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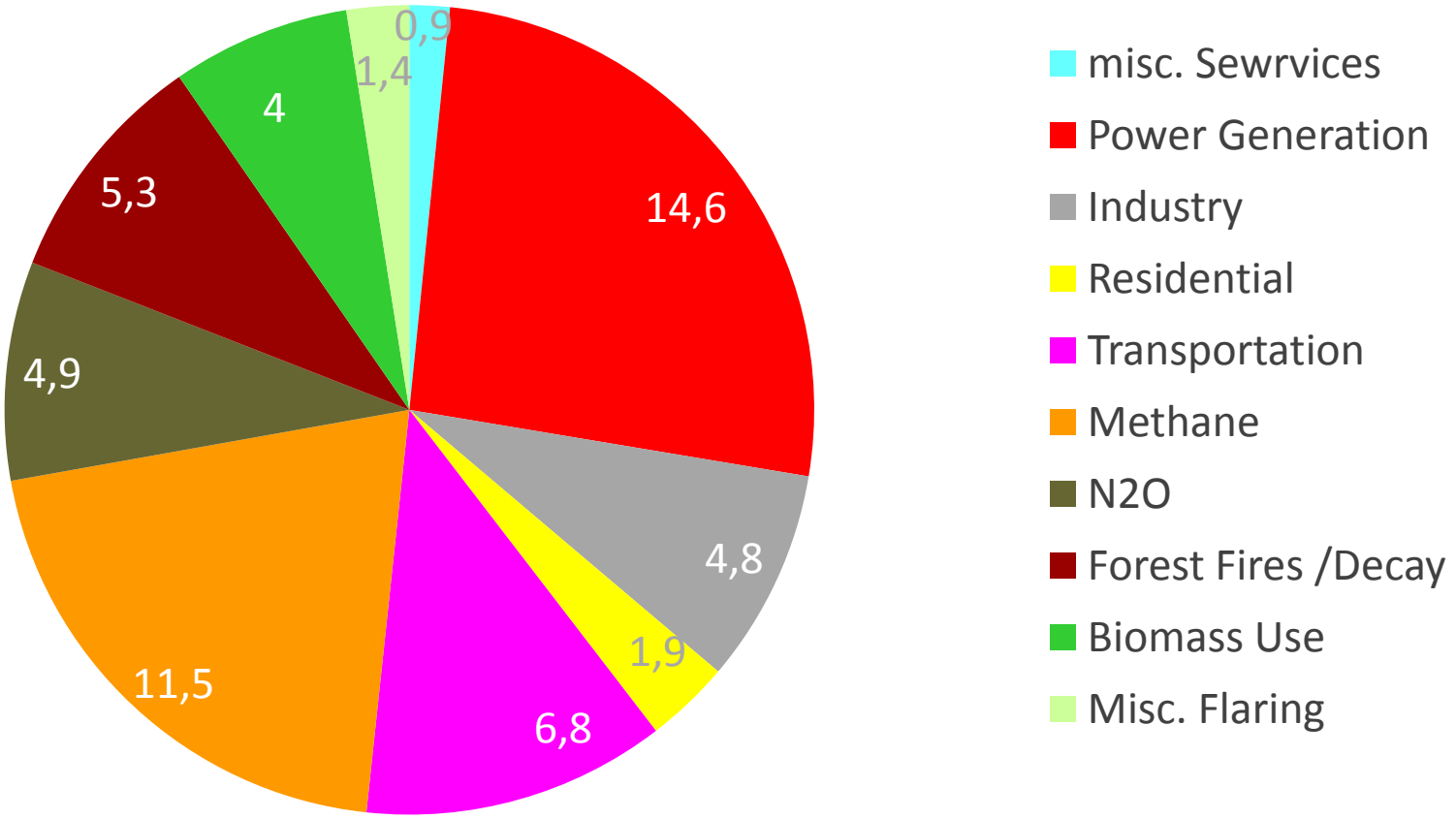
Technologies to Move MSW Challenge in to People Planet Profit Opportunities

via transformation of **Waste into** Synthesis Gas
for e.g. 2nd Generation **Synthetic Fuel**

