Implementing circular economy in the energy and oil & gas industries

An opportunity to improve sustainability performance and create resilient operations

dss+

Protect. Transform. Sustain.

Executive summary

Imagine a world where nothing goes to waste, where every product and material is cycled back into use for as long as possible. This is the essence of the circular economy – an innovative framework that redefines resource management and environmental stewardship.

For the energy, oil & gas sector, embracing circular economy principles is becoming increasingly crucial. With the industry facing significant challenges, such as carbon emissions and resource depletion, adopting circular practices offers a powerful solution. By extending the lifecycle of materials and repurposing waste, the sector can make progress towards its decarbonisation goals and enhance overall sustainability.

Globally, the energy and O&G industries are witnessing transformative circular economy initiatives. Successful examples from various regions demonstrate how these practices can drive efficiency, reduce environmental impact, and create new opportunities. As circular economy concepts gain traction worldwide, with notable advancements in Europe and growing adoption in Latin America, Africa, and the Asia-Pacific, the momentum for change is undeniable.

To support the integration of circular economy principles, dss+ has developed a specific framework to assess the circularity of O&G players. This includes a comprehensive 9-step approach to developing a circular economy strategy, focusing on key areas such as governance structure, procurement, operations, waste minimisation, and alternative revenue streams. Cultivating a company culture that supports these principles will be essential for driving successful implementation across the organisation.

The circular economy is more than a concept; it is a strategic imperative for the energy and O&G sector. By integrating these principles, companies can not only address pressing environmental issues but also unlock new pathways for growth and resilience.

Introduction to the circular economy

The circular economy – a definition

The concept of a circular economy is best understood by contrasting it with the prevailing economic model that has dominated since the industrial revolution. However, its drawbacks are becoming more apparent, impacting society, the environment, and businesses negatively.

The linear process of extracting raw materials, manufacturing products, using them often briefly, and then discarding them - known as the take-make-use-dispose cycle - leads to several adverse outcomes:

- **It depletes natural resources;**
- **It contributes to the accumulation of waste and environmental degredation, pollution of land, water, and air;**
- **It increases greenhouse gas emissions;**
- **It results in the loss of economic value since resources that could be reused or recycled are instead wasted.**

In contrast with the linear, take-make-waste economic model, the **circular economy is a vision of an economy where products and materials do not become waste after the first use**. It is a vision of an economy where products and materials are kept in use for as long as possible; when they can no longer be used, they are turned into new products or materials instead of being disposed of in a landfill or, worse still, ending up in the environment.

According to the International Organisation for Standardisation (ISO)[1], the circular economy is an economic system that uses a systemic approach to maintain a circular flow of resources, by recovering, retaining, or adding to their value, while contributing to sustainable development.

On 22 May 2024, ISO published a new suite of standards to aid the transition to the circular economy. The standards mark the first set of international definitions and rules for the circular economy. These newly published standards represent significant progress, providing a common understanding of the definition of circular economy, business operations according to the economic model, and its monitoring and evaluation. There are environmental and fiscal benefits to such an economy. Recovering and reusing materials and products over and over again can help secure the supply chain of main commodities, maximise economic value, and address resource scarcity and climate change. We are not close to realising this vision; by some estimates, less than 9% of the global economy is circular. However, there is global momentum behind waste prevention, fuelled by regulation, corporate activities, investments, and consumer demand.[2]

> By some estimates, less than 9% of the global economy is circular.

[1] ISO 59004:2024 circular economy – vocabulary, principles, and guidance for implementation https://www.iso.org/standard/80648.html
[2] https://static.portaldaindustria.com.br/media/filer_public/3a/a6/3aa67ad0-4e7c-46c8-8b10-0c6d097f35cf/circular_economy_-_interativo.pdf

The core principles of the circular economy

In many ways, the circular economy is part of ancient knowledge; it is how things have been done for thousands of years, until the industrial revolution.

However, its introduction to modern thought and practice is credited to a few individuals like Swiss architect Walter Stahel and organisations like the Ellen MacArthur Foundation.

