Energy transition & Digitalization

What does it mean for welding and joining-a user perspective

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AWS Houston Chapter

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Todays Agenda

- Objective
- What's Energy transition & Digitalization?
- Energy sector drivers
- Why is it important for Welding, Joining, Construction and Inspection? Impact!
- Technology and Engineering trends
- Success factors
- Open discussion

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Why Energy Transition?

- **Energy transition** is a **significant structural change in an energy system.**
- Entails transition to renewable energy, and perhaps other types of sustainable energy,
- This time, the drivers are different –
  - Driven by a recognition that global carbon emissions must be brought to zero
  - Keep global warming below 1.5 °C
  - Energy mix and technology to enable COP21
- Move towards sustainability through increased integration of renewable energy

Todays focus will be on what can be done at the Welding/Joining/Inspection Level

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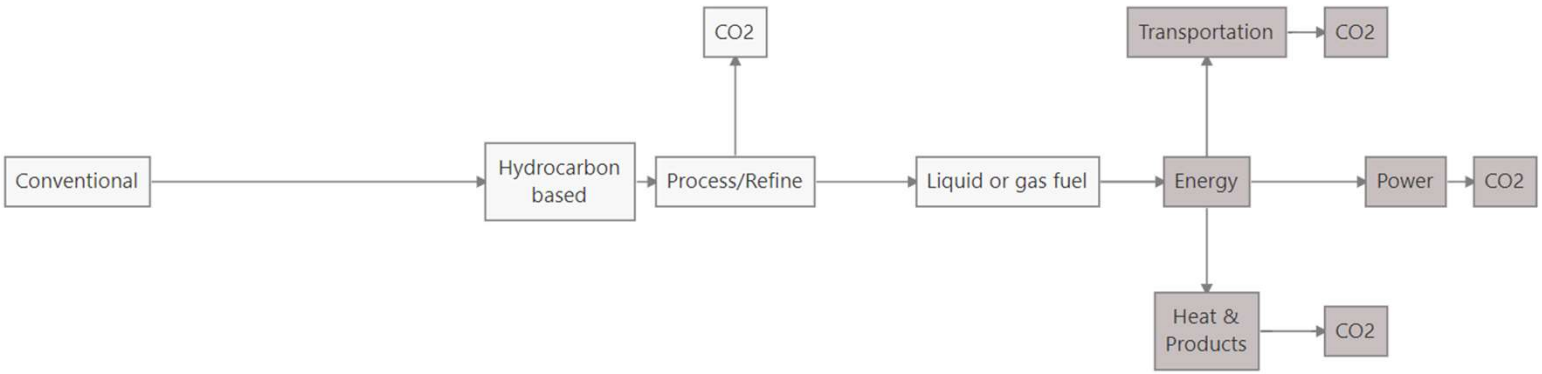
Energy Transition Simplified



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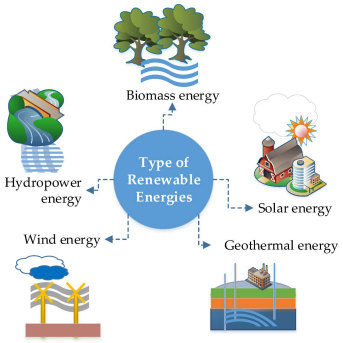
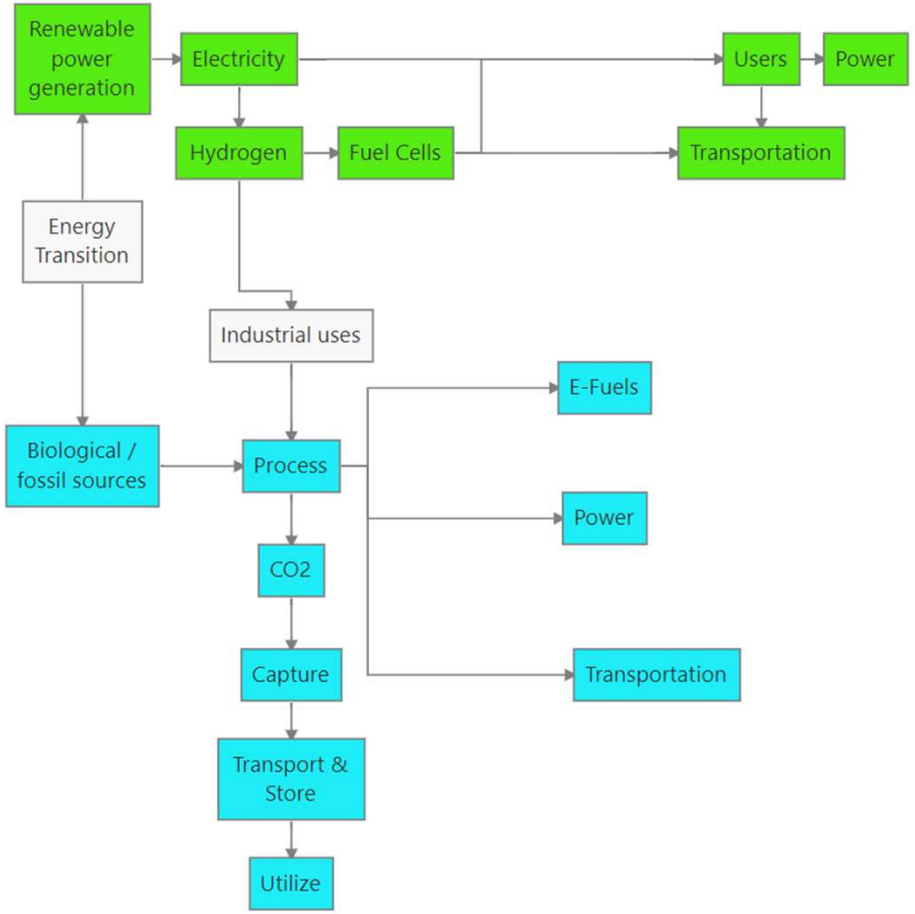
Energy Transition Simplified





