Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Technology Centre for Bio Refining & Bio Energy

Technical and Regulatory Challenges to Development of a BioCNG Transport Fuel Industry in Ireland

www.TCBB.ie

ENTERPRISE IRELAND · UNIVERSITY of LIMERICK · UCD DUBLIN · TRINITY COLLEGE DUBLIN COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH · NDP Transforming Ireland · IDA IRELAND · NUI Galway OÉ Gaillimh

Intro -TCBB

Forum for Industrial/Academic Collaboration to Develop the Bio Economy

Biomass Growth Potential

Large Agri Food Industry

Efficient Waste Systems

Efficient Distribution Systems

- Policy
- Regulation
- Technology
- Market Access
- Supply Chain
- Dev Capital

Bridge gaps to develop economically viable routes to produce and market bio-products and bio-energy

Sustainability Policy

- *Resource Efficiency*
- *Environment*

Statutory Obligations

- *Waste Management*
- *Environmental Targets*
- *NREAP*

Economic Recovery

- *Energy Security*
- *Improved Competitiveness*
- *New Markets*

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Indigenous Market Opportunity
Bio CNG Transport Fuels

Exploit Low Cost of Natural Gas to Develop an Attractive Near Term Gaseous Transport Fuels Market

Leverage availability of gaseous transport fuel network to accommodate interchangeable distribution of both natural gas and renewable bio-methane fuels:

- *Route to market reduces need for ongoing market supports*
- *Deliver near-term meaningful environmental & economic benefits*
- *Offer best option to achieve RES T Targets via indigenous production*

Establishing a Viable Commercial Framework Will Stimulate Development of a Large Indigenous Bio-methane Industry

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Why Bio CNG Transport Fuels?

Macro Drivers - Economic and Environmental Benefits

Environmental – *Sustainability Policy Underpinned by Obligations- Compliance Driven by Moral Imperative & Penalty Avoidance*

- ***EU Sustainability Policies*** *- Climate Change, Environmental Preservation, Health & Wellness, Resource Efficiency*
- ***Renewable Energy Obligations*** (RES T) = displace *10% fossil fuels by 2020 ideally with indigenous production*
- ***Waste Management Obligations*** *–reduced volumes of stabilised OFMSW to landfill by 2016*
- ***Environmental Emissions Obligations*** *- GHG emissions to air, N & P emissions to water/soil - EU Policy for 2030 - proposed obligations to reduce GHG emissions by 40% over 1990 levels but will not set individual sectoral obligations (overall 27% renewable energy target but not oblig.)*

Economic – *With Supportive Commercial Framework Indigenous BioCNG Industry is viable in near term*

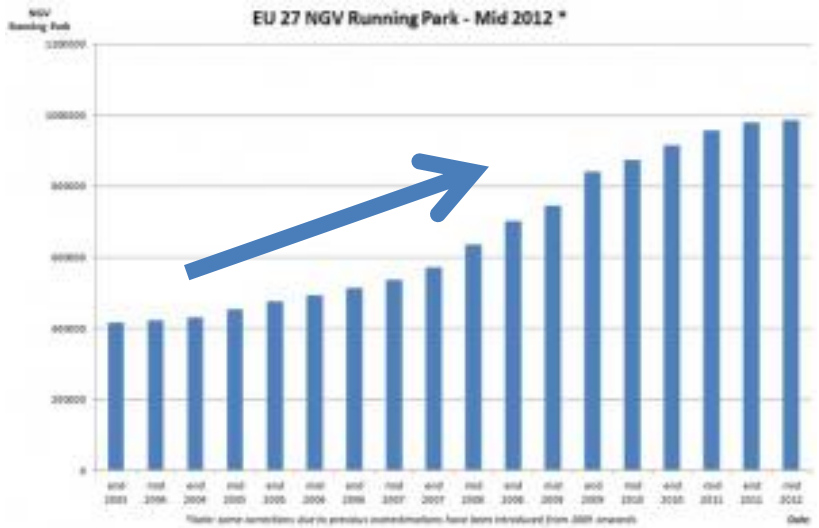
- ***Economic Recovery*** *– Jobs , Trade Balance, Tax Base, Lower Debt /GNP %*
- ***Import Displacement*** *– BioCNG can offset € 2.8 bn outflow for fossil fuels*
- ***Energy Security*** *– indigenous production displaces imports reducing risk*
- ***Corporate Competitiveness*** *– reduced transport/waste processing cost*

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Why BioCNG Transport Fuels?

