Nothing wasted
Smaller scale GTL as a better option for associated gas
Velocys
The company at the forefront of smaller scale GTL

- **Leader** in smaller scale gas-to-liquids technology
  - 15 years and >$300 million invested in product development
  - Exhaustive global patent protection (>7,600 granted GTL patent claims)

- First class **partners** offering a **complete GTL solution**
  - Haldor Topsøe, Ventech, Hatch, Mourik, SGS, Shiloh

- **Commercial roll-out underway**

- **Well capitalised** with **strong resources**
  - Commercial center in Houston, Texas; technical centers near Columbus, Ohio and Oxford, UK
  - Permanent pilot plant in operation
Microchannel reactors
Backbone of Velocys FT technology

- Microchannels enhance heat and mass transfer rates
- Alternating process & coolant layers allow close coupling of exothermic reaction with steam generation aiding the robust performance
- Particulate catalyst in small process channels
Origin of exceptional catalyst performance
Patented organic matrix combustion (OMX) method

- **Traditional catalyst manufacturing**
  - Produces broad distribution of cobalt particle sizes

- **OMX catalyst manufacturing**
  - Produces optimized smaller and more uniform cobalt particle sizes
  - **Higher activity** from smaller particles
  - **Greater stability** from narrower particle size distribution
The Velocys team – working towards one goal
Making smaller scale GTL a reality
Smaller scale GTL for associated gas
Making the most of the resources available
Alternatives to flaring
Gas monetisation options

• **Reinjection.** A cost with no return on investment. Can potentially affect oil recovery

• **Electricity generation.** Good alternative where there is sufficient scale and a nearby market for electricity (at oil and gas production sites & nearly communities in developing countries)

• **Gas pipeline.** Cost-effective solution for moderate/large volumes (stranded gas reserves). Not always possible: Yamal basin in Russia

• **CNG and LNG.** Gas handling requires the establishment of dedicated infrastructure. Generally, more suitable to larger volumes but modular systems advancing.

• **DME, methanol** (other chemical process producing liquid products). Require separate transportation and storage infrastructure

• **Smaller scale GTL.** Economically and logistically possible at the volumes and locations needed for associated gas currently flared
Benefits of smaller scale GTL
GTL delivers higher value at flexible scale

- Diesel production for local or global market
  — Production of “drop in” fuel
  — No switching costs – infrastructure or engines (cf LNG for transport)
  — Demand for diesel increasing

- High value product
  — Diesel worth $200/barrel on North Slope

- Modular plants, suitable for deployment at remote locations

- Hedge between oil and gas markets

- Flexible scale up to 150mmscfd or more
Benefits of smaller scale GTL
FT fuels – producing a valuable, desirable product

• “Drop in” replacement for petroleum derived fuels, lubricants and other products
• Near-zero sulfur, amine, aromatics content
  — Can be used as a blend stock for ultra-low sulfur fuels
• High cetane (70), high performance
  — Meets military specification for aviation fuel
  — FT diesel powered every 24 hour Le Mans winner since 2006
• Lower emissions
  — Lower SOx, NOx and particulates compared to petroleum fuels
  — Quieter engine operation
Creating value from zero-value waste product
Taking the plant to the opportunity – Alaskan North Slope

- Free gas (being reinjected)
- Local diesel demand 3,000 bpd
- Diesel trucked 900 miles
- Local price $200/bbl

The primary source of ULSD in Alaska on the Kenai

The North Slope produces over 500,000 bpd of crude

Two large oil fields on the North Slope need 2,500 bpd ULSD

Two small topping refineries on the North Slope but neither produces ULSD

Two refineries in Fairbanks but neither produces ULSD

Smaller source of ULSD – refinery in Valdez

The National Map courtesy of US Geological Survey
Creating value from a zero-value waste product

- For example, instead of 24 mmscfd being flared
- A GTL plant could make 2,500 bpd product
- Worth (per year)
  - $48 million (syncrude)
  - $64 million (diesel)
  - $142 million (diesel, isolated market)
- With a further significant upside if unlocking constrained oil production or producing specialties