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Energy Sector Drivers

- License to operate
- Safety and environment – Net Zero
- Integrity and reliability of operations
- Efficiency
- Techno economic feasibility
- Meeting the societal needs- ESG
- Subsidies, Incentives and Tax/Cost Environment

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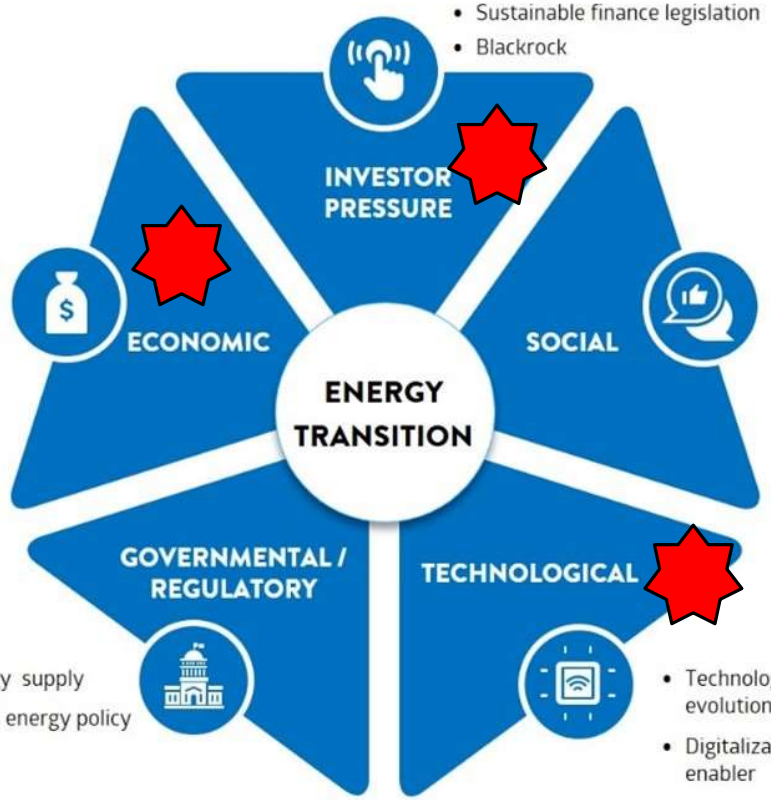
Challenges & Opportunities

KEY FACTORS ACCELERATING THE DE-CARBONIZED ENERGY TRANSITION



- ESG boom
- Sustainable finance legislation
- Blackrock

- Falling cost of clean technology
- Divestments from fossil fuels
- Expanded use of carbon cost mechanisms
- Energy price affordability

- Grassroots environmental movements
- Legal action
- Consumer preference
- Air pollution