Rapid Global Growth - Growing Range of NGV's Available

- *NGV's well established in EU markets (Sweden/Italy/Germany/Austria …..)*
- *Vehicle models range from passenger cars to HGV's, buses, waste collection vehicles - modification kits available for existing vehicles* (€€ supplement ranges from €5k passenger car to €40k HGV)

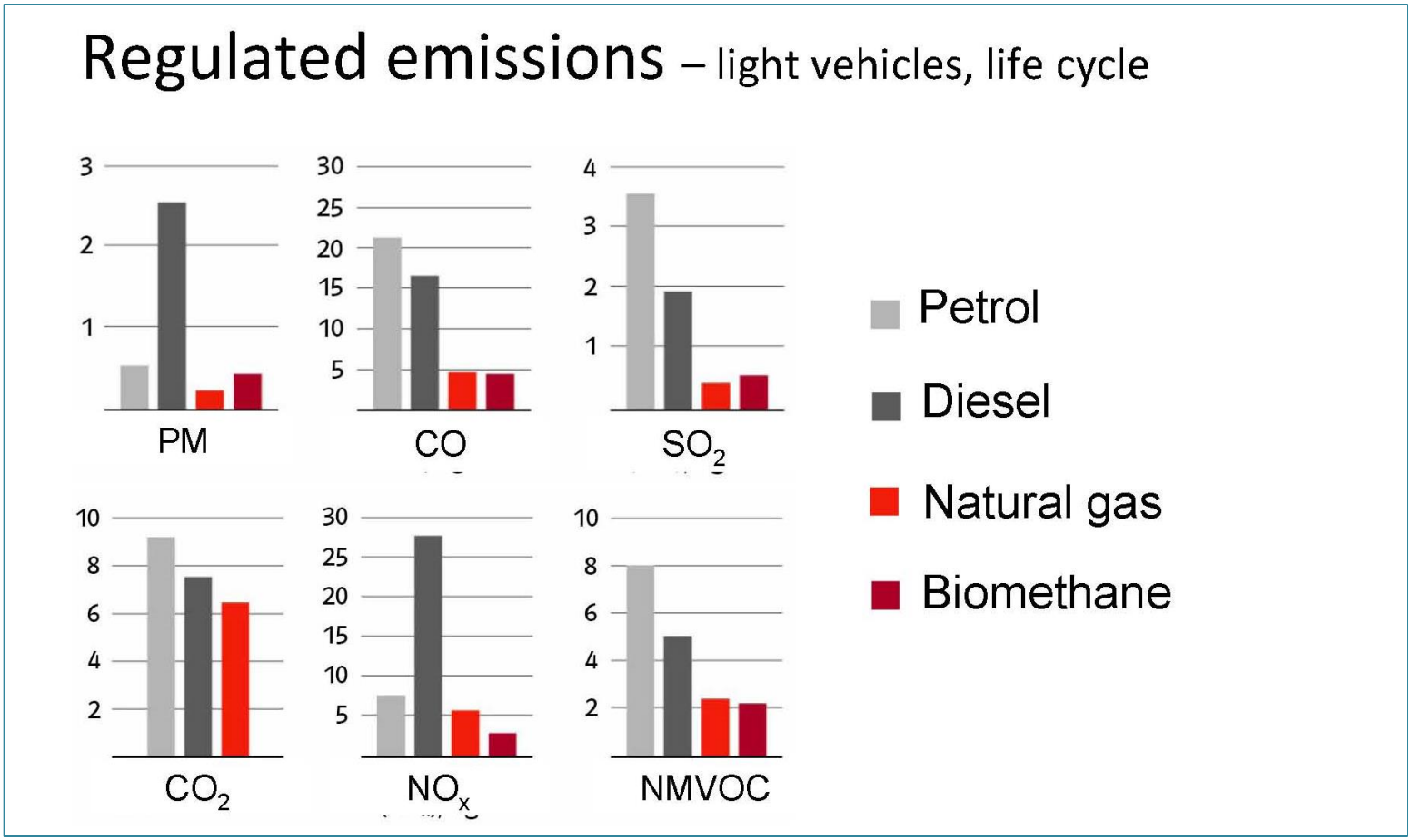


OPEL VOLVO SUBARU IVECO SCANIA MAN FIAT Mercedes-Benz Ford Volkswagen

- *Dual fuel/Bi-fuel options mitigate issue re lack of public gaseous fueling infrastructure – offer national near-term market access*
- *Development of UK market means right hand drive models are available*

Why BioCNG Transport Fuels -Environmentally Attractive

Gaseous Fuels Reduce Greenhouse Gas/Particulate Emissions



