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Organic: Our use of the term Organic includes SEC proved oil and gas reserves excluding changes resulting from acquisitions, divestments and year-average pricing impact.

Shales: Our use of the term ‘shales’ refers to tight, shale and coal bed methane oil and gas acreage.

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Agenda

- About Shell
- The Energy Challenge
- TaCIT & Our Digitalisation Strategy
- Our Innovation Process & the Advanced Analytics CoE
- Use of MatLab in Shell
- An example use case: Quest CCS
- Planned Next Steps
**Business Overview**

**EXPLORATION**
- Exploring for oil and gas: Onshore and offshore

**DEVELOPMENT AND EXTRACTION**
- Developing fields
- Producing oil and gas
- Extracting bitumen

**MANUFACTURING AND ENERGY PRODUCTION**
- Refining oil into fuels and lubricants
- Producing petrochemicals
- Liquefying gas by cooling (LNG)
- Converting gas into liquid products (GTL)
- Upgrading bitumen

**TRANSPORT AND TRADING**
- Shipping and trading
- Regasifying (LNG)
- Supply and distribution

**RETAIL AND B2B SALES**
- Producing biofuels
- Generating power
New Energy Future by 2050

Rising energy demand, supply pressure, climate change

Population
9 billion people, 75% living in cities (2 billion more than today)

Vehicles
2 billion vehicles (currently 800 million)

Rising standards
Many millions of people will rise out of energy poverty; with higher living standards energy use rises

Demand
Energy demand could double from its level in 2000...but CO₂ emissions must be half today's to avoid serious climate change

Efficiency
Twice as efficient, using half the energy to produce each dollar of wealth

Renewables
4 times more energy from renewable sources
Technical & Competitive IT

- Partnering with the business and functions to drive innovation
- Product development through Research & Development to deliver differentiating solutions
- Maintain and enhance technology solutions across Upstream and Downstream
- Enable Projects & Technology division within Shell
What is digitalisation

Shell context

Focus
- How Digital technologies can help address current business challenges
- Technologies that can have a substantial impact on our industry

Is not
- New
- An outcome
- One off thing
- Only in the future

Industry definition*
“The use of Digital technologies to change a business model and provide new revenue and value-producing opportunities”

*Industry definition has been sourced from Gartner

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Disruptive Digital Themes

Technologies:
- Advanced Analytics
- Computational Technologies/HPC
- 3D Printing
- Wearables & New Realities
- Internet of Things & Sensors
- Robotics
- Disruptive Future Technologies

Innovation Themes:
- Mobile First
- Everything to Cloud
- Migrate to the Cloud
- Design for Mobility
- Enhanced algorithms/compute power
- New business insights
- Novel designs/parts manufacturing
- Contextual interaction
- Interconnected devices & people
- Address the ‘human exposure bottleneck’
- Innovate for the future

Maturity of Theme:
- Design for Mobility
- Migrate to the Cloud
- Enhanced algorithms/compute power
- New business insights
- Novel designs/parts manufacturing
- Contextual interaction
- Interconnected devices & people
- Address the ‘human exposure bottleneck’
- Innovate for the future

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What does the Advanced Analytics Centre of Excellence do?

**Strategic Objective**

1. **Platform Development**
   - Scale & grow Production Platform to meet needs of Advanced Analytics community in Shell
   - License Analytics Lab to user communities for Proof of Concepts
   - Develop enterprise licensing agreements for Analytics software and drive convergence
   - Translate Proof of Concepts into supported Business Services leveraging standard Production Platform
   - Analytics Lab a test-bed for cutting-edge tools & techniques

2. **Value Identification & Delivery**
   - Validated pipeline of opportunities constantly updated & iterated
   - Robust valuation methodology
   - Execution of ⭐ Proof of Concepts
   - Inventory Optimisation
   - HSSE Incident Prevention
   - Market Basket
   - Processes to assess business impact & coordinate investment proposals
   - Assure & extend business cases by progressing ⭐ Proof of Concepts to production

3. **Network Co-ordination**
   - Raise profile of AA within Shell and develop greater sense of community with the support of senior leaders
   - Generate best practice benchmarks and materials for analytics delivery in Shell
   - Technical, Commercial, Data Science & Tooling streams
   - Single point of contact, advice & best practices relating to Advanced Analytics
   - Identify & attract relevant skills & capabilities, and coordinate interventions where appropriate

**Methodology**

- Analytics Network & External Partners
- Analytics Education & Communication of best practise
- Core Team with Technical & Commercial skillset
- Innovation Remit
- Analytics Lab to trial & test technology in supported environment

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### MatLab Usage in Shell

#### UPSTREAM
- Operated
- Joint ventures
- Deepwater
- Safety & environment
- Production excellence
- Exploration

#### INTEGRATED GAS
- Venture development
- Production excellence
- Qatar
- Australia & New Zealand
- Russia
- Safety & environment
- Ventures
- Commercial/NBD

#### DOWNSTREAM
- Refining
- Pipelines
- Chemicals
- Trading and Supply
- Retail
- Lubricants
- Business to business
- Biofuels

#### PROJECTS & TECHNOLOGY
- Innovation, R&D
- Technical IT
- Project execution
- Global technical expertise
- CO₂ management
- Safety and environment
- Contracting and procurement

#### FINANCE
- Finance
- IT
- Investor relations
- Tax
- Strategy
- Planning and appraisal
- Internal audit

#### HR & CORPORATE
- HR
- Real Estate
- External Relations
- Shell Aircraft
- Health
- Security

#### LEGAL
- Legal
- Compliance
- Intellectual property

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Matlab Applied
Quest Background

- The Albian oil sands in Canada produce 255k barrels per day of heavy bitumen products which are upgraded at Scotford.

- Dense phase CO2 captured and compressed from the Scotford Steam Methane Reformer Units (around 1.2 Mt/yr).

- The CO2 is transported by pipeline to three injection wells near the Scotford Complex and stored approximately 2,300 meters underground in a deep geological formation.

- As part of Shell’s license to operate they need to monitor the site to check the CO2 is not leaking back into the atmosphere.
The Challenge

- Quest CCS is a critical innovation for Shell.

- CO2 is captured and stored underground and government funding is contingent on Shell proving the CO2 stays in the ground.

- Innovative sensors (based on lasers) have been installed at the plant to monitor the atmosphere for CO2 emissions.

- Algorithmic approaches are required to distinguish actual CO2 events from “background noise”
Technical Solution

- Over the past 8 years Shell’s remote sensing’ group have been developing surface monitoring algorithms for measurement the Quest monitoring verification (MMV) program:

- Primary objectives are to:
  - Ensure containment
    - Verify absence of environmental effects.
    - Detect early warning signs of loss of containment.
    - Trigger additional safeguards
    - Safety critical - ALARP
  - Ensure conformance - LightSource technologies to address ‘containment’ objective.
Solution – Advanced Analytics Lab

- Deploy the monitoring algorithm using the Matlab Production Server in the Advanced Analytics Lab (PoC).
- Provide daily monitoring and alerts depending on algorithm results.
- Improved visibility of algorithm results.
- Eliminate manual effort involved in running the analysis.
- Productionise Quest by embedding solution in a fully supported IT landscape (October 2016).

Value:
- Compliance with regulation assures access to government funding /reduced exposure to fines & penalties/license to operate.
Solution – Target Architecture

Externally Managed with:  
- Surface Laser Sensors (x3 pads)
  - Atmosphere Monitoring (Specifically monitors for CO2)
- Computer
- Cellular Modem
  - Daily @ 12 am CST
- DMZ

IT Managed

- Visualisation (Process Book)
- Value Model (SSP-S)
- Super Collective
- PI-AF (SSP-S)
- S-FTP
- PI UFL
- Matlab

- 75 tags: Fields: 3 Fields/Injection paths
- Weather: 10 attributes
- Ultrasonic: 6 attributes
- Boreal: 8 attributes
- Additional PI Tags required for write back

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Quest Visualisation (Process Book & Power BI)
Shell & Matlab, the Future?

More explicit linkage to other Digital Themes:
- **Internet of Things** - Edge computing
- **High Performance Computing** - Distributive/Spark computation
- **Mobility** - Smart apps development/management

Immediate Priorities for 2017
- Enterprise licenses
- Continued deployment through MPS
- Prove the business value of current Matlab projects in innovation pipeline:
  - Bitumen image analysis
  - Excel trading
  - MADA
  - Acoustic sensing