- Security of energy supply
- Carbon and clean energy policy
- Smart cities

- Technology innovation and evolution
- Digitalization as a technology enabler

Source: Cowen and Company, LLC

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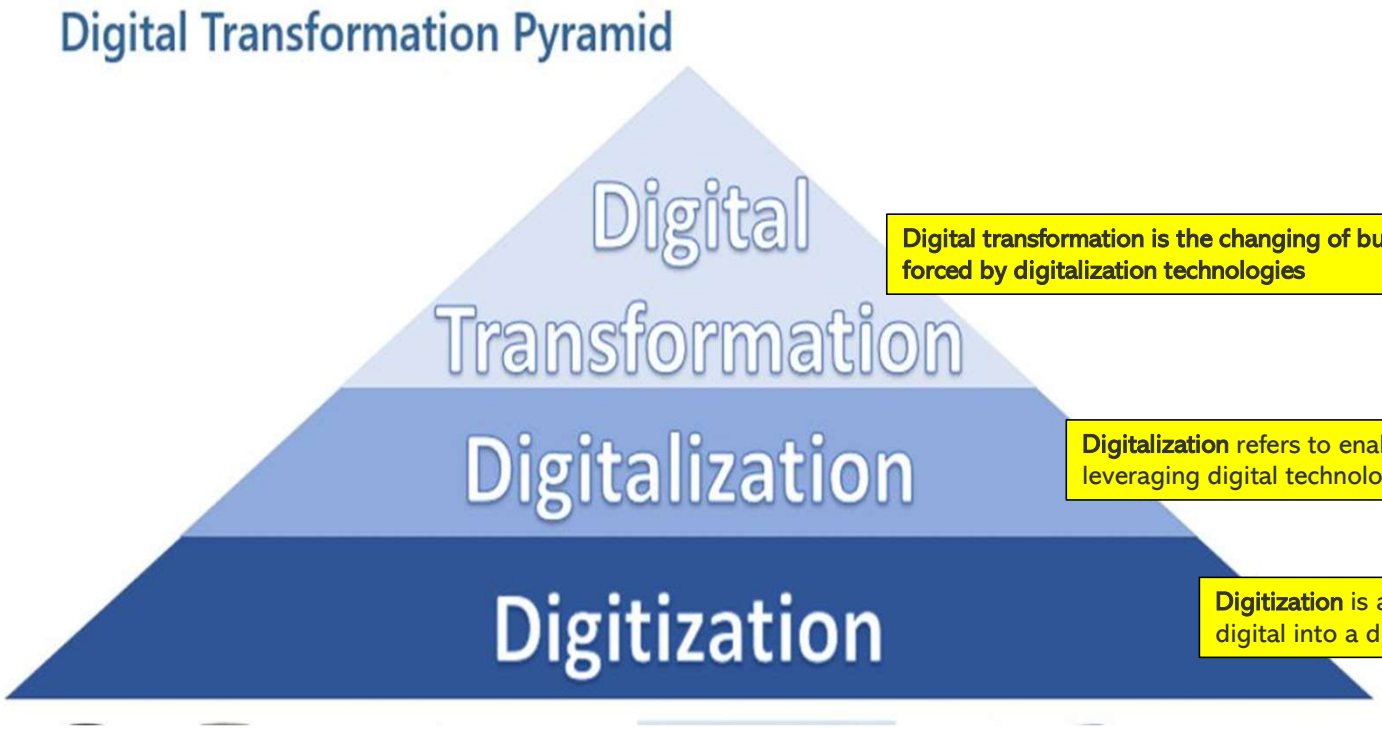
Digital Transformation



Digital transformation is the changing of business processes enabled or forced by digitalization technologies

Digitalization refers to enabling or improving processes by leveraging digital technologies and digitized data.

Digitization is about converting something non-digital into a digital representation or artifact

Todays focus will be on what can be done at the Welding/Joining/Inspection Level

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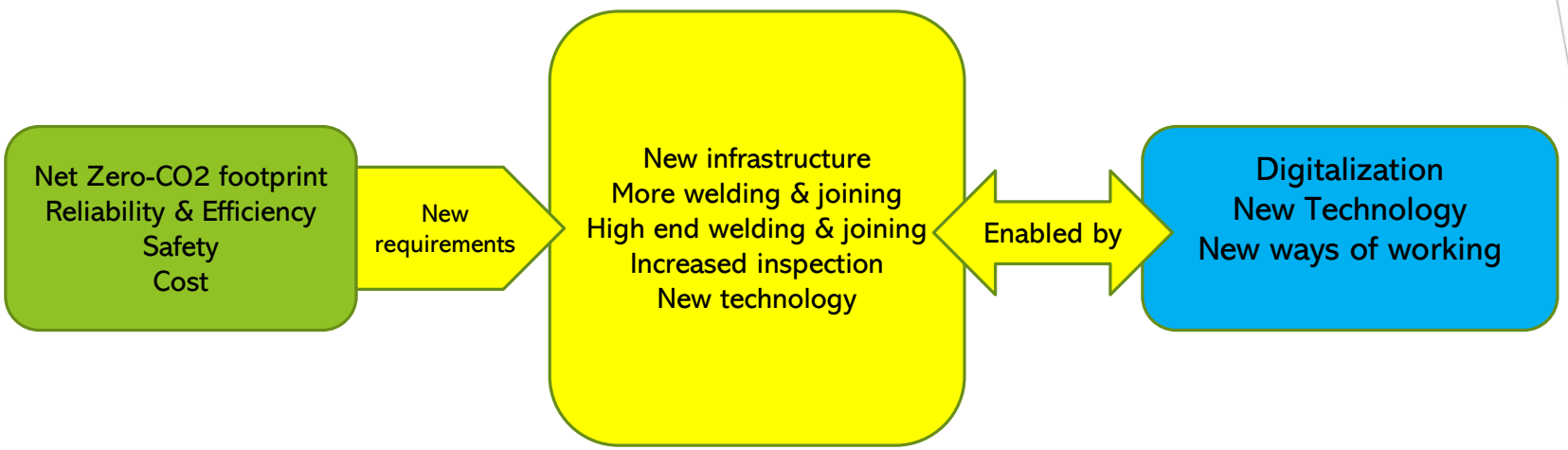
Welding & Digitalization