Source : Biomaster

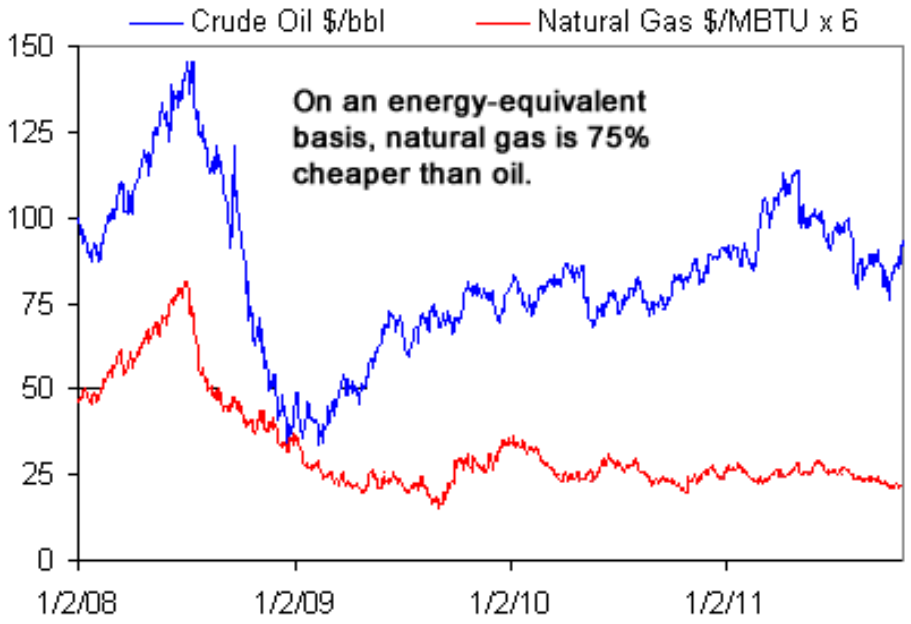
Especially Relevant in Light of Upcoming Euro6 Emissions Standards

Biorefining & Bioenergy

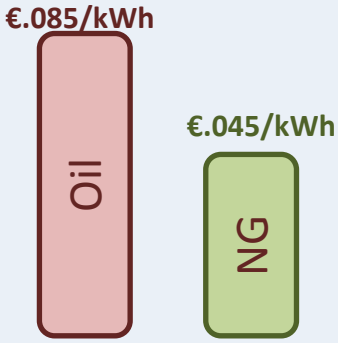
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Why BioCNG Transport Fuels- Leverage Low Cost Supplies of NG

Ireland Benefits from Secure Supplies of Lower Cost of Gaseous Fuels



Irish Energy Prices



- *NG is low cost - < €0.50 per M³ & int'l fracking/LNG means low price likely to remain stable over time*

Highly competitive market mitigates concerns over security /pricing of supply

Cost Differential Can be Leveraged to Supply Lower Cost Fuels

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Why Bio CNG Transport Fuels?