Total Global CO_2 Equivalents

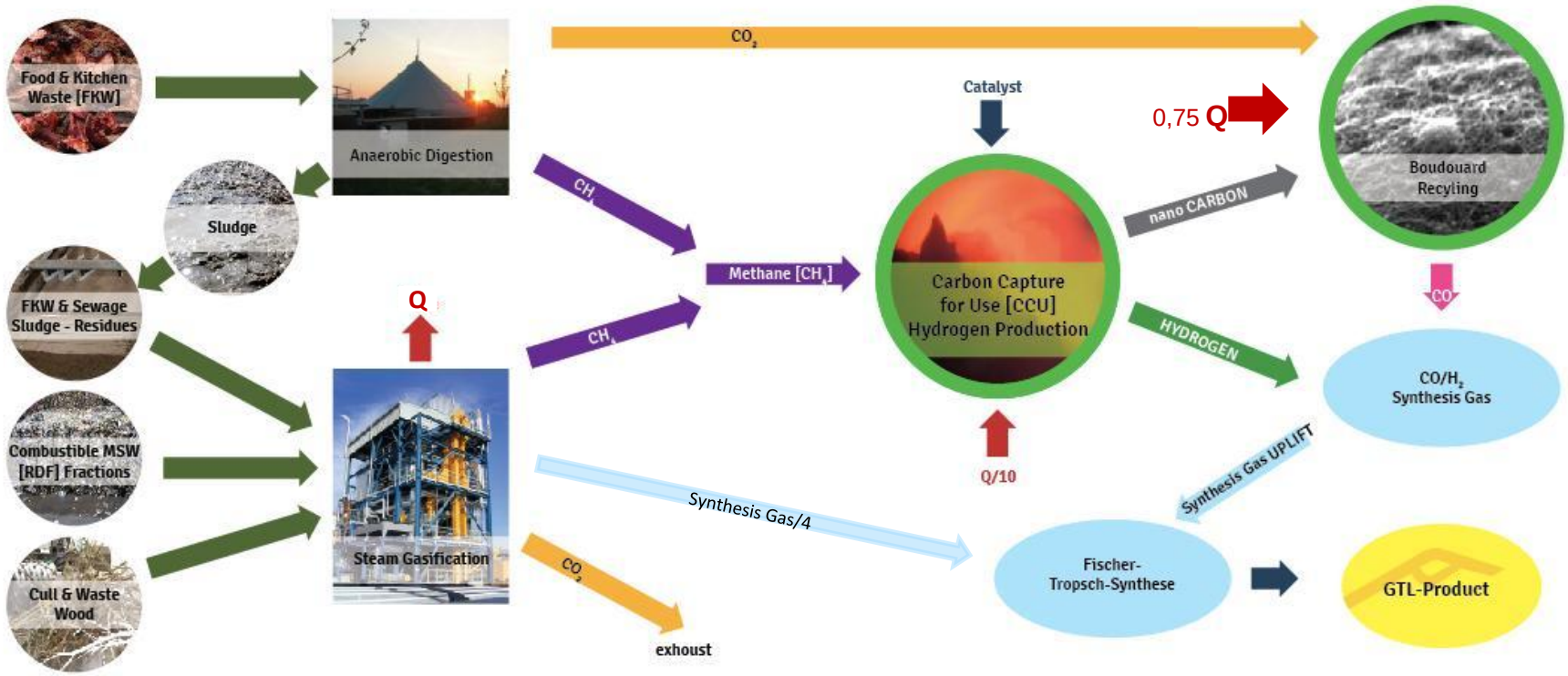
Anthropogenic CH_4 from decomposing organics => #2 !



Source IEA 2009

TRL3 Bio-Refinery Simulation by TU VIE

to synthesize **Waste** in**to** the **Fuel** of tomorrow by OUR UNIQUE SOLUTION PROPOSITION [USP]



"In 30 years we will either fly on 2nd generation bio-fuel or not at all anymore."
*(Dr. Alexander Zschocke, Senior Manager Aviation Bio-Fuels of **Lufthansa**, Fuels of the Future Conference, Berlin 2012)*