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The Future Landscape for W/J/I

New infrastructure
More welding & joining
High end welding & joining
Increased inspection
New technology

New Opportunities

- Wind turbine welding
- Fuel cells fabrication-clean welding (laser, GMAW..)
- Electrolyzer fabrication
- Thermal / Plasma spray instead of solid alloys for vessels
- Repurposing-welding, repair, reinforcement
- Remote / autonomous welding
- Intelligent inspection and QA
- 3D Printing
- Non-metallic pipe-joining, repair

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Potential Opportunities for Welding & Joining

- Net Zero-CO2 footprint
- Reliability & Efficiency
- Safety
- Cost

- Increased construction of new infrastructure
- Increased use of additive manufacturing for fabrication
- Novel techniques to optimize construction cost & reliability
  - New construction techniques/modularization
  - New welding and joining techniques (e.g. Laser hybrid, Wire laser for **additive manufacturing**
  - Increased use of thermal/plasma/HVOF spray where high alloys are required
  - Exotic metal welding – process and consumables
- Inspection, monitoring and sensing (new/repurposed)
  - Automated inspection techniques- online
  - Increased use of weld prediction and automation for efficiency and safety
  - Increased use of autonomous systems for inspection and monitoring
- Non metallics for transportation- hence joining and integrity

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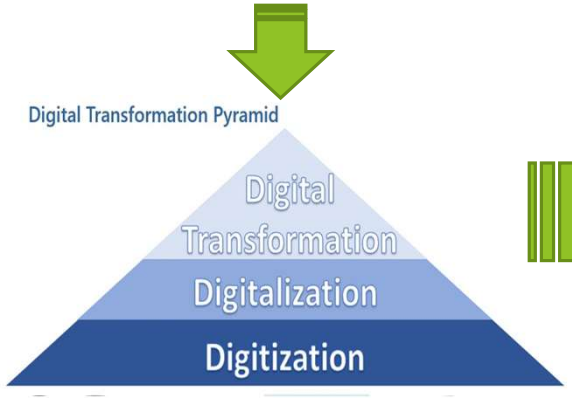
Digitally enabling welding and joining (examples)

- **Net Zero-CO2 footprint**
- **Reliability & Efficiency**
- **Safety**
- **Cost**



- Design & Cost
  - ML in design – Balancing cost and reliability
  - Efficiency
- Quality assurance
  - Data management
  - WPS/PQR management automation/ decision making
  - Additive manufacturing QA
- Safety & Reliability
  - Using digitalization to improve predictions
  - Digitally enabled inspection feedback mechanisms improve and safety
  - Digitalization to reduce human exposure to hazardous environments
  - improved inspection techniques with built in artificial intelligence
  - welding systems with built in machine learning and feedback loops

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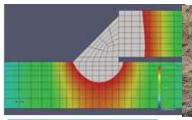
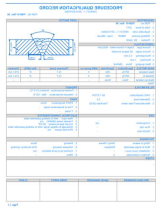
Digitalization Examples