According to the latter, a circular economy:

- **Keeps products and materials in use;**
- **Eliminates waste, pollution, health risks and wildlife and habitat loss;**
- **Regenerates natural systems.**

There are many approaches to being circular. Included below are some examples of approaches that are currently used for everyday products or services (figure 1).

Design for longevity

Making goods and services last longer.

Design for disassembly, recycling, and modularity

E.g. Fairphone designs smartphones that can be taken apart so that, if one part breaks, it can be re-placed instead of replacing the entire phone. Adidas makes one type of trainer from one type of material to make it easier to recycle.

Product as a service

Selling the service of mobility rather than a car or the service of laundry rather than a washing machine enables design for longevity. A common example is electric scooter rental, such as Tier in the UK and GCC.

Sharing services

Like Airbnb or Fon (for Wi-Fi sharing) maximise the use of assets and services.

Refurbishing and Repair

Patagonia's famous repair services extend the life of its sporting goods, preventing the need for customers to buy new products.

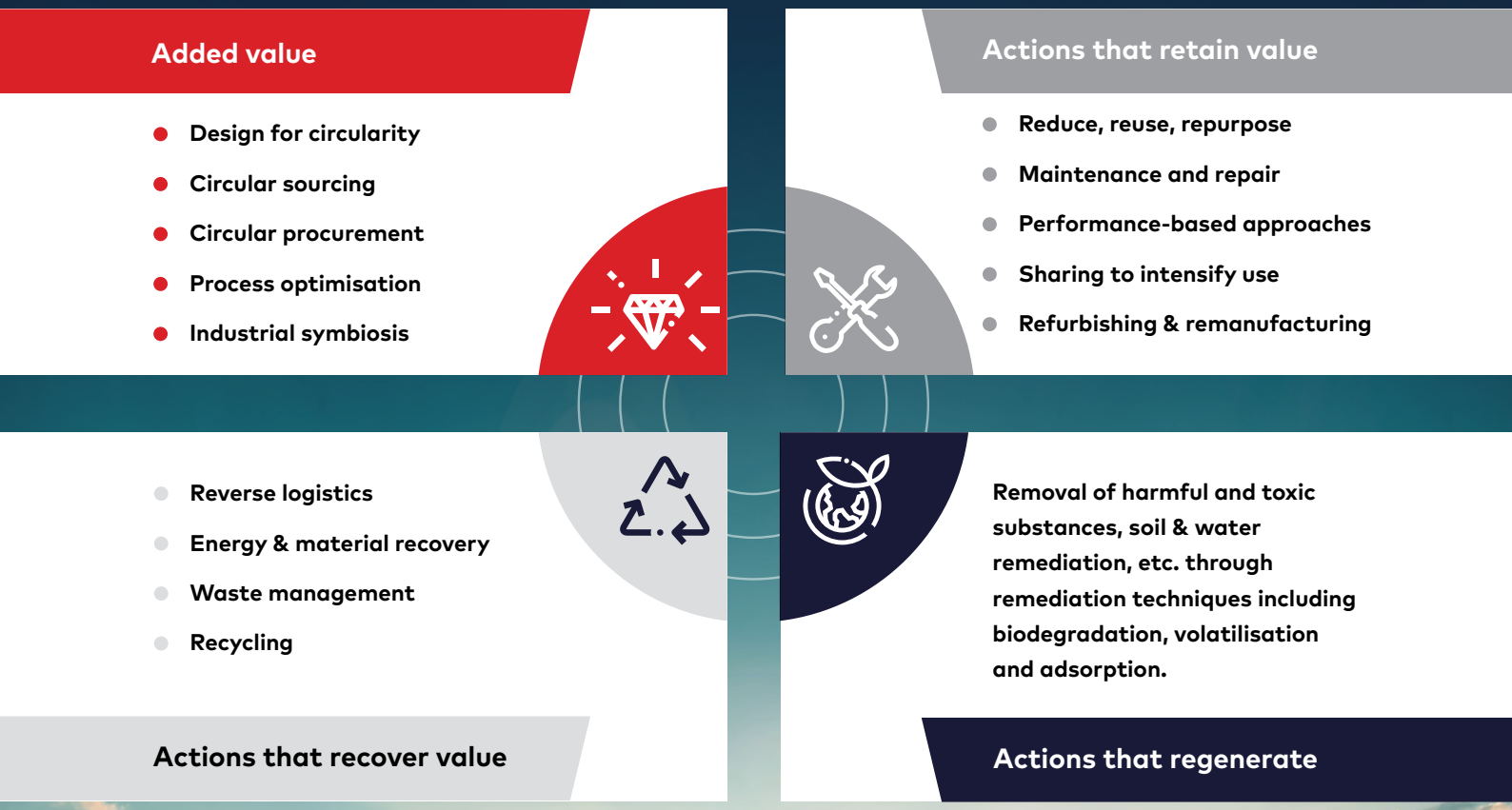
Material substitution

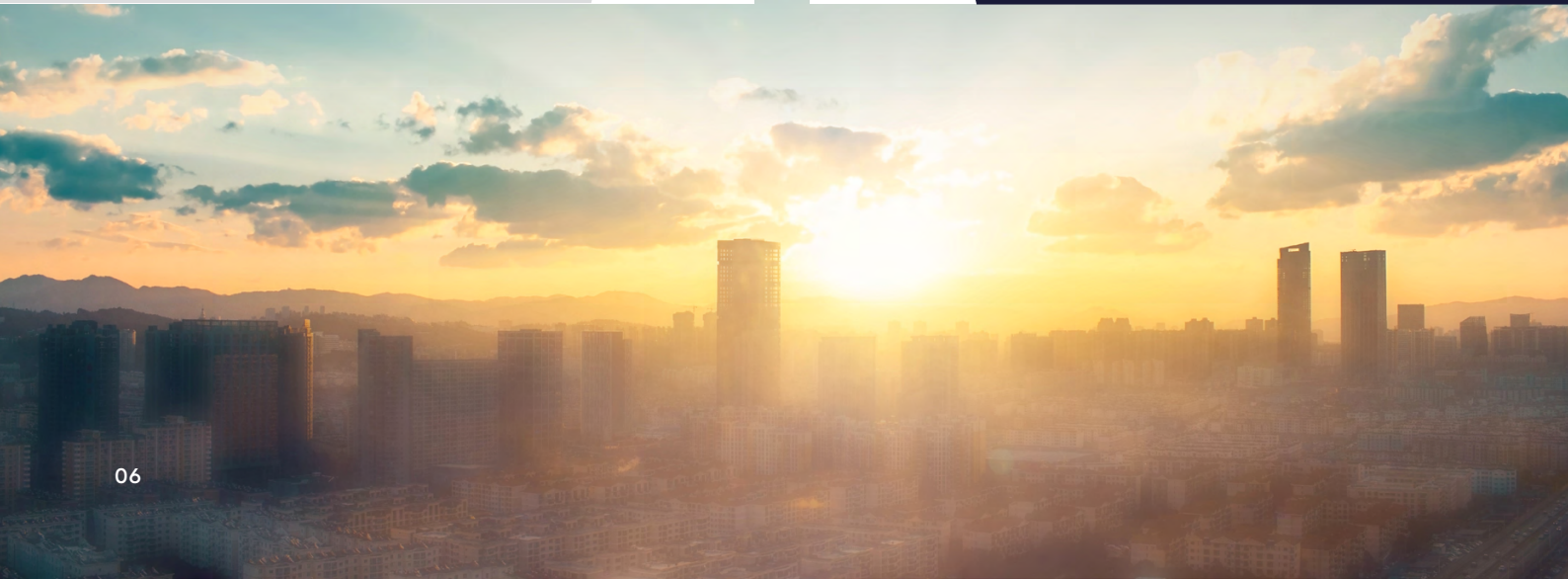
Substituting fossil-based with renewable materials, incorporating more recyclates over virgin materials. E.g. using bio-based tiles or bamboo beams instead of steel ones.