Energy Efficiency State of Art from Organics

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

steam driven dual fluidized bed gasification

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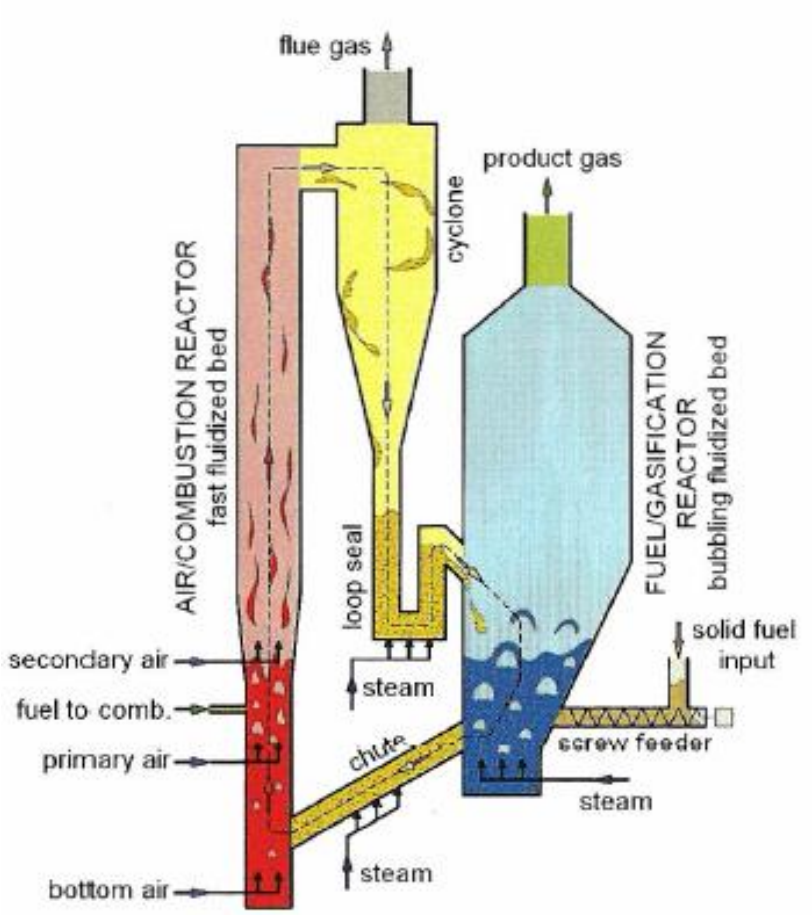
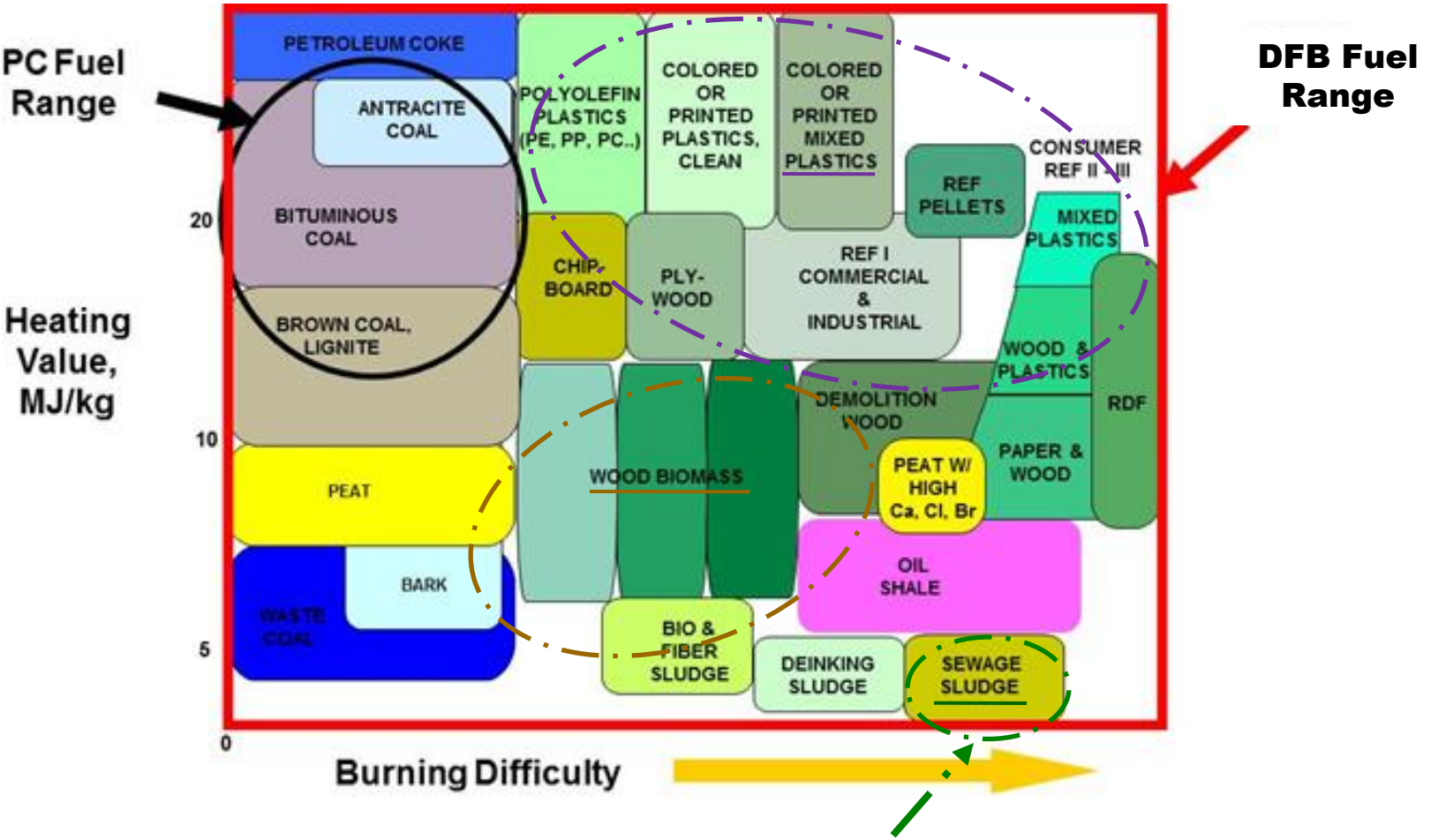
for thermo-chemical use of solid fuels



- ✓ no direct combustion of fuel
- ✓ anaerobic atmosphere in the “decomposition chamber”
- ✓ solid fuel transformation into usable energy is induced by a heat transferring medium
- ✓ producer-gas contaminants are primarily Hydrides that can be separated out by gas-cleaning
- ✓ ashes are extracted by cyclones and final filtering
- ✓ combustion chamber can be run air at NO_x uncritical temperature
- ✓ the system has a multi-year TRL 9 industrial scale track record