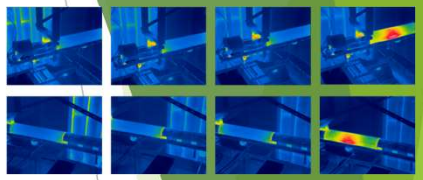
01 **Simulation & data science**



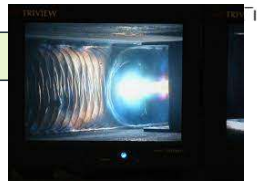
Hot tap design

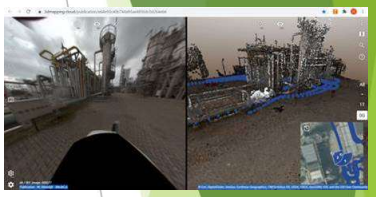


WPS/PQR automation

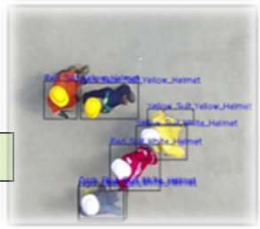


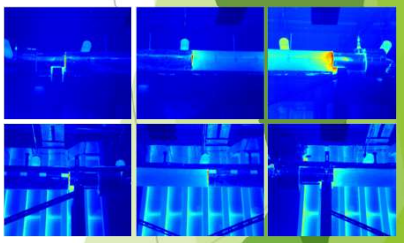
02 **Visual & IR Monitoring+(1)**



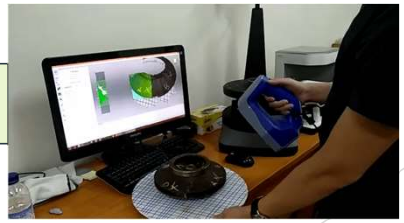


03 **Drones/Robots +(1)+(2)**





04 **Additive Manufacturing & Quality Control**



1. Key to sustained success
2. Augmented capabilities
3. Simple to Complex

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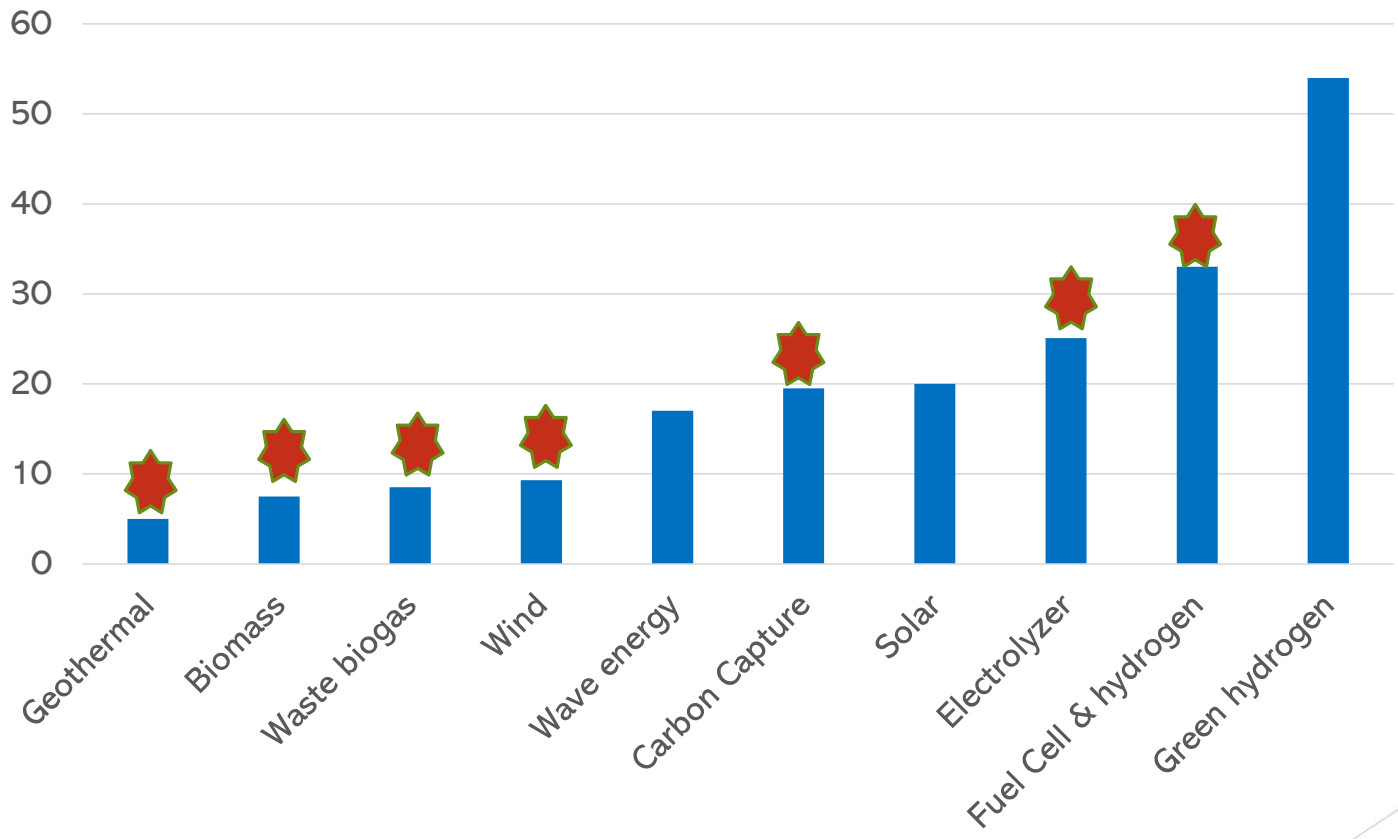
Projected growth rate- 2020-2027/28



