Energy Transition

We Build a Better World

FLUOR®

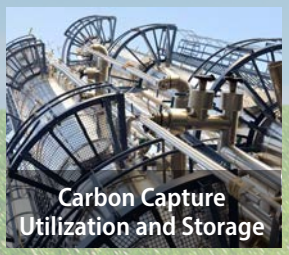
At a Glance

We provide professional and technical solutions that deliver safe, well-executed, capital-efficient projects to clients around the world. Fluor provides engineering, procurement, and construction (EPC) services that are the essential building blocks of development and progress.

112 years' global experience | 83 offices in 28 countries on 6 continents | 1,500+ subject matter experts
1,200 active patents | Uncompromising commitment to safety

Energy Transition

As society is increasingly demanding cleaner, lower carbon energy, fuels, and products, Fluor assists our clients on their journey through the Energy Transition to a more sustainable business.


Carbon Capture Utilization and Storage

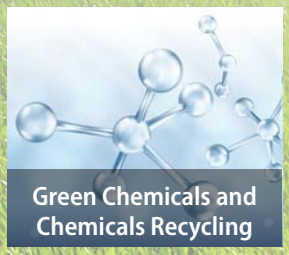

Hydrogen


Renewable Fuels


Asset Decarbonization


Gasification


NuScale™ Small Modular Reactor


Green Chemicals and Chemicals Recycling


Battery Chemicals


Offshore Wind Energy


Energy Storage

FLUOR®

From Concept to Completion

Fluor uses our vast network of technology and project execution experts to develop solutions that address our clients' Energy Transition needs anywhere in the world.

CONCEPTUAL DEVELOPMENT

Program Management | Strategic Alignment | First-of-a-Kind Technology Development | Pilot and Demonstration Plant Strategy | Commercialization and Scale-up | Conceptual Design | Technology Assessment | Sustainability Assessment | Project Financing

DESIGN

Advanced Process Modeling | Conceptual Design | Estimating | Feasibility Studies | Permitting | Process Simulation | Project Financing | Routing | Scope Definition | Siting | Technology/License Evaluation

ENGINEERING

Advanced Work Packaging | Cost Control | Detailed Engineering | Fabrication | Front-end Engineering | Modular Construction | Planning & Scheduling | Process Simulation | Safety Planning | Systems Integration

PROCUREMENT

Contracts Management | Expediting | Fabrication | Logistics | Low-Cost Country Sourcing | Materials Management | Purchasing | Requirements Planning | Supplier Quality | Staffing Resources | Warehousing

FABRICATION

Contractor Management | Material Control | Modular Construction | Purchasing | Quality Control | Safety Programs | Self-perform Fabrication | Sourcing

CONSTRUCTION

Construction Management | Contractor Management | Craft Staffing & Training | Equipment, Tools & Fleet Services | Field Mobilization | Modular Construction | Project & Program Management | Quality Control | Rigging | Safety Programs | Scaffolding | Self-perform Construction | Workface Planning

START-UP

Commissioning | Engineering Support | Initial Production | Plant Readiness | Precommissioning | Systems Checkout | Turnover | Validation

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Energy Transition Markets

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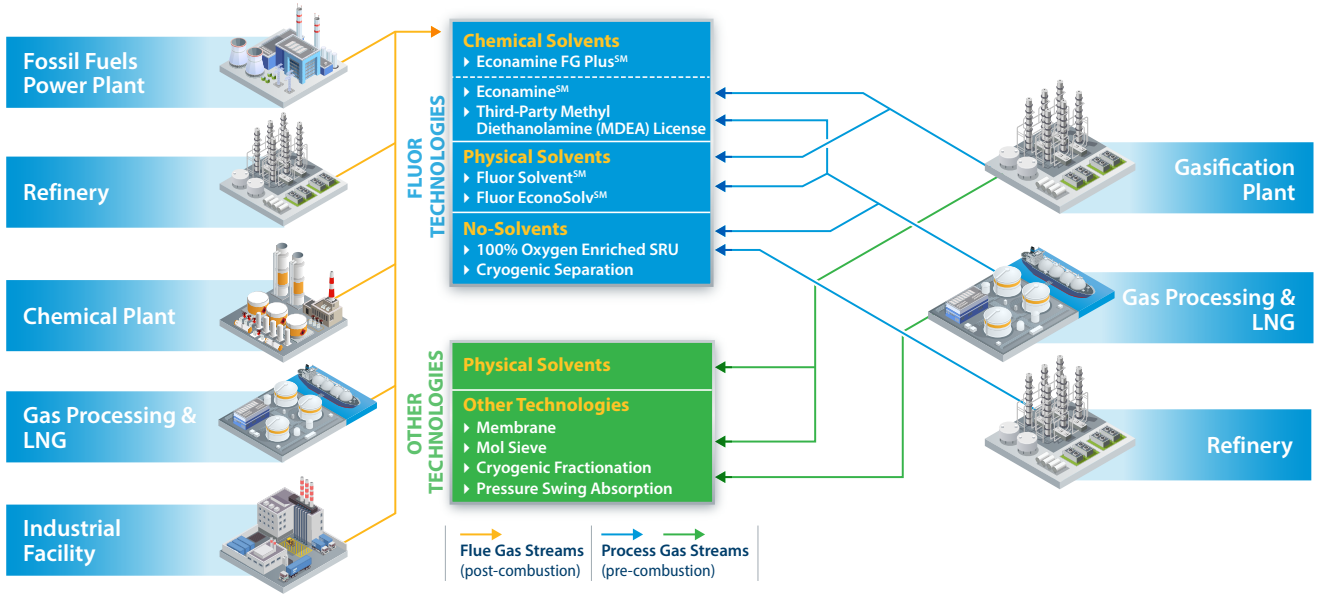
Carbon Capture, Utilization and Storage