Opportunities for CO_2 recycling

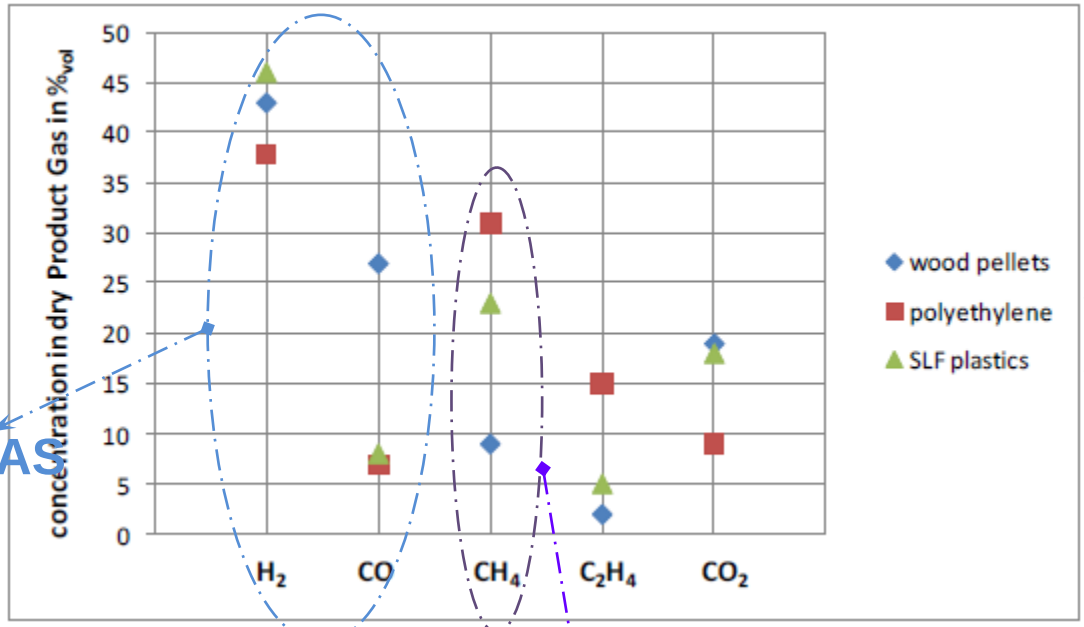
Fuel Flexibility



up to 30% of the heating content of fuel could come from even from sewage sludge

SD-DFB Gasification Fuel Flexibility

Gas Yields from different feedstocks



typical RDF fractions of MSW

SYNTHESIS GAS

- higher value usage paths than CHP

METHANE in competition with **NATURAL GAS** cannot be exploited at price covering costs

state of art CHP co-combustion

- requiring off-take subsidies
- you loose it if you don‘t use it

Technology Readiness Level

history & planned level of industrialization (biomass)

Gothenburg, [S]

500 GJ SNG scale-up plant

Gothenburg, [S]

120 GJ SNG pilot plant

Oberwart, [AUT]

33 GJ CHP_{ORC} plant

TU Vienna [AUT]