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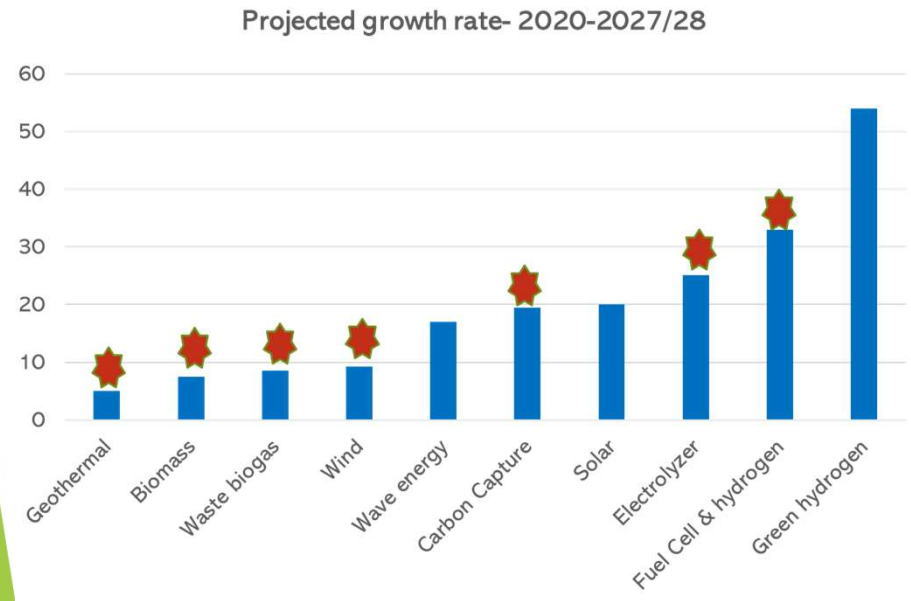

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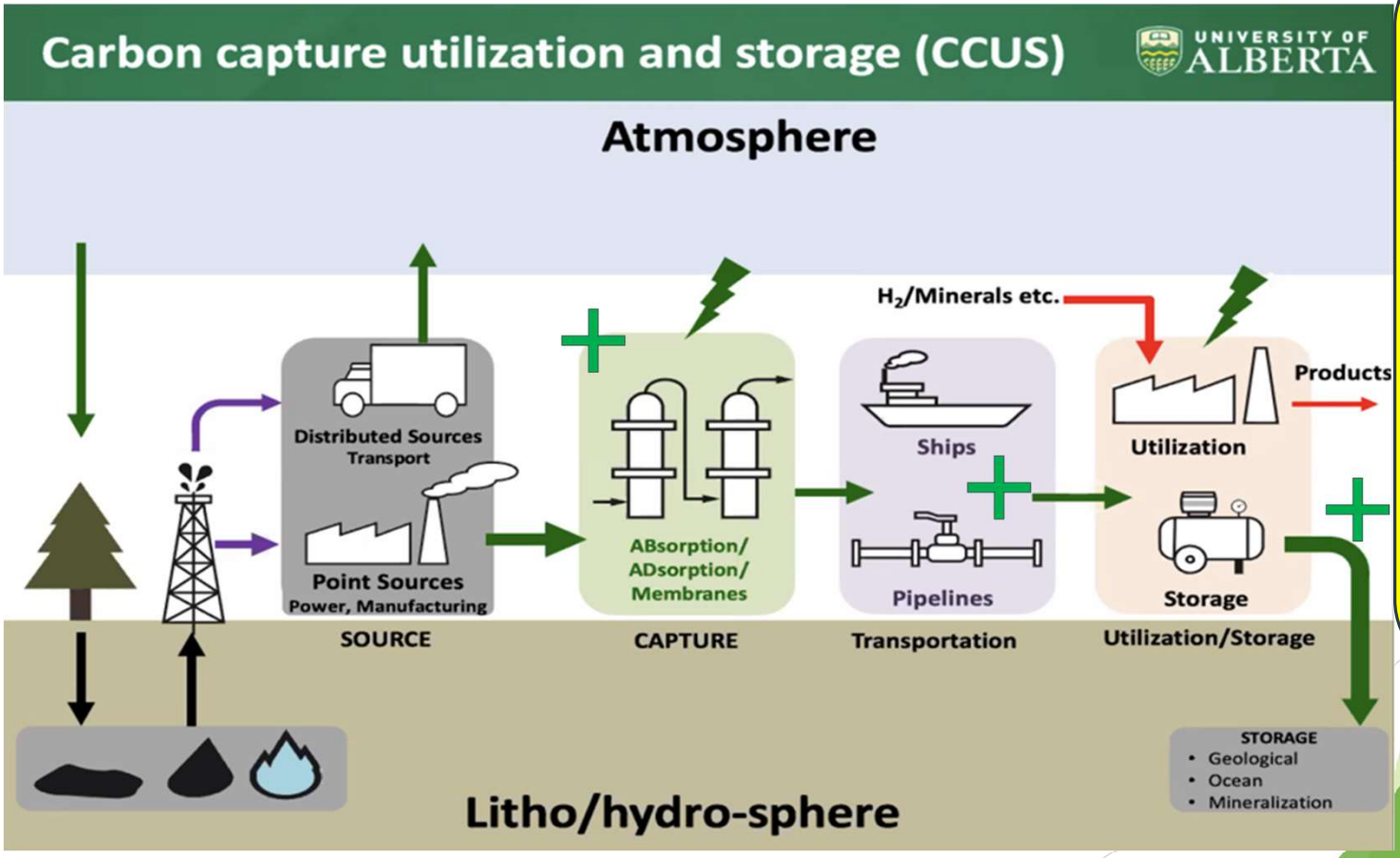
Carbon Capture, Storage (and Utilization)