Figure 1: Circular economy principles and examples

ISO 59004 categorises the actions that can contribute to a circular economy into the categories below. Figure 2 could also be construed as core aims of the circular economy.

Figure 2: ISO 59004 categorises the actions that can contribute to a circular economy.





Reduce

Reduction of waste (products and materials)

Reuse

This is where a waste stays in its existing physical form and can be valorised through repair

Recycling

Recovery of the material from waste, e.g. steel and plastic recycling or production of biogas and compost

Energy recovery

Recovery of energy from incineration (electricity and thermal)

Disposal

Final disposal with incineration without energy recovery or landfill

Figure 3: Waste hierarchy

Visualising the circular economy

The concept of a **circular economy** can be briefly explained through the waste hierarchy, often **encapsulated by the "4Rs"(Reduce, Reuse, Recycle and Recovery)**, which ranks circular economy strategies by their ability to preserve the value of products and materials. Here's a brief overview with **examples from the energy, oil and gas sector:**

Reduce

The most effective strategy is to prevent waste from being produced in the first instance.

For example, in the oil and gas industry, efficient project planning and process optimisation can significantly reduce unnecessary material use and associated waste production. An example is optimising drilling processes to minimise offcuts and unused materials.

Reuse

The next preference is for reusing products and materials.

In this sector, reusing could mean repurposing by-products from production, like using drill cuttings in construction materials, or returning used pallets and drums to suppliers for future shipments. Expired catalysts and chemicals can also be sent back to suppliers instead of disposal. Reusing lithium-ion batteries from electric vehicles (EVs) for solar power storage is another example.

Recycling

This involves processing materials to create new products. While recycling is environmentally beneficial, it's not always the most value-preserving method due to the energy and cost involved.

In the oil and gas sector, recycling can include the reprocessing of ferrous metals and glass. However, challenges exist, such as the difficulty in recycling complex polymers and the lack of infrastructure for recycling bio-plastics.

Recovery

This refers to converting waste into energy, such as through incineration for electricity or thermal energy. While it prevents environmental leakage, it has downsides like material value loss, air emissions and potential pollution.

The oil and gas industry might use waste-to-energy processes for mixed or hazardous wastes. Composting and anaerobic digestion of organic waste are other forms of recovery, producing nutrient rich organic material or biomethane, respectively.

Disposal

Disposal is the least preferred option in the waste hierarchy and represents a failure to implement circular economy practices.

In the context of the energy, oil and gas sector, disposal methods vary in environmental impact. Landfilling, littering, or incineration without energy recovery do not prioritise prevention, re-use, nor recycling. Furthermore, it misses an opportunity to turn today's waste into tomorrow's raw materials, enhancing economic resilience by further reducing resource intensity and import dependency.

The circular economy from strategy to action

The circular economy can play a fundamental role in decarbonising the economy and making sure the energy, O&G sector can meet its targets; most of the activities underpinning this approach have a net carbon benefit and can thus help companies to meet their decarbonisation objectives: utilising material from recyclates, instead of virgin sources can reduce up to 80% of the carbon content embedded in materials, like plastics.

A systemic approach is recommended to determine which circular economy interventions are best suited and most impactful for each company as well as to embed circularity into mainstream operations. To prioritise circular economy interventions, it is recommended that each company triangulates the solutions available based on a series of pre-defined criteria, presented in Figure 6.

Effort for implementation

Maturity of technology in the region: this concerns the level of establishment or popularity of the technology so far, judged by the number of other companies utilising the technology for waste processing. Technologies that are lesser known or not widely tested will be rated lower than those already being successfully implemented across the region.

Level of interest: This is a more subjective assessment based on how eager or willing individual companies are to relocate. Keen companies gain a higher score.

Cost of technology

Processing at national, regional, international levels: to evaluate the commercial impact (either negative or positive) compared to current disposal expenses, the cost of treatment per ton or cubic metre.