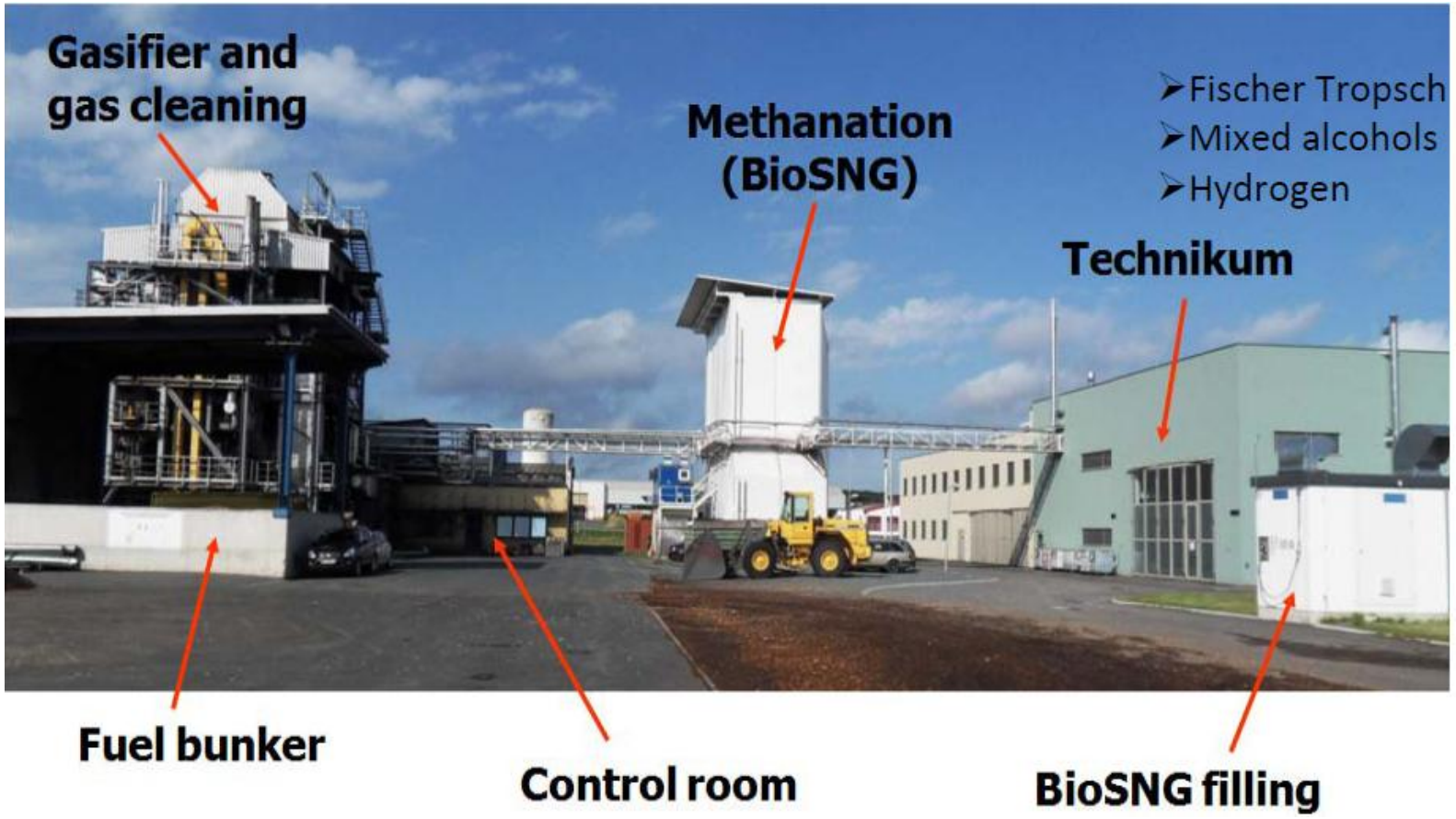
360 MJ Laboratory

1999 2008 2013 2017

Source: Swedish Gasification Center Conference 2013 R. Gebhart

> 30,000 operating hours demo-plant

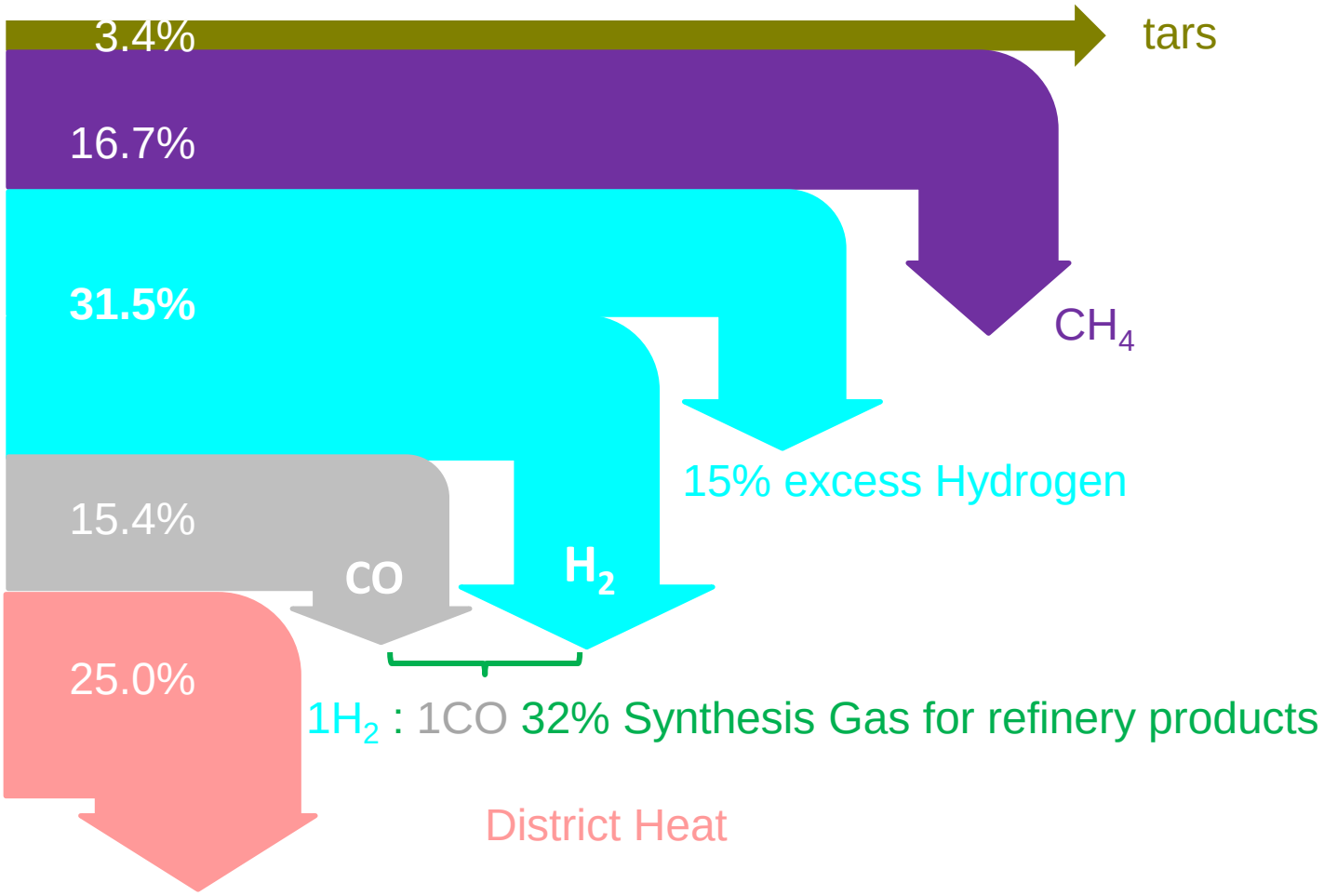
Poli-generation producer gas platform at Guessing (AUT)