- Capture vessel fabrication, thermal spray
- Welding SOFC for CO2 capture
- CO2 pipeline fabrication/integrity
- Wells equipment
- Non-metallic pipe joining
- Prediction tools-weld integrity & quality

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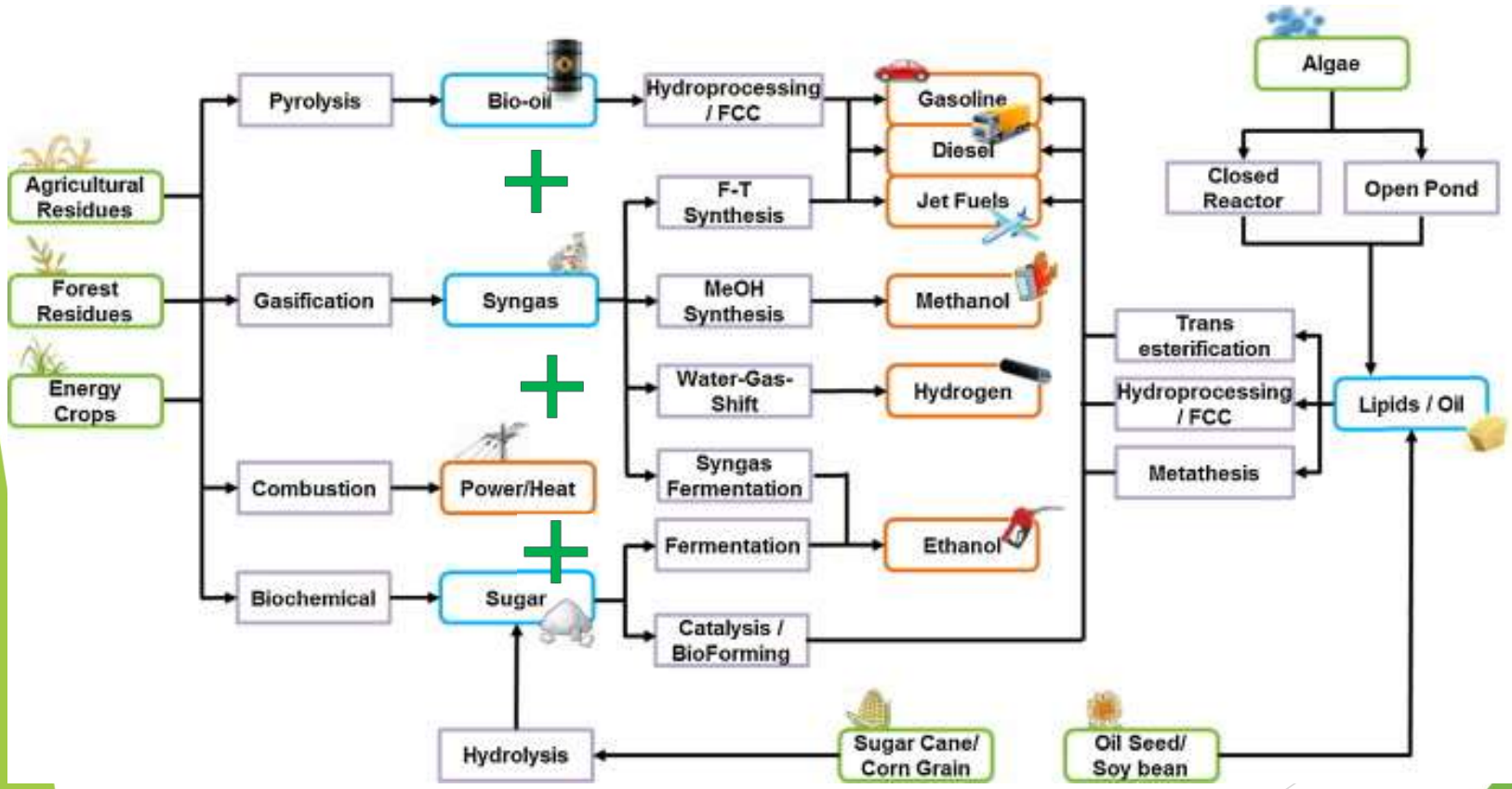
Biofuels