Based on $59/barrel WTI, May 2015
Remote locations bring other requirements - logistics
Smaller scale GTL realises profits faster

- Shortens the time between concept and being operational
- Build plants wherever the opportunity is
- Accesses markets faster – no need for pipelines
- Enables products to be sold locally
Smaller scale GTL...improves the economics

Our design leverages standardisation, unlocking opportunities that were previously uneconomic

• Up to 15,000 barrels per day (150 mmscfd)
• Our design is specific for smaller scale plants, not just a scaled down large plant
• Our components are standardised, reducing costs
• Our strategic partnerships allow us to deliver at volume
Smaller scale GTL… works for anyone

Velocys unlocks more business by working flexibly – allowing companies to capitalise on more opportunities

- Smaller projects means more opportunities, accessible to more companies

- We have strong partnerships with key players throughout the value chain

- Velocys can support all aspects of project development and execution
Smaller scale GTL… works anywhere

Our plants are modular, so they are easier to ship and faster to install, even in the most remote or challenging locations

• Our reactors are significantly smaller and lighter than conventional technology

• As much as 70% of a plant can be factory-built before installation

• Modular components fit in standard containers for ease of shipping

• Building is fast, we have reduced the risk of delays, and plants can even be integrated with existing facilities
First smaller scale GTL plant under construction
First ENVIA Energy plant being built
Adjacent to WM East Oak landfill in Oklahoma City, USA
ENVIA Energy
Oklahoma City project

• Landmark for GTL
• Landfill gas + natural gas
• Major companies committing to smaller scale GTL
• Entered into all main contracts; procurement of all major equipment completed; key permits received

• Construction begun
  — Commissioning and start-up H1 2016
• Will be our commercial reference plant – a major milestone
  — Demonstrate parallel operation of full scale Velocys reactors
Site preparation work continuing
By Ventech and its subcontractors in Oklahoma City
Module and vessel fabrication underway
At Ventech, Pasadena, Texas
Reactor cores being manufactured
By Shiloh Industries, Ohio
Reactor pressure vessel assembly underway in Wisconsin
Extensive validation testing complete at Velocys pilot plant

• Integrated GTL pilot plant at the Velocys Ohio, USA site

• Provides
  — Performance data to support differing client designs
  — Product for client studies
  — Permanent training facility for plant operators

• Platform for
  — Developing our own field support staff
  — Demonstrating future product generations
Piloting alternative scenarios
Expect the unexpected

- Commercial plants in any industry are subject to feed and situational variances
- A robust technology must be resilient to these changes
- Approximately 1,000 hours dedicated to alternative modes and regimes this year
- Extensive computational modeling also conducted
Piloting alternative scenarios
Expect the unexpected
GTL for associated gas solutions
Commercial reference site in operation
What then?

• Even where flaring penalties are in place, there does not currently appear to be the political will for them to be widely enforced

• Having a commercial reference plant up-and-running at a scale suitable for using associated gas will
  — Demonstrate smaller scale GTL as an economically viable alternative to flaring

• Smaller scale GTL could then
  — Become a real catalyst for change
  — Galvanize political will for strength & action
  — Pave the way for regulations to be more widely enforced
  — Become the way that producers unlock otherwise constrained oil production
GTL at a gas gathering point
A solution for a small area rather than a single wellhead

- Unlikely to be the volume of gas required
- Drop-off in gas volume too fast to support a GTL plant through its lifetime
GTL at a gas gathering point
A solution for a small area rather than a single wellhead

- Gas gathered from multiple wells coming on-line at different times
- Smooths out fast decline in production rates from individual wells
- Sustains gas flow for plant lifetime
- Feedstock flexibility
  — Dry or wet gas
  — Sour gas – H₂S removed at start of process
  — Inerts accommodated
Smaller scale GTL solution for associated gas

Pre-feasibility study complete

- Engineering: Zeton
- Syngas: Praxair
- FT: Velocys
- Capacity: 200 - 300 bpd
- Next step:
  — Site specific engineering study with gas resource owner
Other commercial projects
Velocys Project Solutions
Driving the GTL opportunity by developing its own projects

- In 2014, Velocys became a direct developer of GTL projects through the acquisition of a leading project developer.