Gaseous Fuels Can Be Priced at Discount to Fossil Fuels

1 M^3 Natural Gas (bio or fossil) = 1 litre diesel equiv. energy value

Vehicle Type	Passeng'r	10T Deliv'r	HGV
Assume Annual Kilometres Driven	30,000	40,000	120,000
Assume Avg Klm/Ltr	15.0	5.5	3.0
Assume Avg Annual Diesel Consumption	2,000	7,272	40,000
Assume Incremental Capital Cost for NGV Modification	€ 5,000	€ 30,000	€ 40,000
Assume Avg Life	7	5	3
Avg Incremental Capital Cost per Annum	€ 714	€ 6,000	€ 13,333
Assume Diesel Prices – (incl VAT)	€ 1.50	€ 1.50	€ 1.50
Ex VAT Diesel Price @23% VAT		1.22	1.22
Less: Hauliers Fuel Rebate			-0.07
Net Price to Motorist/Haulier	€ 1.50	€ 1.22	€ 1.14
Discount Req'd to cover Incremental Capital per Annum	€ 0.36	€ .82	€ .33
Fuel Price Delivered (Excl VAT)	0.93	€ 0.40	€ 0.81
Fuel Price Delivered (Incl VAT)	€ 1.14		
Target discount for gaseous fuels	24%	67%	34%

EU experience indicates discounts attract early market uptake

Level of Discount is Case Specific – Need Measures to Reduce Incremental Capital Cost

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Why Bio CNG Transport Fuels?

Proven Technologies De-risks Deployment in Ireland

Variety of Proven Anaerobic Digestion Technologies


Farm Digester


High rate WWT


Landfill Gas


MSW Dry Digester

Variety of technologies are proven & commercially available


Biogas Upgrade Units


Natural Gas Production

Transport via Gas Grid Injection



Or Compressed Gas Cylinders

Dispensing via High-Speed Commercial Units




Or Low Speed Residential Units





Wide Range Of NGV's

CNG can fuel both short haul and long haul trips

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Why Bio CNG Transport Fuels?

Large Supply of Wastes/ Residues – 2nd Generation
Dual Value Underpins Economic Viability

Wastes/Residues incur processing, storage and disposal costs
AD Generates Energy & Reduces Processing/Disposal Volumes (costs) – Dual Value

Agri-Food / MSW Residuals	Qty Estimate
Flared Landfill Gas	80m M^3
Landfill OFMSW	400k DMT
Cattle/Pig/Poultry Manures	2,000k DMT
WWT & Leachate COD	75k DMT
WWT & Septic Tank Sludge	100k DMT
Grass / Silage/Energy Crops	4m DMT

300 m M^3 Bio-methane p.a.
Energy Value = €210m p.a.
Reduced Waste Costs = €50m p.a.

Developing AD Infrastructure Based on Wastes/ Residues Opens Up Market for Use of Sustainable Energy Crops – Path for Expansion

400k Hct's = 1.2 Bn M^3 Bio-methane

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Why Bio CNG Transport Fuels?

Identified Routes to Market

- **Near term routes to market target widely available private fleets – Dairy/ Municipal Waste/Municipal Bus**

–Large volume users

–Local routes & central hubs = efficient fuel dispensing

–Improves industrial competitiveness – reduced cost

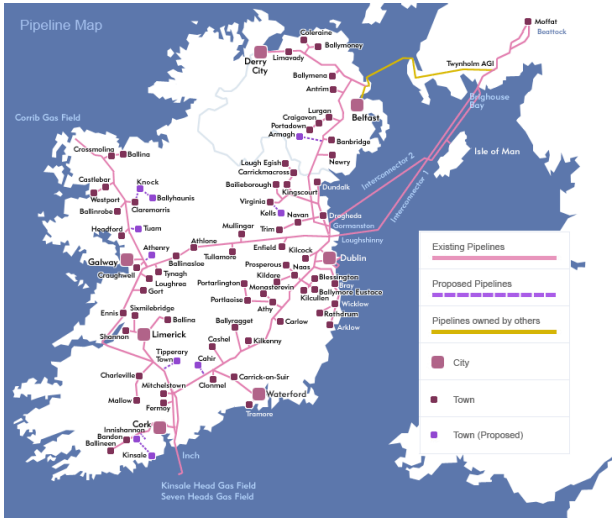
–Leverage initial rollout to develop nat'l distribution

