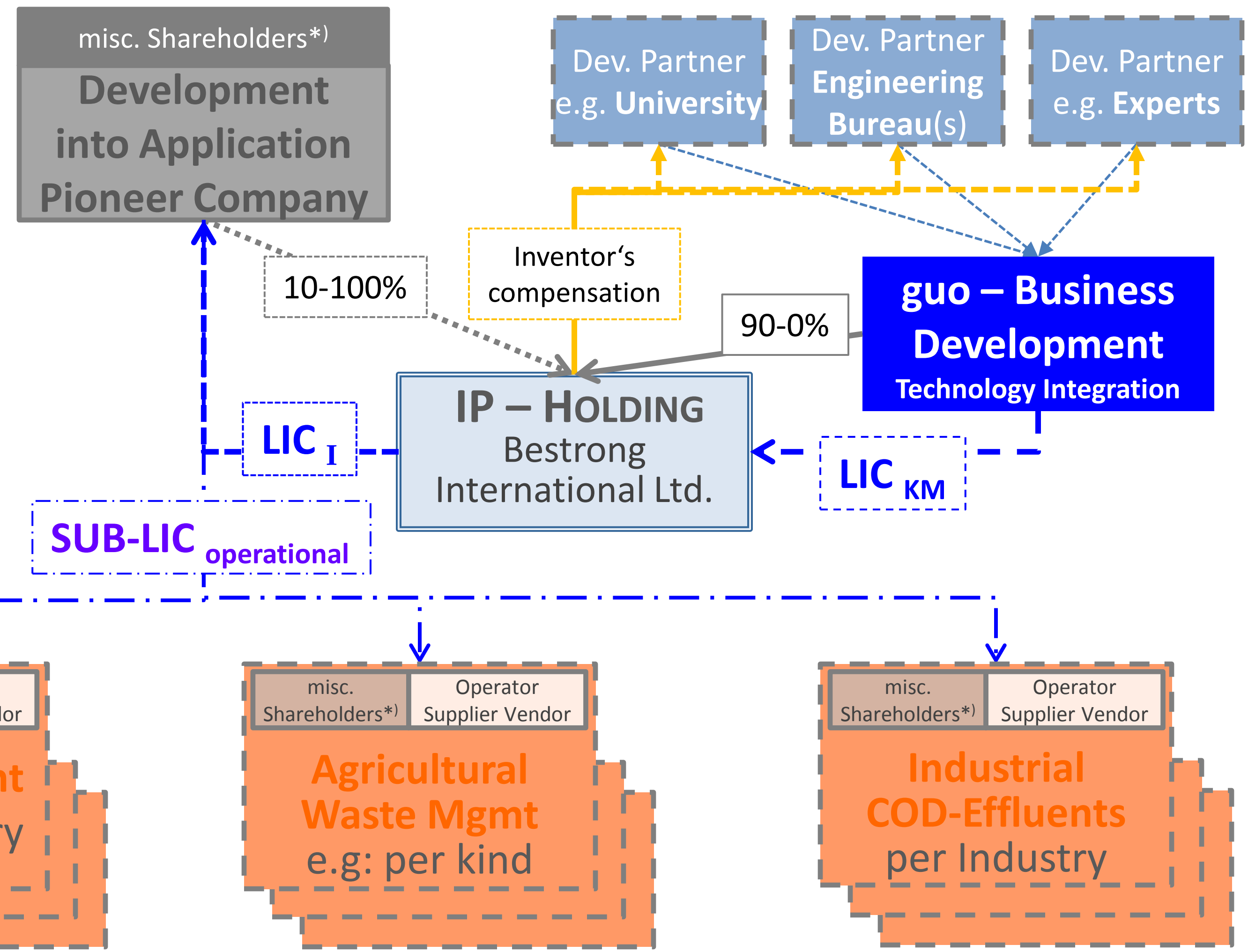


Biogas Plants were developed because 21% end up in manure & sewage

PPP – Know-How **Licensing** Structure

Roll-Out Business Model for CCU Bio-Refinery Technology

DEVELOPMENT & IMPLEMENTATION FUNDING



License Fees shall flow always in the opposite direction of blue arrows for **know how & rights provision by license**