- Velocys Project Solutions is the project development arm of Velocys.

- Velocys is committed to leading the development of the smaller scale GTL market.

- Velocys has the:
  - Highest motivation for successful project development
  - Best understanding of the entire plant

- The company has allocated significant resources to build a successful project development effort.
Works for anyone – Velocys working flexibly
Deploying project development know-how

Velocys FT technology

Knowledge of integration of Velocys FT in overall GTL plant

Relationships with and capabilities of partner organizations, Mourik, UOP, Haldor Topsoe, SGS, Ventech…

Velocys Project Solutions, knowledge of how to develop a successful project to FID: financing, supply and offtake contracts, permitting

VPS will not compete with customers. Technology available for license to third parties.

Velocys acts as technology licensor with project developer’s preferred partners

Velocys acts as technology licensor with established partners

Velocys Project Solutions (VPS) available to work with project owners or prospective clients to help ensure success

In-house project development expertise brings value to third party developers’ projects
Other public-domain commercial projects announced
Pipeline growing and progressing

- 4,800 bpd plant supplied from Marcellus; future expansion planned to 10,000 bpd
- Initial engineering complete; Permits received or in progress

- 1,100 bpd biomass-to-liquids plant in Oregon, USA
- FEED study complete (summer 2014)
- Awarded $70 million construction grant from DOD (Sep 2014)
- Targeting FID H2 2015

- 2,500 bpd waste-to-liquids plant at former Coryton oil refinery in Thurrock, Essex, UK
- Pre-FEED complete (summer 2014), now entering FEED
- BA signed offtake for all jet fuel from facility (worth $500m)
Stranded and associated gas
  — Russia, Caspian

Product driven
  — Africa – jet fuel
  — Asia – lubricants

North America
  — Ethane usage
  — Midstream processing
  — Waxes and lubricants

Fuel in remote locations
  — Australia – diesel for mining

Non-gas feedstock
  — Waste – tipping fee e.g. $75/bbl; RINs $42/bbl
  — Coal – US, Australia

Pipeline growing and progressing
Other opportunities being actively pursued
Summary
Velocys – at the forefront of smaller scale GTL

• Smaller scale GTL projects are advancing
  — Vast natural gas resources going to waste (zero cost)
  — Many others even today’s low oil price environment

• Velocys, the company at the forefront of smaller scale GTL technology
  — 15 years and >$300 million invested in its unique innovative technology

  — Exhaustive global patent protection (>7,600 granted GTL claims)

  — Broad & deep in-house capabilities

• Commercialisation underway
  — Waste Management JV, Ashtabula, Red Rock Biofuels, Solena
Thank you

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Gas flaring appendix
The Bakken. Source: NASA’s Earth Observatory
Flaring – the scale of the wasted resource

• Each year, 140 billion m³ of natural gas (4.9 TCF) produced with oil is flared at thousands of oil fields worldwide — With a further 6.5 TCF reinjected to avoid flaring alone

• Results in >300 million tons of CO₂ being released to atmosphere

• Equivalent to emissions from ~77 million cars

• If this wasted gas was used for power generation it could provide more electricity than Africa currently uses (750 billion kWh) World Bank

• In North Dakota alone, of the ~1,350 million cubic feet per day of gas produced, 69% is sold, only 3% is used at the production site and 28% is flared to atmosphere EIA August 2014

• Size of opportunity for GTL using associated gas as feedstock 2.7 million bpd (assuming monetisation over 100 years)
Geographical distribution of the opportunity
Volumes of vented and flared gas

Source: Infield, World Bank, Internal Analysis
Geographical distribution of the opportunity
Many isolated opportunities

Source: KPMG report