Environmental assessment

CO2 emissions: IPCC2021 GWP100 - this approach is grounded in the definitive governmental release of the IPCCs 'AR6 Climate Change 2021' report, employing the Life Cycle Assessment (LCA) methodology specific to waste management.

Circularity Profile: defined according to the waste hierarchy, where the management scenario at the top of the hierarchy gains a higher score and should be prioritised compared to technologies that only seek to dispose or process for energy (bottom of the pyramid). Use of waste as a raw material in other processes achieves additional environmental benefits (and so a higher score) due to the avoidance of using raw materials.

Figure 6: Multi-criteria approach to determine the circular economy solutions to be prioritised

How dss+ can help?

Many companies in the energy, O&G sector and beyond have yet to fully operationalise their circular economy pledges and strategies.

What follows is a dss+ stepwise process to transpose circular economy into action based on existing best practice.

In order for a circular economy strategy to be effective, it is essential that the circular economy is not viewed as a separate, isolated programme but is embedded into the company's core processes and business decisions.[3]

Examples of aspects that can be evaluated include how:

- To embed materials-related considerations in business strategy;
- Circular economy criteria can inform financial decisions (e.g.: investments, M&As);
- To embed circularity criteria in procurement decisions.

[3] https://circulareconomy.europa.eu/platform/sites/default/files/2023-08/China%27s%20Circular%20Economy%20Transition_%20Challenges%20and%20Solutions%20Ahead.pdf

dss+ **suggest 9 concrete steps to develop a circular economy strategy**. A number of these steps are already being carried out as part of existing dss+ client projects.

1.

Define the boundary

Setting boundaries that could include a specific number of sites, offshore operations, corporate, a specific number of materials – to be considered for the strategy.

2.

Identify and measure waste streams generated during the operations

Carrying out a baseline material inventory (using weight as metric), specifically looking at the materials going in and out of the facilities in the boundary chosen. A standardized and comprehensive measurement system plays an important role on a circular economy strategy.

3.

Identify the major sources of waste

Ranking the waste hotspots by (a) mass; (b) economic value (e.g. cost of disposal or lost value), and hazardousness (c) or a weighted combination of the three.

4.

Define circular economy measures

Start with defining posssible measures for each material stream, to reduce, reuse, recycle and recover the waste hotspots in line with the waste hierarchy and costing their implementation.

5.

Define the budget

Defining the budget for waste minimisation efforts while considering the value and long-term benefits these initiatives create, ensuring alignment between financial resources and potential savings.

6.

Set targets

Setting targets for waste prevention, reuse, recycling and recovery that are aligned with the activities prioritised and the budget allocated.

7.

Map stakeholders

Identifying the human resources necessary to deliver the desired outcomes, as well as their upskilling/ training needs. Sometimes, the stakeholders needed do not work for the company, but they are contractors, suppliers, customers, or other partners. Defining partnerships needed.

8.

Implement strategy

Following the PDCA (Plan – Do – Check – Act) methodology.

9.

Monitor progress

Ensuring that progress is regularly monitored and that issues are troubleshot as they arise.

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Figure 7: dss+ framework for circular economy implementation

Given the nature of energy and O&G operations, the most likely opportunities around circular economy are:

- Putting in place the necessary **governance** of circularity – by creating an oversight structure and ensuring that it is integrated in business strategy and with other sustainability topics.
- Creating a **culture** that ensures that employees understand the importance of waste prevention and that they feel empowered in their roles to contribute to this goal. For this, regular coaching and training, together with new processes, are normally employed.
- Establishing circular economy **procurement** criteria and requirements and using them alongside financial, performance, and quality criteria, as well as broader sustainability criteria, in the procurement process. In addition, ensuring that contractors respect waste and circular-economy legislation through regular audits.
- In your **operations**, the most likely opportunities include:
  - **Reducing waste** by optimising processes, enhancing material efficiency, and implementing sustainable practices to minimise resource consumption and disposal costs;
  - Setting up **alternative revenue streams**, e.g. processing by-products or waste from other industries;
  - Developing **partnerships** with the value chain - technology suppliers, contractors, competitors, or customers.