- **Available NG Grid Offers Near Term Nat'l Reach**
- **NG Underpins Quality/Stability Perception**

– *NG is low cost - < €0.50 per M^3 & fracking/LNG means low price likely to remain stable over time*

– *Supports discount pricing strategy*

– *Highly competitive market mitigates concerns over security /pricing of supply*



Low Cost Market Entry Leveraged to Expand Roll Out Nationally

Biorefining & Bioenergy

AN ENTERPRISE IRELAND
& IDA IRELAND INITIATIVE

Technical & Regulatory Challenges to Establish Economic Viability of Bio Methane

- *Attractive Commercial Framework*
- *Production & Distribution Efficiencies*

ENTERPRISE IRELAND · UNIVERSITY of LIMERICK · UCD DUBLIN · TRINITY COLLEGE DUBLIN COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH · NDP National Development Plan Transforming Ireland · IDA IRELAND · NUI Galway OÉ Gaillimh

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Bio CNG Transport Fuels

Economic Viability Requires Short Term Supports

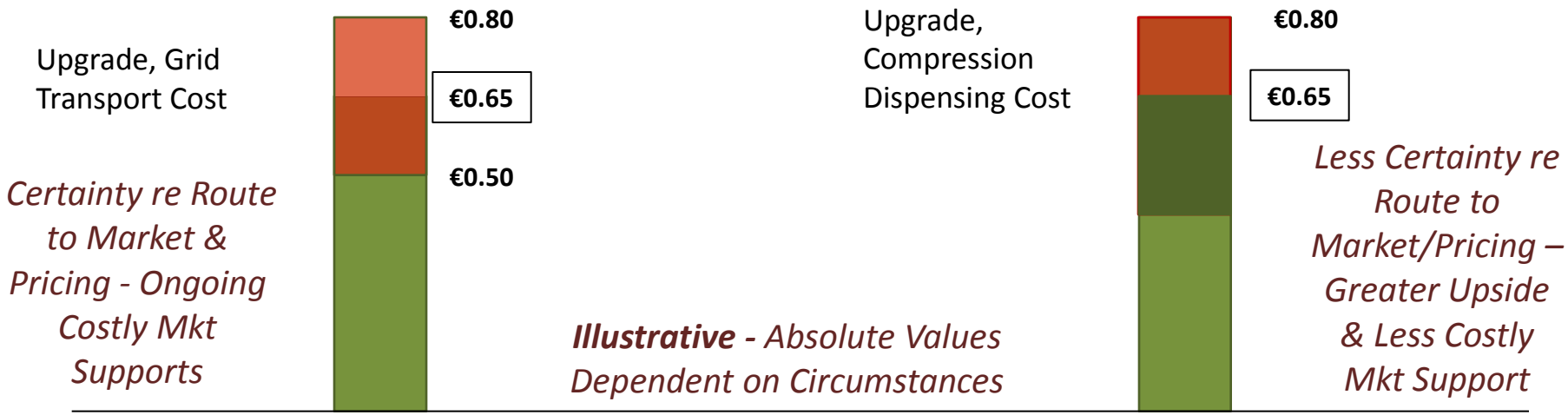
Target Price to Producer €.65 per M^3 CH_4

CH_4 for HE CHP REFIT

- 36MJ/M^3 = 10kWh$_T$ @ 42% elect efficiency = 4.2 kWh$_e$ @ €0.16 = circa €0.65/M^3
- Local grid connection available ?
- HE qualified ?
- Valorise residual heat ?
- Offsite Utilisation - upgrade + transport req'd - higher revenue offset by added cost

CH_4 for BioCNG Transport Fuels

- Target price to market €.80/M^3 Delivered
- Target Cost of Supply
- Upgrade/transport/compress'n/dispensing
- Short Term Market Support Req'd