Why Innovation has a hard time to happen

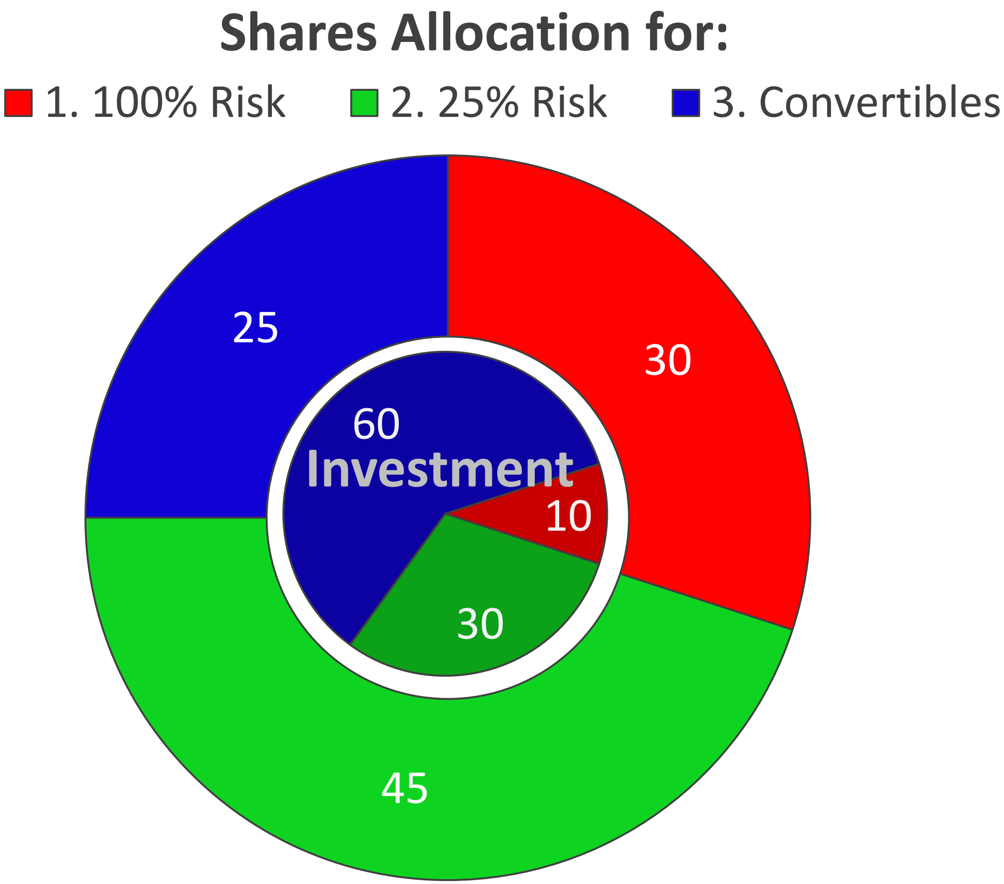
lacking 7 – 10 year horizon financing for DEVELOPMENT & IMPLEMENTATION

– Institutional **"Private" Equity** is commonly re-financed by bonds with less maturity needed by **BUSINESS DEVELOPMENTS**
– Roll-up **Mezzanine** Call-**Loans** could accommodate timing risks but subject to impairment test of lender's accounting
– Pre-defined annuity loan financing is totally inadequate

- Properly executed INNOVATION IMPLEMENTATION is usually limited to remaining DEVELOPMENT risks
  - ✓ at reasonably definable maximum (e.g. 10 – 15%)
- and ultimate IRR – PERFORMANCE risks
  - ✓ usually in a ball-park of ±25% (capex, opex, learning curve)
- How many **FINANCIAL PRODUCTS** sell at much less tangibility?
  - ✓ isn't there room for **STRUCTURED RISK PROFILE CERTIFICATES**?