Examples of circular economy practices in the energy and O&G sector

Numerous instances of circular economy initiatives successfully carried out by the energy, and O&G industries across various regions and sectors are readily accessible on the websites of International Oil Companies (IOCs). Analysing them demonstrates that there isn't a single correct method for achieving circularity. However, as a fundamental guideline, it is advised that:

- The selected strategy or method for the circular economy should concentrate on significant issues – specifically, it should aim at addressing the primary sources of waste, considering their weight, volume, toxicity, and economic value.

- Efforts to manage waste should not only mitigate it but also generate business value. This can include enhancing the value of by-products, improving resource efficiency, or opening up new business avenues. Circular economy is already proving to be profitable for energy companies worldwide. Thus, when evaluating investments and expenses, the potential for generating revenue must also be taken into account.

Regulatory overview

The concept of the circular economy is progressively being incorporated into national strategies and laws worldwide.

Currently, there are more than 30 national roadmaps and strategies in place, with an additional dozen in the policy draft stage. Europe leads in legislative scope, but this scenario is rapidly evolving as countries in Latin America, Africa, and the Asia Pacific region start to introduce their own legislation related to the circular economy. This information outlines the current global regulatory landscape and also touches on the situation within the GCC (Gulf Cooperation Council) countries.

Figure 4: Circular economy global regulation overview

Source: Internal research conducted by dss+ strategic policy intelligence team

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The European Union

Legislation

The European Union is the undisputed leader globally at legislating for a circular economy. The EU passed the first circular economy Action Plan, a policy strategy document, in 2015, which was followed by a second document in 2020. Both documents set the direction of travel for legislation around circular economy.

The most meaningful legislative packages to have come out of the second plan that have implications for internal trade, as well as imports, include:

A. **Electronics and ICT:** amendments to the Ecodesign Directive (2009), which is in the process of becoming the Ecodesign for Sustainable Products Regulation (ESPR). The recast version builds on the original stipulations concerning energy efficiency for electric and electronic products to include requirements around durability, repairability, resource use & efficiency, as well as the release of microplastics.

B. Legislation concerning **plastics**:

a. The Single-Use Plastics Directive (2021) covers, through bans and other limitations, 70% of the litter found on EU beaches. It targets 10 common single use plastics (SUP) items (e.g.: cutlery, straws, Q-tips), as well as fishing gear.

b. Amendments to the chemicals legislation REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) to contain microplastics resulting from detergents, paints, and cosmetics. Discussion on introduction of standards for measuring microplastics release from textiles.

c. Revision of Packaging and Packaging Waste Directive (pending), with the aim of making all the packaging on the EU market recyclable by 2030 and to decrease the use of virgin materials in packaging. Likely measures will include targets on packaging waste reduction at the member state level, as well as targets for minimum recycled content for secondary and primary packaging from 2030.

C. A new **Batteries** Regulation that modernises the previous Directive from 2006 and that requires, among others, that batteries be repurposed, remanufactured, or recycled at the end of life. It also requires minimum recycled content of cobalt, lead, lithium, and nickel with a staged approach that will last from 2026-2036.

D. The introduction of recycled content requirements for **construction** materials and products in the revised Construction Product Regulation. This in addition to the existing recycling targets for construction materials, with which many member states have had issues and which have largely been met through downcycling of construction materials in uses like backfilling.

E. **Corporate disclosure**: Corporate Sustainability Reporting Directive (CSRD) requires companies above a certain size in the EU to report on a series of environmental and social impacts, including resource use. Standard ESRS E5 requires that companies set measurable targets for resource use and circular economy, that they measure resource inflows and outflows, that they set up a reduction plan for virgin resources and a mechanism to follow and verify performance.

Other relevant regulatory and financial developments

Aside from EU-wide legislation, different member states and local and regional authorities have introduced circular economy incentives and legislation that build on the EU legislation.

For instance, in 2020 France introduced some of the most stringent legislation in the region via its circular economy Law. Furthermore, municipalities and regional government have been introducing regional and local action plans, requirements and measures. Public procurement is a particularly influential tool that public authorities have in the EU, seeing how it accounts for some 14% of the EU's GDP or EUR 2 trillion per year.

Most notably, the EU is using its financing programmes and institutions to promote circularity. For example, the LIFE (L'instrument financier pour l'environnement) and Horizon 2020 funding programmes operated by the EU Commission have financed more than 100 innovation projects related to circularity. Likewise, the two multilateral financial institutions in the EU, the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) both have earmarked funding for circular economy projects and are working to raise further funding for such projects from the private sector.

Deep dive

The regulation of chemical and advanced recycling of plastics

This topic remains a contentious subject for which clear legislation is pending. Advanced recycling of polymers is an area of innovation that the petrochemicals, energy and O&G sectors have increasingly been investing in. Pyrolysis, the main form of chemical recycling, can address problem plastics that cannot be recycled via mechanical recycling, the industry claims, such as flexible plastics from packaging, polystyrene, polyurethane, and others.* The number of chemical recycling projects has been increasing – with notable investments from Shell, ExxonMobil, Dow Chemicals, DuPont, Repsol, BASF, and others. Industry appears to have an appetite for more such projects and is demanding clarity from a legislative standpoint.

> The crux of the issue, from a legislation perspective, is what proportion of plastics can be considered as"recycled" content following pyrolysis.

The crux of the issue, from a legislation perspective, is what proportion of plastics can be considered as "recycled" content following pyrolysis. With the technology advancing fast and a lack of transparency from the individual actors, it is unclear what ratio of pyrolysis oil, which is an intermediary in the process, is transformed into plastics and what proportion goes on to be refined into fuel for aviation and heavy transport. By some estimates, approximately 25% of pyrolysis oil is converted into polymers and 75% into fuel, though this ratio can vary based on the technology and operator.

The issue is that polymers that are used for energy are not considered recycled material by either the European Union or the US' Environment Protection Agency (EPA). At the same time, there are differences among countries; for instance, both the UK and Spain afford tax exemptions for advanced recycling in the same way they do for mechanical recycling.

While, in general, the market for chemical recycling is picking up, some argue that greater legislative clarity could further boost investment.

* 2024 data

The Americas

In North America, the uptake of circular economy in legislation has taken place mostly at the regional level and has concerned primarily plastics – with many of the more than a thousand such measures in the US and Canada targeting plastic bags and straws. However, since 2023 Canada has been working on transposing some elements of France's **Act on Waste** and **circular economy** into federal law. Specifically, Canada has amended its Consumer Protection Act to make it mandatory that specific electronics be reparable by 2026 and has introduced legislation against greenwashing in order to enable consumers to receive accurate information about the environmental impact of the products they purchase. That said, many of the circular economy measures in North America remain piecemeal as opposed to being guided by an overarching national legislation or strategy, which is the case in the EU and many of its member states.

In the US, the **EPA's National Recycling Strategy (NRS)** and **Draft National Strategy to Prevent Plastic Pollution** focus, as their names indicate*, largely on waste recycling and, among the different material streams, on plastics. The NRS primarily focuses on mechanical recycling of municipal solid waste; as indicated in the deep dive above, it does not yet address the issue of chemically recycled polymers, though the EPA has clarified that it does not consider the conversion of non-hazardous solid waste to fuel or fuel substitutes to be recycling.

Several countries in Latin America and the Caribbean, including Chile, Peru, Costa Rica, and Colombia, have developed national strategies and roadmaps around circularity and are beginning to roll them out, targeting in particular consumer goods, packaging, and industrial waste.

* https://www.epa.gov/system/files/documents/2023-04/Draft_National_Strategy_to_Prevent_Plastic_Pollution.pdf

Asia-Pacific

Several countries in Asia-Pacific, including most notably India, Vietnam, Indonesia, and Australia are either developing or have recently rolled out national legislation around circularity. India, for instance, developed a circular economy roadmap in 2023 to reduce plastic waste and has begun to introduce measures to phase out single-use plastics and boost recycling.

China, in its 14th 5-year plan (2020-2025), set **three targets** related to resources:

- **To expand the network of recycling centres in the country;**
- **To train workers in circularity; and**
- **To raise public awareness about the importance of waste prevention.**

GCC

Environmental policies across the Gulf Cooperation Council (GCC) countries are increasingly focusing on circular economy principles, although the specifics and progress vary from country to country.

Kuwait

Kuwait's New Environment Protection Law: while Kuwait has not explicitly outlined a national circular economy strategy, its environmental protection law emphasizes waste management, pollution reduction, and the conservation of natural resources. These aspects are foundational to the circular economy, indicating Kuwait's indirect approach to adopting circular principles.

Oman

Oman Vision 2040: while not explicitly labelled as a circular economy policy, Oman Vision 2040 includes sustainability as a core pillar. The vision aims for economic diversification and sustainable development, with initiatives likely to incorporate circular economy principles such as waste reduction, resource efficiency, and sustainable manufacturing practices.

Qatar

National Environment and Climate Change Strategy: launched in 2022, this strategy includes targets that directly support circular economy principles, such as using 35% recycled materials in construction projects by 2030 and achieving a 15% recycling rate of municipal waste. This demonstrates Qatar's commitment to integrating circular economy practices within its national development plans.

Saudi Arabia (KSA)

Saudi Green Initiative: as part of its Vision 2030, Saudi Arabia launched the Saudi Green Initiative, which outlines ambitious environmental goals, including reducing emissions, planting billions of trees, and increasing the share of renewables in the energy mix. These initiatives are aligned with circular economy principles, focusing on resource conservation, energy efficiency, and sustainable growth.

United Arab Emirates (UAE)

UAE circular economy Policy 2021: the UAE adopted this national policy to transition towards a circular economy. It aims to close the loop of resource use and waste through sustainable finance, renewable energy, and other key sectors. The policy is part of the UAE's broader strategy to achieve economic sustainability and reduce environmental impact.

Impact of existing and upcoming legislation

EU legislation is likely to have the biggest impact on internal and external trade. Products and packaging that will be put on the EU market – whether they be food and beverage, electronics, construction materials, or batteries – will need to respect the requirements for repairability, durability, recyclability, etc. Furthermore, producers or vendors active in different EU member states are being required to pay landfill tax, as well as Extended Producer Responsibility fees, and are subject to other national and regional requirements.

The GCC countries are all moving towards integrating circular economy principles into their national agendas, with the UAE and Qatar showing particularly strong commitments through explicit policies and targets. Saudi Arabia's ambitious environmental goals also indicate a robust approach to sustainability, aligning with circular economy principles. Oman and Kuwait are making progress, though they could benefit from more specific circular economy strategies and targets. Overall, the region shows a promising trend towards sustainability and resource efficiency, with each country contributing to the circular economy movement at its own pace and capacity.

> EU legislation is likely to have the biggest impact on internal and external trade.

Conclusion

Embracing a circular economy in the Oil & Gas sector is no longer just a forward-thinking sustainability initiative; it has become a crucial driver of competitive advantage and long-term viability. By focusing on key areas such as waste minimisation, resource efficiency, and innovative practices, companies can achieve transformative outcomes. These include operational cost reductions, enhanced resource resilience, and a workforce fully engaged in sustainability-driven processes.

The dss+ circular economy (CE) framework provides an integrated, strategic approach to implementing circular economy principles, tailored to meet the specific challenges and opportunities of the energy and Oil & Gas industries. This framework supports the creation of a robust governance model that not only ensures regulatory compliance but also drives continuous innovation, positioning companies as leaders in environmental stewardship.

By adopting circular economy practices, organisations stand to gain both environmental and economic benefits, from reduced waste and emissions to improved operational efficiencies. In a sector where efficiency and sustainability are essential for survival, this holistic approach ensures that companies are not just adapting to change but leading it – securing a more sustainable and profitable future in an increasingly resource-conscious global economy.

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