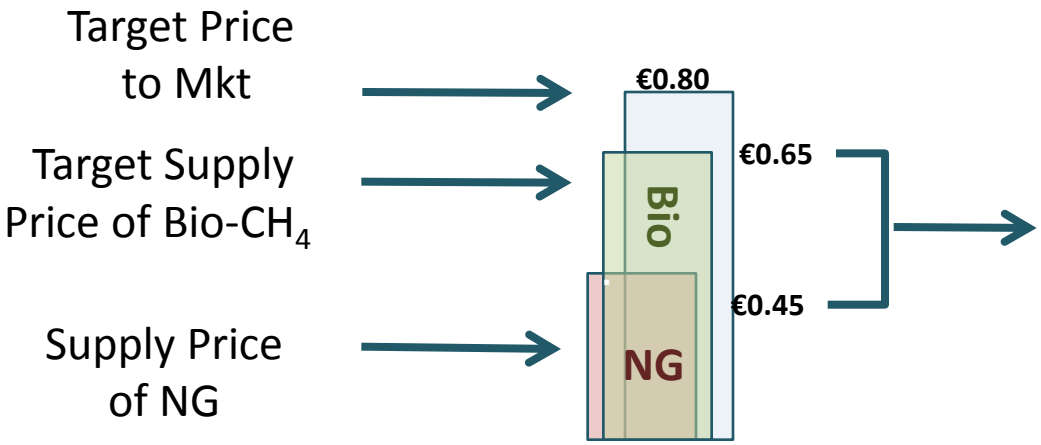


Upside = Reduced Market Supports

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Commercial Framework
Facilitating Market Development

Bio-methane Competitiveness vs Natural Gas- ***current gap between low cost of NG vs target cost of bio-methane supply risks demand for NG overwhelming demand for higher cost bio-methane***



- *Need stimulus to incorporate BioCH4 in fuel mix – other than price equalis'n*
- *Avoid Near Term Constraint to Market Development*
- *Min blend req'd @ levels > than RES-T obligat'n to stimulate indigenous production – BBO or similar measure*

Over time mechanism to establish parity between supply of NG and supply of bio-methane, ideally resulting in a minimum support price to support indigenous production of bio-methane

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Commercial Framework
Facilitating Market Development

Biofuel Blending Obligation = 6% of transport fuels

- **Concept: BBO enables distributors to purchase biofuel or cert's –** *price for certs should track cost differential of imported biofuel*
  - *1 Cert = qualified Ltr. of biofuel placed on market …. tradable (non redeemable)*
  - *Distributors to produce cert's equal to blending %.....non-compliance penalty*
  - *Importing 1st gen biofuel to meet oblig'n costs €.10-€.20 > Ltr. diesel……underpin cert value*

- **Opport. For BioCH_4 Producers– as per Legislation BBO applies to gaseous fuels**
  - *BioCH_4 from waste is 2nd gen biofuel qualifying for dual cert's…… Need sustainability ruling*
  - *"Volume Conversion Factor" for gaseous fuels= 1.5 for CH_4…….3 Certs for BioCH_4?*
- **Current regul'ns apply to liquid biofuels only – framework req'd for gaseous fuels**
  - *When are gaseous transport fuels placed "On Market"? ……. How tracked & measured?*
  - *Who earns certificates – producer or distributor?*

Concerns: Parallel issues re liquid biofuels – support access to finance??

- *Prevent obligation ultimately supplied via imports – subsidised biogas from EU markets*
- *Excess supply of cert's cause price decline…….. Introduce min redemption price ??*
- *Issuing large no of multiple cert's do not meet EU obligations……. Limit Issuance??*

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Commercial Framework
Facilitating Market Development

Excise Taxation– ***Gaseous propellants do not currently attract excise tax – default position based on lack of historical use rather than considered policy***

- **Copper Fasten Current NG Derogation for Period**
  - *Underpins availability of financing & support market rollout –*
  - *Over time room for carbon tax on NG fuels*
- **Ongoing derogation for bio methane** - *Consistent with most EU state policies*