Source: Future Energy Technology R&D Platform of University of Technology Vienna

Energy distribution of process outputs

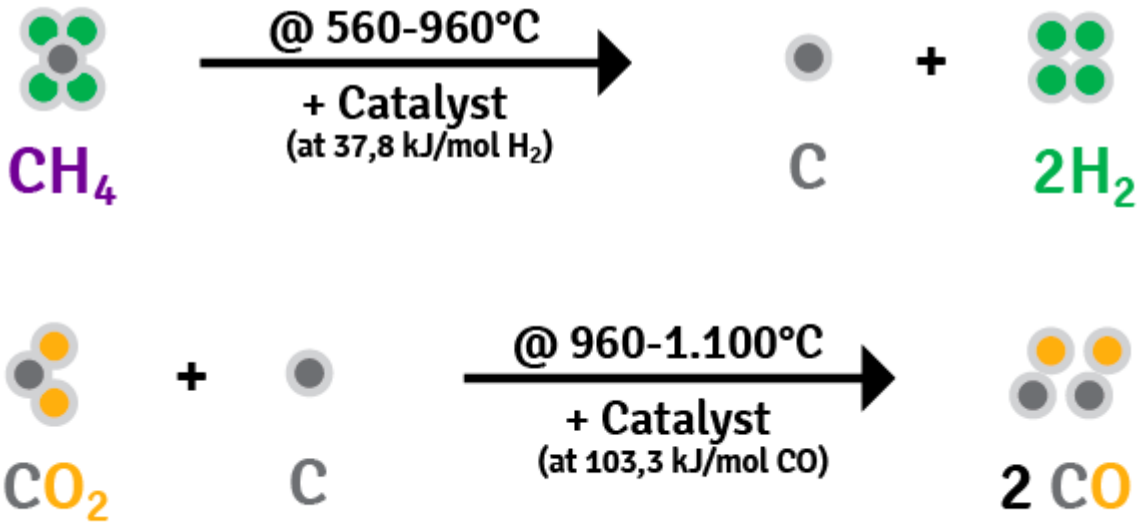
≥ 67% Product Gas plus 25% usable heat



Source: University of Technology Vienna

Uplift of **ADDED VALUE** from Methane

Carbon **C**apture for CO_2 & WASTE HEAT RECYCLING **U**se



"DRY THERMO-CATALYTIC DISSOCIATION" of hydrocarbon gas had been industrialized from synthetic diamond fabrication for high performance materials. Application to **DECOMPOSITION-GAS** from organic matter can **UNLOCK FULL TRANSFORMATION OF ABUNDANT-HYDROCARBONS** into chemical **SYNTHESIS HYDROCARBON PRODUCTS**.

CNT/H_2 co-production-TRL6 pilot plant

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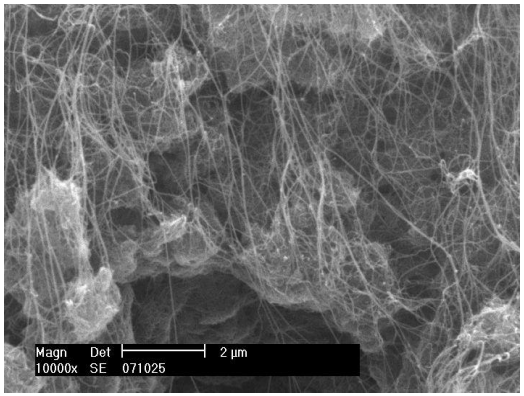
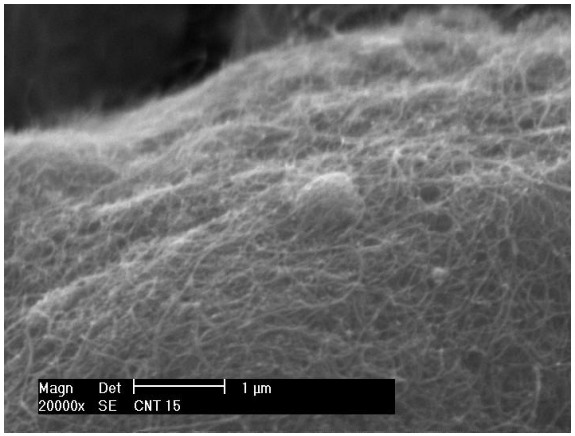
Operated at C-Polymers [Austria]



Removal of Catalyst

CNT Agglomerates



Courtesy of C-Polymers GmbH, [AUT]