- New equipment fabrication, thermal spray
- Pipeline fabrication & inspection
- Non-metallic pipe joining

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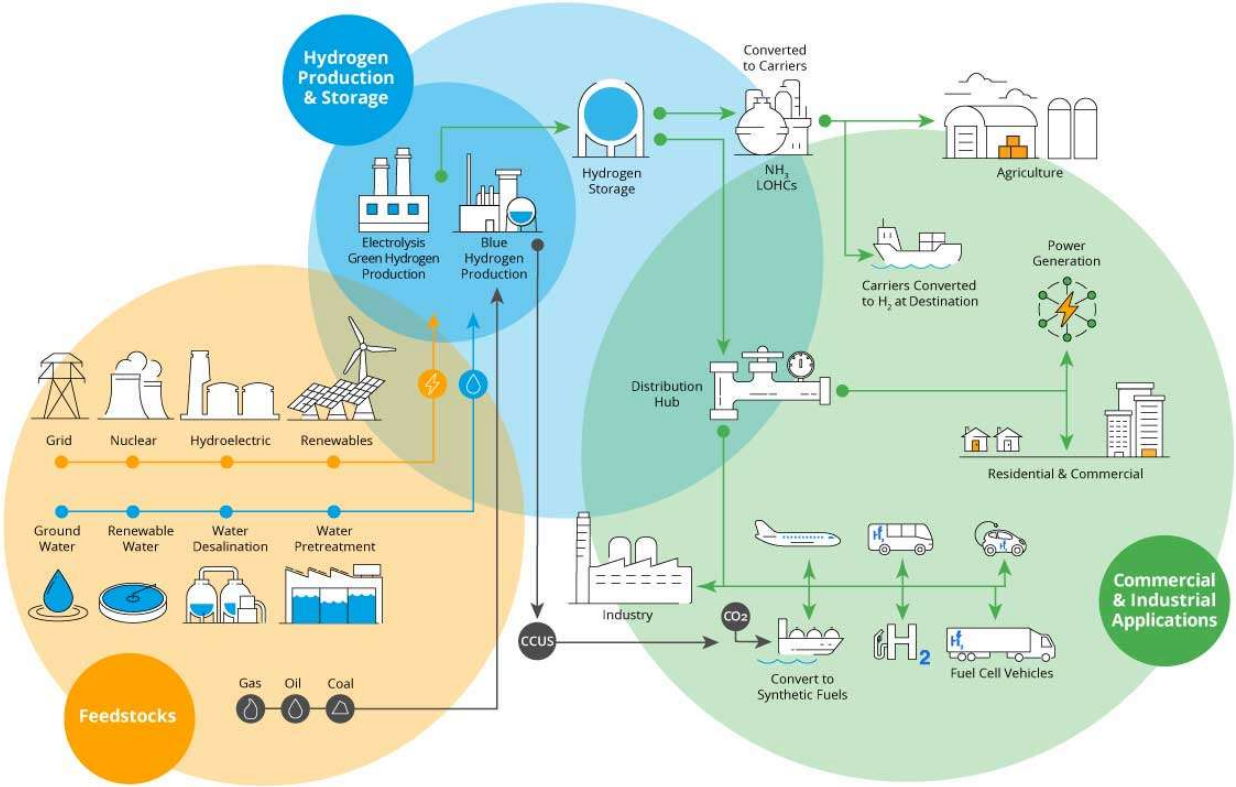
Comprehensive Hydrogen Value Chain



- Fuel Cells, Electrolyzer fabrication
- New blue hydrogen & Efuels equipment
- H2 pipeline fabrication/integrity
- Wells equipment
- Non-metallic pipe joining
- Prediction tools-weld integrity & quality

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Success Factors

- **Human factors**
  - Do not forget the human factor
  - More of interdisciplinary work than before
  - Collaboration and communication will be key
  - External partners
- **Skills**
  - Most current skills are portable to the new environment
  - New skills-digital literacy, automation must be acquired
- **Acceptance**
  - Energy Transition & Digitalization are here to stay. More “When” than “If”
- **Embrace Uncertainty**
  - Uncertainty of timelines-technical, non-technical, policy factors
  - Carefully pick the areas to develop that have applicability in multiple scenarios-welding and joining fall in that category
- **Value Generation**
  - Start small-establish value proposition, demonstrate (MVP)
  - May not see immediate value in certain areas

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Concluding…….

- Significant growth in the ET sector in the coming years
- The welding and inspection sector will greatly benefit from the growth
- Leveraging new technologies in joining and inspection and digitalization are key enablers
- Most welding, joining and inspection skills are portable to ET
- Upskilling required – Digital literacy, thermal spray, novel inspection methods
- North American markets will rely heavily on human ingenuity
  - Balancing net zero, Reliability, safety and cost

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Thank You

Questions ?????

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