- **Migrate Excise tax to Carbon tax – polluter pays**
  - *Increase over time as market develops – maintain target differential NG vis a vis diesel*
  - *Use proceeds to fund distribution infrastructure or Bio CH_4 supports*
- **Concern re Lost Excise Tax on Oil**
  - *Replaced by Carbon Tax on NG over time*
  - *Corporate & employment taxes on indigenous economic activity will offset lost excise tax revenue*
  - *Reduced cost of unemployment*
  - *Reduced EU penalties*

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Commercial Framework

Facilitating Market Development

Measures to Support NG Vehicle Procurement, Training and Finance Will Overcome Inertia & Expedite Market Development

NGV's – ***Incentives may be required to promote adoption of NGV's***

- *Grant programme for first 1,000 NG HGV's & Commercial*
- *Market support programme for NGV's comparable to electric vehicle prog.*
- *Demonstrates market support to vehicle manufacturers*

Support Resource Training – ***qualified NGV technicians, AD engineers and gaseous fuel distribution/dispensing engineers required***

- *Develop training programme for technicians/engineers*
- *Facilitate ability to modify vehicles locally …….. reduces cost*

Critical mass will address many cost related issues-
Measures to support NGV rollout less costly than biogas production supports - Capital Supports Enhance Market Uptake of NGV's and Address Key Component of Cost-Benefit Relationship re Use of Gaseous Fuels

Biorefining & Bioenergy

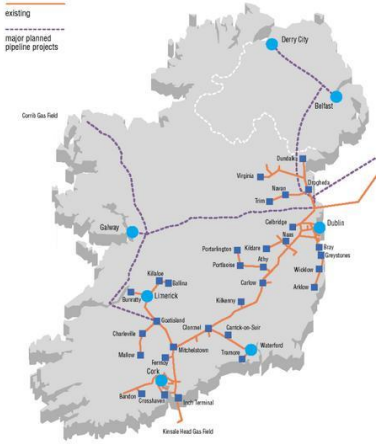
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Commercial Framework

Facilitating Market Distribution

Grid Injection Protocol – ***a low cost grid injection protocol is essential to market development & consistent with EU policy on renewable fuels***

- ***Stratified Service/Tariff Structure –***
  - *Low cost regulated access/transport svc ……. €5.00 per MWh*
  - *Preferential single national tariff for bio-methane injection and transport irrespective of point of entry or off-take*
  - *Optional conditioning/customised services – commercial tariffs*
- ***Socialised recovery of initial capital costs*** *- over a long timeframe*
- ***Specialised Shipper Arrangement –*** *designated agent for bio producers*



- ***Operate access points as aggregator sites***
- ***Standardised technical spec's for access points***
  - *Both hi/low pressures*
- ***Quality control***
  - *Accomodate minor variations in bio-CH_4 spec*
- ***Shrinkage Gas*** *– Mkt outlet for bio-CH_4*

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Commercial Framework
Facilitating Market Distribution

Measures Supporting Access to Low Cost Distribution Infrastructure Will Expedite Market Development

Distribution Infrastructure- ***Upcoming EU Alternative Fuels Infrastructure Directive requires construction of CNG dispensing infrastructure by 2020***

- *Dispensing stations to be available every 150 Klm*
- *Funding mechanism to support capital investment in gaseous fuel distribution infrastructure is required*

Standards for Gaseous Fuels/Dispensing Technology – ***distribution of BioCNG transport fuels can be expedited with adoption of standard specificat'ns***

- *EU spec's are forthcoming – final decisions reserved for national regulators*
- *Gas quality specifications likely to parallel UK market spec's*

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Commercial Framework

Facilitating Production Infrastructure

Regulatory Measures Supporting Easier/Lower Cost Production Infrastructure Will Expedite Market Development

Integrated Planning / Licensing Process – ***planning permission, waste licensing, ABP certification - serial process is costly and can take several years***

- *Process to integrate/expedite planning & licensing is under review*
- *Finalisation of ABP Licensing for Farm Based Co-operatives*
  - *Determine Requirement for Pasteurisation of animal manures when sourced from multiple farms*