Carbon capture, utilization and storage (CCUS) will play an important role in the Energy Transition as industries like power generation, refining, chemicals, steel, gas processing, and cement reduce carbon dioxide (CO_2) emissions to meet net-zero goals. CCUS units can be retrofitted on existing facilities or installed with new facilities. CO_2 capture hubs are being developed to efficiently decarbonize industrial clusters utilizing economies of scale to capture transport and store large quantities of CO_2.

We help clients mitigate CO_2 emissions globally through our long history of flue gas carbon capture as both a licensor and as an engineering and construction company.

30+ LICENSED ECONAMINE FG PLUS PLANTS | DESIGN/BUILD OF 400+ CO_2 REMOVAL PLANTS



Fluor designs and builds carbon capture units tailored to our clients' requirements regardless of the selected technology.

Fluor CCUS Technologies

Post-combustion. Fluor continues to build upon our Econamine FG Plus technology capabilities through enhanced solvent formulations, lower emissions and waste production, and a menu of advanced energy reduction configurations that can be selectively implemented into any plant design.

Fuels experience. Econamine FG Plus is commercially proven for CO_2 recovery from flue gases derived from a variety of fuels including natural gas, coal, light fuel oil, heavy fuel oil, and liquid propane gas.

Process experience. Econamine FG Plus' operating experience includes steam reformers, gas turbines, gas engines, and coal-fired/natural gas boilers. It can also be applied to cement and steel mills.

Pre-combustion. Fluor Solvent can be utilized in high-pressure pre-combustion processes to capture CO_2. With 50 years of operating experience, it offers many advantages such as no heat required for regeneration of solvent, production of a dry treated gas, and tolerance of varying CO_2 levels.

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Carbon Capture, Utilization and Storage

Path to a Successful CCUS Project

As a global EPC company, Fluor's experts develop solutions that incorporate the latest advancements and information from projects around the world. We add value to critical aspects of CCUS projects to produce viable project plans that can be delivered on time and within budget.

Critical Aspects of CCUS Project Execution

CONCEPT

Business case development.
Includes financing details such as enhanced oil recovery (EOR), tax credits, cap and trade programs, and other government incentives and funding options.

CO_2 storage.
Determine the optimal design through our understanding of EOR and sequestration locations, as well as carbon hubs or new pipeline and compression facilities.

DESIGN

Health and safety.
The first and key consideration in all aspects of execution, inclusive of safety in design for construction and operations.

Licensor selection.
Leverage our in-house expertise and experience while objectively evaluating the best solution for the project.

Energy efficient design.
Design to maximize CO_2 captured while optimizing the facility's energy consumption.

ENGINEERING & PROCUREMENT

Systems integration.
Reliably integrate CCUS into operating facilities with consideration for utilities, operability and process synergies.

Critical equipment.
Global sourcing of key critical equipment to meet project capacity and schedule.

CONSTRUCTION

Logistics and construction.
Strategic identification of execution models that consider project location, logistics, and labor availability to manage risks and deliver improved project performance.

Modularization.
Capitalize on opportunities to maximize productivity off site and reduce construction risks.

Fluor's role as a carbon capture licensor provides our project execution teams with unparalleled insight into the complexities and nuances of integrating CCUS technology.

Combining this knowledge with our regional teams' engineering and construction experience allows us to evaluate and provide comprehensive CCUS strategies tailored to clients' requirements, regardless of the technology used.