Competitive Analysis

Technology comparison at incineration practices / FICFB

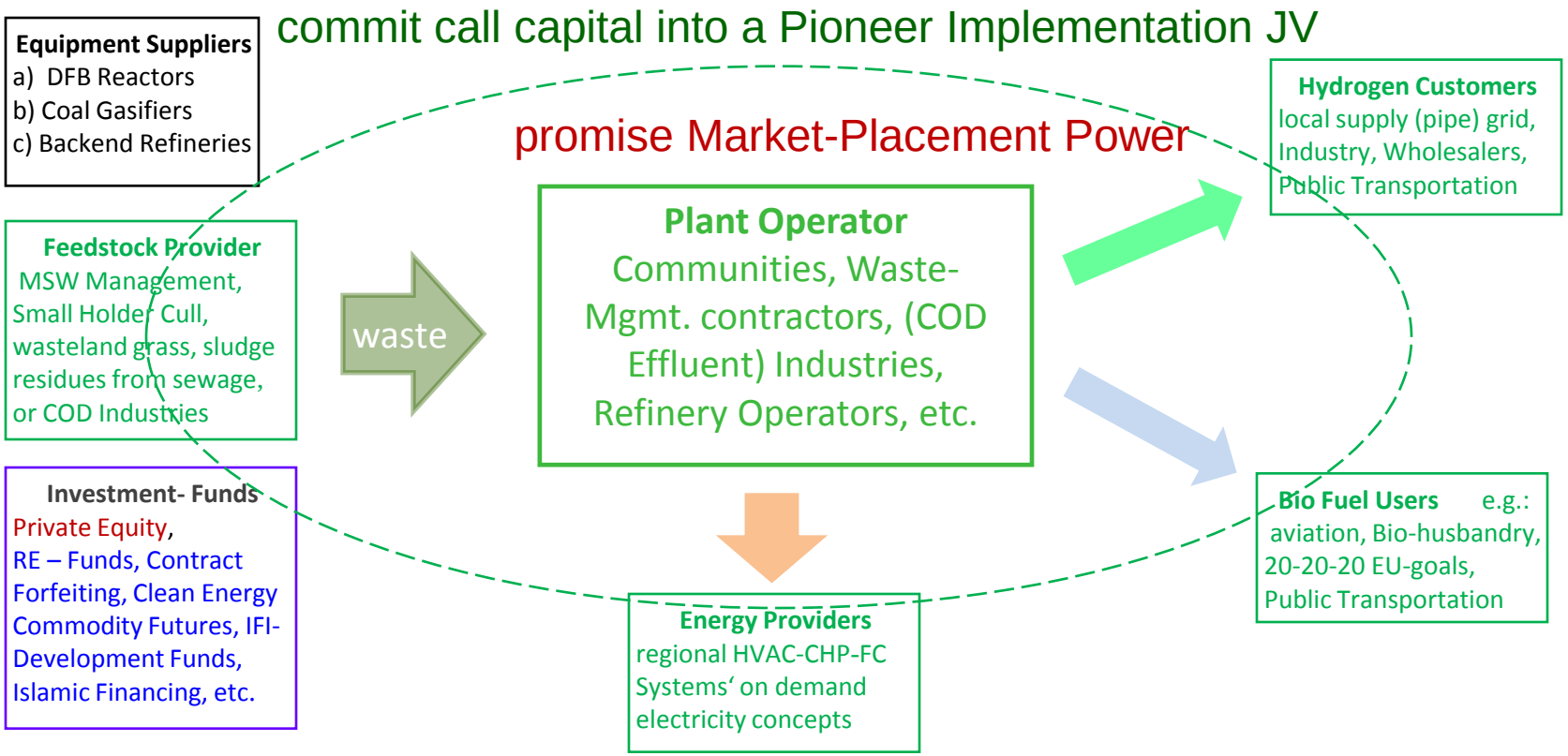
260,000t/a	WIP 90's	WIP now	FICFB + ADOS CHP	FICFB + ADOS CCU
aux. fuel	800,000GJ	0GJ	0GJ	0GJ
Electricity	40,000MWh	67,600MWh	105,900-210,000MWh	0-210,000MWh
Heat	470,000MWh	426,400MWh	324,400-405,000MWh	192,750-405,000MWh
Syn.fuel	0bbl	0bbl	78,400- 0bbl	205,000 – 0bbl
€$_{rev}$/t MSW	**-42,38**	**35,49**	**71,06 – 63,36**	**145,00 – 63,36**

based on the following price assumptions:

Electricity	€ 44/MWh$_{el}$
District Heat	€ 15/MWh$_{th}$
Diesel (syn.fuel)	€ 0,85/litre
FT-Wax	€ 2,36/kg