Preferential Rates/Property Taxation -

-0- rating for all AD whether processing agricultural, municipal or industrial feedstocks will promote rollout of production infrastructure

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Fuels

Addressing Technical Challenges Re Market Development

Enhancing Biogas Production/Valorisation

Improved Methods for Biogas Production from Waste Sources -

- *Solids Pretreatments & Enzyme Technologies*
- *Low Temperature Processes*
- *Low Cost Small Farm Scale Digesters*
- *Hi Rate WWT Systems*

Improved Co Product Valorisation

- *Organic Fertilisers*

Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Fuels

Addressing Technical Challenges Re Market Development

Reducing Cost of Upgrade/Conditioning/Transport

Reducing Upgrade/Conditioning Costs-

- *Variety of Technologies Available – costly*
  - *Energy Demand*
- *Consider localised conditioning to lower spec*
- *Aggregator "polishing" sites facilitates:*
  - *Sizing of plant – benefits of scale*
  - *Integration of technologies*

Reducing Transport/Dispensing Costs –

- *Improved road haulage transport technology*
- *Reduce energy costs re dispensing compression*

Biorefining & Bioenergy

AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

BioCNG Fuels
Facilitating Market Development

Demo Projects Can Generate Market Confidence

Availability of Low Cost Finance –

constrained in current climate

– *EU financial instruments offer a source of development finance*

Key to Market Development is to Attract Investment Capital
Framework Applicable over Economic Life of Projects (15-20 years)

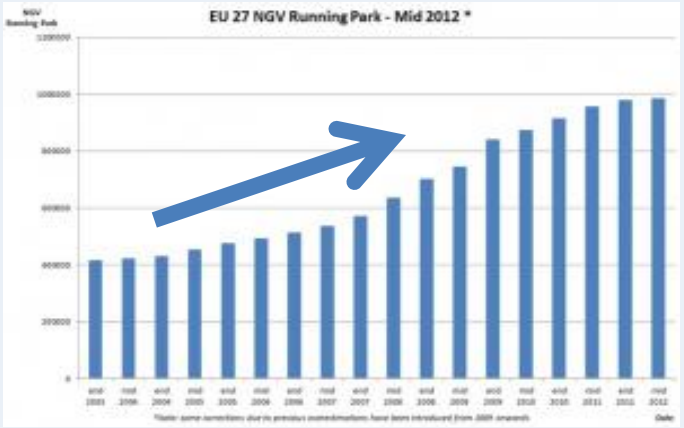
Biorefining & Bioenergy
AN ENTERPRISE IRELAND & IDA IRELAND INITIATIVE

Bio CNG Transport Fuels

Summary - A Growth Opportunity

- AD of wastes and residues is economically viable
- Dual value & expansion into AD of energy crops offers ongoing growth
- EU and state policies support sustainable development of renewable energy

- Emulate rapidly growing EU markets
- BioCNG fuels - lower price attractive to hauliers and motorists
- BioCNG fuels both passenger vehicles & HGV's
- BioCNG suitable for both short/long haul trips
- Fast –fill dispensing is convenient
- Proven distribution and vehicle technologies de-risks market deployment



- Natural gas & upgraded bio-methane are interchangeable.
- Bio-methane industry can leverage grid coverage & co-development of NG transport fuel market to access market outlets nationally
- Technology & sources of Irish NG underpin secure NG supplies & stable pricing
- Roll out of distribution network obligatory

Economically, Environmentally and Technically Viable

Commercial Viability Dependent on Supportive Framework

Biorefining & Bioenergy

AN ENTERPRISE IRELAND
& IDA IRELAND INITIATIVE

Technology Centre for Bio Refining & Bio Energy

Developing a (Bio)CNG Transport Fuel Industry in Ireland

www.TCBB.ie

ENTERPRISE IRELAND
UNIVERSITY of LIMERICK
UCD DUBLIN
TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH
NDP Transforming Ireland
IDA IRELAND
NUI Galway
OÉ Gaillimh