California Resources Corporation Elk Hills CalCapture
with Econamine FG Plus
1.5 million tons CO_2 capture per year

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Hydrogen

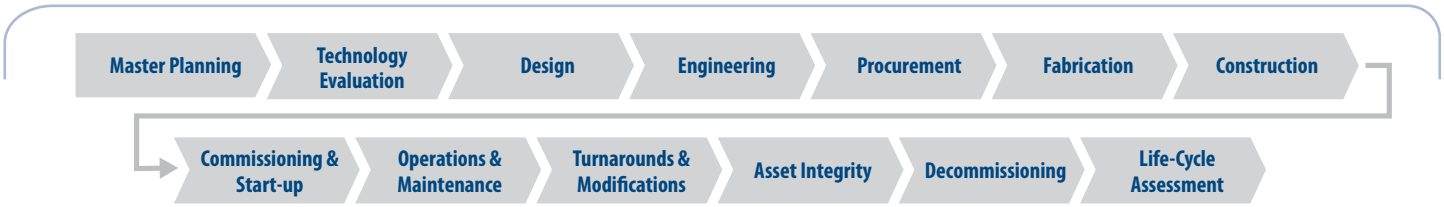
Hydrogen will play a significant role in the Energy Transition. As hydrocarbon fuels become a smaller part of the world's energy mix, hydrogen can be used to store and transport the energy our economies need to function.

Combining Fluor's experience in hydrogen-production systems, carbon capture, system integration, and supporting systems design results in solutions that address our clients' Energy Transition goals with cost and schedule surety.

Master Planning

Through our master planning service, Fluor applies our market and financial analysis with our expertise in industrial, infrastructure, and urban business segments to help clients attract investors and realize their goals. Master planning in the hydrogen economy yields **higher productivity and project competitiveness,** taking into account changing markets and investor strategies so clients can readily adapt to the Energy Transition.

From concept to completion, Fluor provides fit-for-purpose project solutions to help countries, regions, and companies enhance their future competitiveness.



Beginning with master planning, Fluor can perform all aspects of hydrogen project execution.

Hydrogen Life Cycle

ENERGY SOURCE	PRODUCTION	STORAGE	TRANSPORT	USERS
GREEN H_2 **Renewable Wastes** ▸ Agriculture ▸ Municipal/Domestic ▸ Industrial **Wind** **Solar**	**Biomass Process** ▸ Biological ▸ Thermochemical **Water Splitting** ▸ Thermolysis ▸ Photolysis ▸ Electrolysis	**Physical** ▸ Compressed H_2 – Bullets/Spheres – Caverns ▸ Cryo-compressed H_2 ▸ Liquefied ▸ Slush **Material-Based** ▸ Metal Hydrides ▸ Liquid Organic H_2 Carriers (LOHCs) ▸ Sorbents (MOFs, zeolites, nanotubes) ▸ Chemical (Ammonia)	**Pipeline** ▸ Blended ▸ Dedicated **Truck** ▸ Compressed Cylinders ▸ Liquid Tankers **Barge/Ship**	**Industry** ▸ Refinery Reactant (e.g., hydrocracker, desulfurization) ▸ Chemical Reactant (e.g., ammonia & methanol) ▸ Synthetic Fuels (e.g., Fischer-Tropsch diesel/ jet/naphtha) ▸ Iron & Steel (e.g., direct iron reduction) ▸ Industrial Heat (e.g., burners, boilers, furnaces) **Power** (e.g., fuel cells, gas turbines) **Transportation Fuels/ Filling Stations** ▸ Light Duty ▸ Heavy Duty **Residential Heating**
GREY H_2 **Fossil Sources** ▸ Oil ▸ Gas ▸ Coal	**Hydrocarbon Reforming** ▸ Steam Reforming ▸ Partial Oxidation ▸ Autothermal Reforming **Hydrocarbon Pyrolysis**			
	BLUE H_2 **Grey H_2 + CO_2 Capture** ▸ Econamine FG Plus ▸ Fluor Solvent	**CO_2 Storage**		
PINK H_2 **Nuclear**	**Water Splitting**			
TURQUIOSE H_2 **Natural Gas (Methane)**	**Pyrolysis**			

Fluor offers professional and technical expertise specific to each stage of the hydrogen life-cycle.

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Hydrogen

Applying Life Cycle Project Experience to the Hydrogen Market

Blue Hydrogen

Fluor is a leader in the field of hydrogen plant design, having designed and constructed plants back to 1968 and recently responsible for the engineering, procurement, and construction on three hydrogen plants totaling 1,195 MMSCFD in eight trains. These units use state-of-the-art technology with pre-reforming, parallel steam reforming, and exchanger reforming. