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Digital Transformation in the Upstream Energy Transition

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Stellae Energy

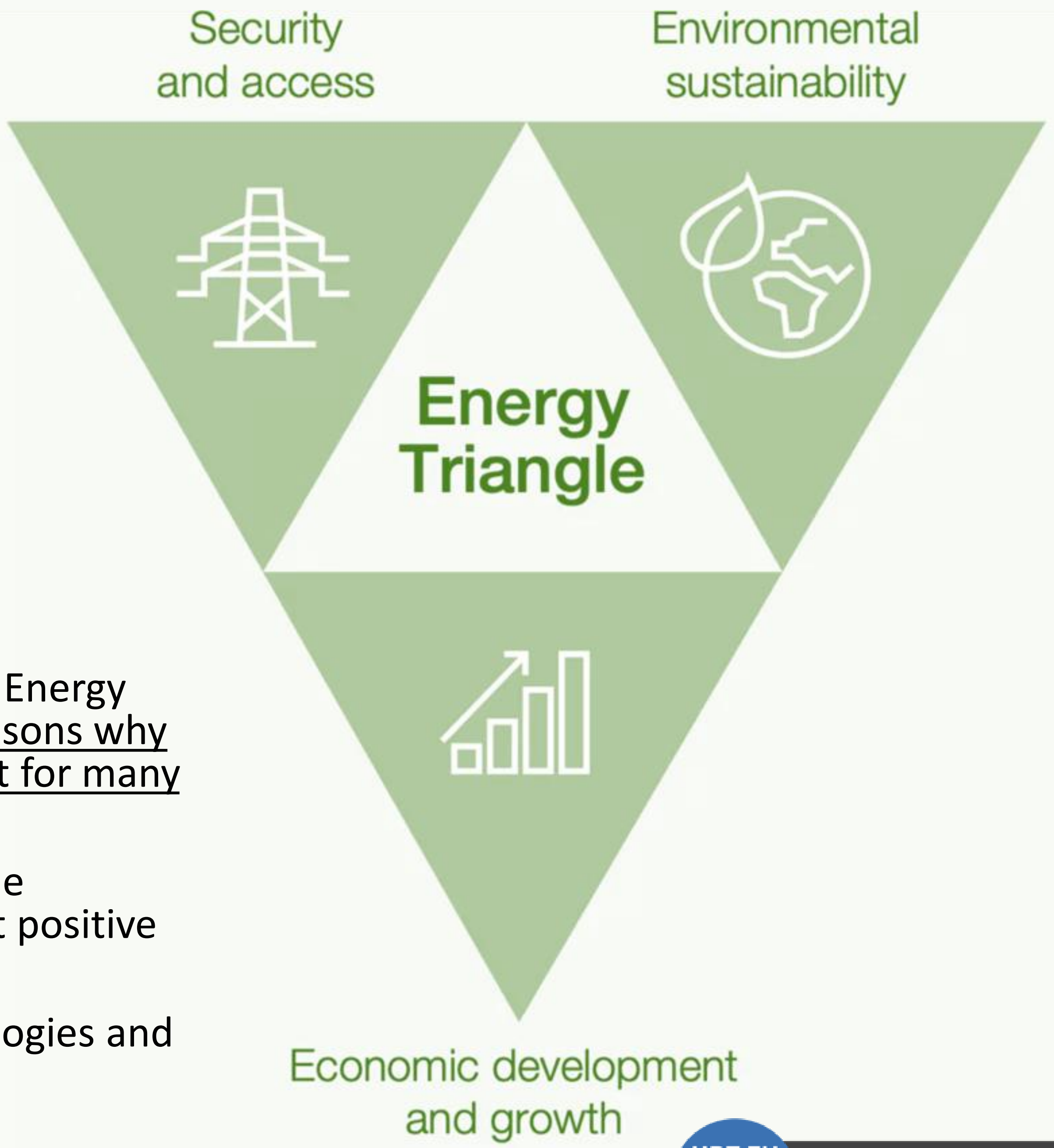
Stellae Energy Background

- Stellae Energy are a UK energy company based in London with a team of experts located in the UK as well as internationally;
- We are an Energy Transition company that is capable of creating end to end Renewable Energy solutions - not promoting just one technology or source of energy;
- Our management background is many years working internationally in the Upstream and Extractive industries across all development phases;
- Stellae Energy works with its global partners in variety of ways, from being a active partner in energy joint ventures to providing strategic advice and project management services.;
- For the Upstream industry, we offer a range of commercial models from Advisory Services to Project Management to Equity Participation to Finance / Build / Operate, helping Operators with the Energy Transition as described in today's presentation.

The Energy Transition

- Several steps are involved:
  1. Improving energy usage efficiencies;
  2. Reducing waste and GHG emissions;
  3. Implementing Carbon Capture measures;
  4. Increasing the use of Renewables.

- A successful Energy Transition needs to balance the Energy Triangle as shown here. <u>This is one of the major reasons why the Upstream industry will continue to be important for many years</u>;
- The Upstream industry is well positioned and has the necessary technical capabilities to deliver significant positive outcomes for the Energy Transition;
- The intelligent use of Digital Transformation technologies and tools will help facilitate these outcomes.



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Upstream Industry Challenges

- From subsurface resources, the Upstream industry works with carbon based reservoir fluids (i.e., oil, condensate, and gases) and produces carbon based products (i.e., processed liquids and distillates and compressed and liquified gases);
- At each step along the process, there could be leaks or emissions which need to be detected and eliminated for safety and value reasons;
- The recovery factor of extracting hydrocarbons from reservoirs is important – increased recovery captures more value, but it also means that the carbon footprint associated with this extraction is reduced and spread across more units of production. Every additional barrel of oil or cubic foot of gas extracted may help reduce the number of total wells required to be drilled and the number of facilities required to be constructed. Updated with production data, subsurface digital twin simulation models help optimise these recoveries;
- Exploration, drilling, and development requires energy to power the equipment, rigs, and vessels, and these power sources need to be efficient to avoid wasting energy during running or when providing standby power support. Operational digital twins gather IoT data to ensure everything is running as designed and responding to the varying power demands of the operations.

Energy Usage Efficiency

- Rotating equipment and machinery run in Integrity Operating Windows which are involve a range of input settings and observed operating data;
- Digital transformation technologies and tools would help monitor these inputs and help make adjustments (i.e., inlet air cooling or warming; water injection into turbine combustors; filtering inlet air, etc.) to ensure optimal performance and minimise potential degradation;
- IoT instruments are used to monitor the inlet conditions using thermal measurements, pressure differentials, visual and IR thermal cameras, laser scanning, and particulate distribution mapping;
- Operating data monitoring would use similar IoT instruments as well as acoustic and vibration sensors to ensure the equipment is running smoothly and in a manner to prolong operating life before any maintenance is required (planned or unplanned);
- Advanced Analytics including Machine Learning and AI would help process input and operating data to help determine if any changes would be required to improve energy usage performance or prevent unnecessary maintenance of equipment.

Reducing Waste and GHG Emissions

- With typical equipment and connections, there could be a number of potential leak paths for methane or other GHG emissions. Methane leaks are ~80 times worse than CO_2 emissions (*on 20 year timescale*) and there is increasing legislation being considered and implemented to penalise operators for these leaks. The Global Methane Pledge just announced at COP26 aims to reduce methane emissions by 30%. Methane leaks could also be a serious safety risk for people and assets in the right amounts, concentrations, and hazardous locations;
- Fortunately we have good fixed and moveable technologies to help monitor and locate any such leaks. IR imaging cameras have been widely used, combined with algorithms to process images to distinguish different types of emissions and liquid leaks. Handheld manual devices are commonly used, but robotic ground units, drones, and even satellites are being increasingly deployed to monitor facilities, equipment, wellheads, flowlines, and pipelines. Gas detectors are a rapidly improving technology with (1) lasers-based sensors reducing the detectable ppm concentrations and increasing detection distances; (2) spectrometric sensors to detect site specific chemical signatures; and (3) economical printed sensor patches with chemicals and nanoparticles designed to detect specific trace chemicals;
- The benefit of routine regular autonomous surveys and connected sensors is that the data can be loaded into an operational digital twin with all visual and numerical data able to compared with prior data to highlight any changes in emissions requiring action.

Carbon Capture and Storage

- Carbon dioxide emissions from point sources like wellheads or "post-combustion" exhausts are easier to capture and process for storage;
- At wellheads, low BTU gas with high percentages of CO_2 would have the benefit of higher pressure and concentration, both of which help make carbon capture easier;
- Several "post-combustion" technologies including membrane systems, supersonic separation, and amine based scrubbing process systems combined with treatment and compressions systems would be able to isolate and extract CO_2 from exhaust streams;
- Sophisticated control systems are used to optimise the efficiency of these technologies and help minimise energy usage. IoT sensors, data collection, and processing this data with Advanced Analytics helps "tune" these systems;
- This technology is fairly well developed for onshore facilities and is being rapidly improved to allow the use on offshore platforms and FPSO's (e.g., *Aker Solutions' modular "Just Catch"*);
- Subsurface storage locations would include either depleted oil or gas reservoirs or deep saline aquifers. There are tens of thousands of potential storage locations. Sensors would be required to monitor the storage process and the ongoing storage integrity. An "asset digital twin" could collect and analyse this data and highlight any developing issues.

Increase Use of Renewables 1

- Conventional gas fired power generation is often used for the production and processing of upstream fluids, but every hydrocarbon molecule burned is one less molecule to sell and their combustion results in carbon emissions;
- One solution being pursued by several offshore facility operators and contractors is to use Fixed or Floating Wind Turbines linked to the adjacent drilling or production facilities;
- Another solution is to use the electrification of offshore facilities from onshore Renewable sources which could be Solar PV, Wind Turbines, Geothermal, or Hydropower;
- All these Renewable Energy systems would utilise safety and control systems linked to IoT sensors to monitor input and outlet conditions to ensure safe and efficient operations (e.g., in high wind conditions to help minimise cut-outs);
- Intermittent Wind Turbines would normally produce periods of significant excess electricity and this electricity needs to be captured and stored for use in the periods of intermittency. One way to do this is to use electrolysers to produce Hydrogen, which is able to be used as a high capacity, long duration Energy Storage System. To be able to monitor and balance supply and demand and to produce this Hydrogen, sophisticated control systems linked to IoT devices would be used.

Increased Use of Renewables 2

- Onshore Upstream Facilities would have a greater choice of Renewables including Solar PV, Geothermal, and maybe even Hydropower due to the possibility of using adjacent land resources;
- The extractive Mining industry has been great proponents of using Renewable Energy to power their remote facilities and the Upstream industry can duplicate this success;
- Renewables are either Intermittent (i.e., Solar PV or Wind Turbines) or Persistent (i.e., Geothermal or Hydropower).
  - Intermittency can result from climate changes, weather, seasonal variations, and night. The past year has seen a phenomenon called "Global Stilling" with wind speeds having dropped about 15% from "normal";
  - Persistent Renewables are able to provide dispatchable baseload, just like current carbon based power generation systems. Without Persistent Renewables or carbon fuel based back-up power generation, there would be a need to have high capacity, long duration Energy Storage Systems. Once again the use of Hydrogen is a potential solution using digital control systems;
- Sophisticated weather monitoring systems can help adjust the balancing of Renewables in an Energy Mix to help meet the varying power demands of the Upstream facility. Renewable Energy infrastructure would utilise IoT sensors to monitor the performance and maintenance (e.g., PV module damage) requirements.

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Conclusions

- Digital Transformation technologies and tools along with workflow changes (including Culture) have seen rapid scaling and advancement in the Upstream industry over the past ten years:
  - IoT sensors have advanced from being used for safety and control systems to be used for integrity monitoring of the physical fabric and mechanisms;
  - Processing in central control rooms has widened to include Edge processing and Cloud storage and processing;
  - Data used for dashboards has moved into Advanced Analytics. Reactive operations and maintenance decisions have become Predictive, Prescriptive, Preventative, and finally Cognitive, with autonomous decisions advancing;
  - Inspections have begun shifting from manual "Rounds" to remote "Robotic / Drones" and "Virtual Reality" using a variety of visual and IR cameras, LIDAR, motion, vibration, and thermal sensing;
- The Net Zero challenge from our stakeholders and regulators is helping to prioritise the Energy Transition and all that it involves. All these Digital Transformation technologies and tools are very applicable as the Energy Transition progresses including the use of a wider variety of potential Energy Mixes;
- The Future looks fairly positive with these solutions, but the challenges require continued advancement.

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Thank-you for your interest

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