Outline of likely Investment Certificate

e.g. emission of differentiated Risk Profile Share Bond



Equity needed:		£ 85mill.
	year 1-2	£ 7mill.
	year 3	£ 60mill.
	year 4	£ 18mill.
Expansion Loans:		£ 125mill.
	year 4	£ 65mill.
	year 5	£ 20mill.
	year 6	£ 40mill.
Plant Assets built:		£ 420mill.
	year 2	demo plant
	year 3	1 pilot plant
	year 4	2 mod.plants
	year 5	2 roll-out
	year 6	1 opt. plant
	year 7	3 off shelf
	year 8 +	36%/a by FCF

Likely Public Interests in MSW Innovation

worth providing some risk hedging guarantees or tax accounting?

- 58% of 72Mt/a UK $MSW_{incl.\ C\&I}$ = organic (DEFRA 2010)
  - 35% combustible (22% paper & cardboard, 8% plastics, 3% wood, 1,7% textile
  - 23% fermentable (green garden, food & kitchen, super market scrap, etc.)
  - \+ 7Mt/a = 10% $MSW_{equivalent}$ sewage sludge residue (at $60\%_{DB}$)

➢ UK CCU Bio-Refinery Feedstock potential:

$30{,}000 MWh^{-1}{}_{chem}$ or 700 plants á $45MWh^{-1}{}_{chem}$

- ✓ 100mill barrel synthesized gasoline/kerosine per year, at U$ 110/barrel (equivalent to £ 80/t dipping fee)
- ✓ 22,500 new high qualification jobs in bio-refineries plus additionally affordable low jobs in MSW logistics (we accounted for £ 30/t MSW in our business case model)
- ✓ final sink requirement reduction to 12 – 15% almost inorganic

How else fill the white gap opening?

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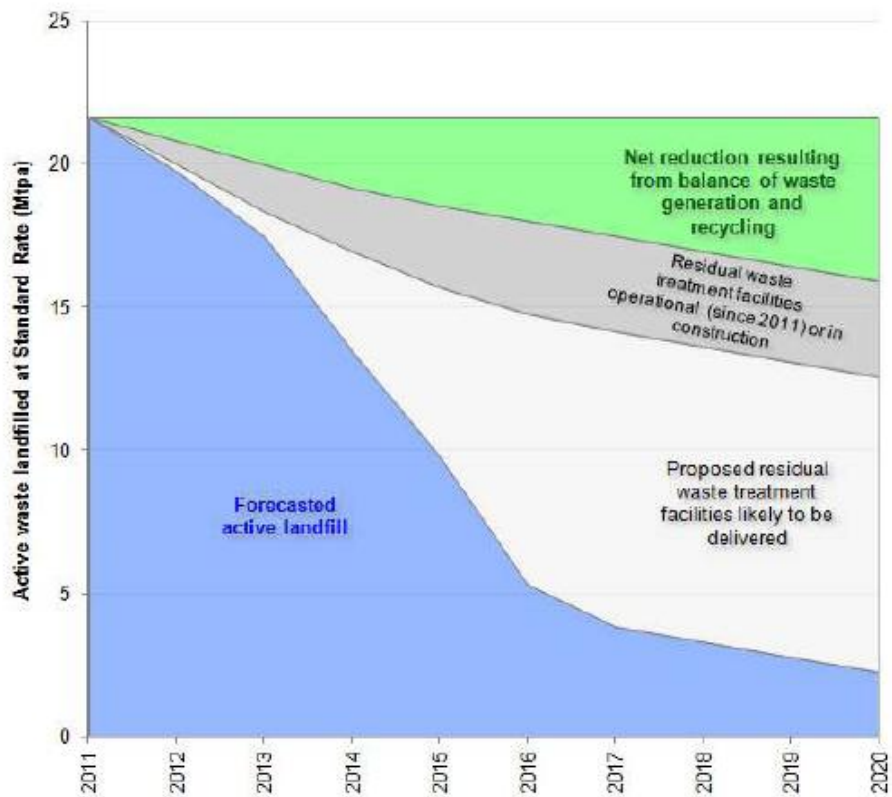
CIWM

Forecasted tonnage of active waste to landfill in the UK, up to the year 2020



Is there urgency for INNOVATION in UK's Organic MSW treatment ?

Can Europe’s #1 City of Finance help to develop the models for IMPLEMENTATION of INNOVATIONS ?

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