Looking for an Operators‘ Consortium

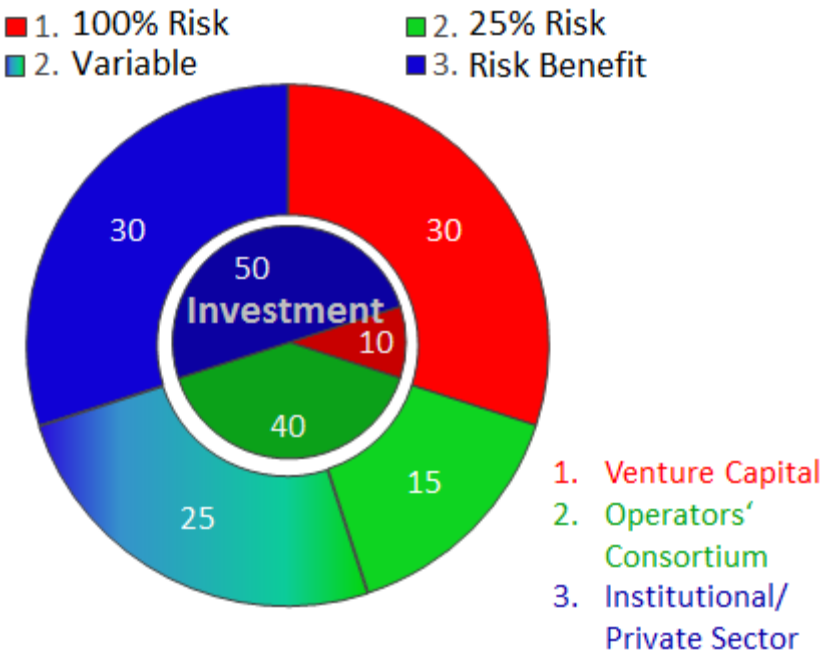
covering multiple local Waste to Value Supply Chains

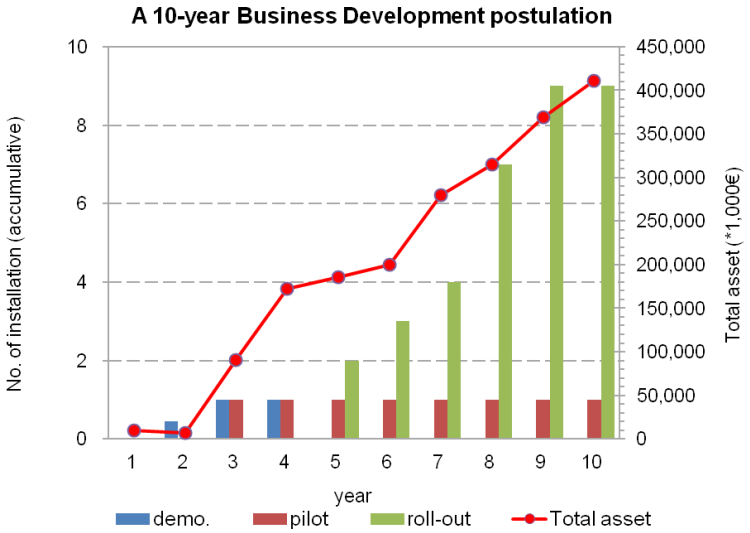


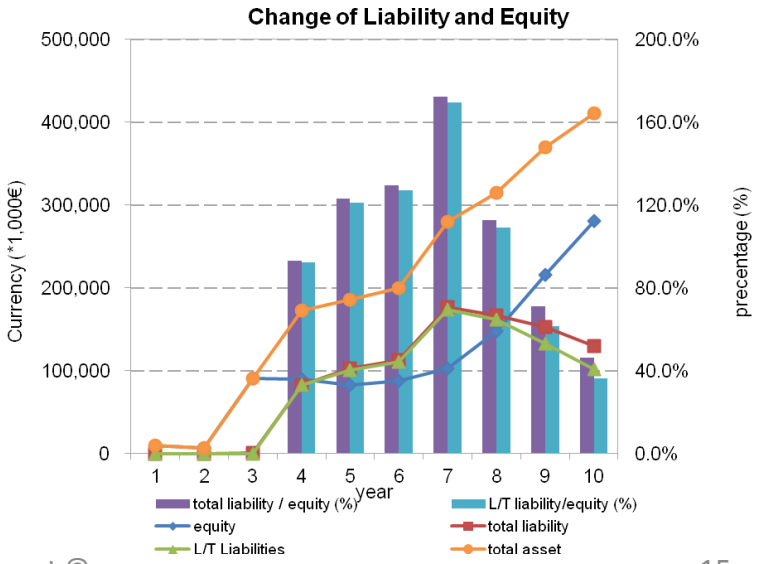
COMPETENCE & MARKET POWER of each NATIONAL SET OF CONSORTS plus uncoupling from POLITICAL (regulatory) RISKS shall enable VENTURE CAPITAL financing of DEMO-VALIDATION

Proposed Innovation Financing Structure

differentiated RISK PROFILE SHARE BONDS (with partial variable share allocation)







ECONOMICALLY lean & ECOLOGICALLY the cleanest Solution :

- 10-year IRR > 20%/a at ≥ €0.55/ltr. gasoline & less aerosols
- investment returns follow energy price index –> inflation hedge
- resource- & energy- efficiency => sustainability
- long term cost leadership in Waste to Energy Business

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We look for partners to industrialize and roll-out this MSW-Innovation

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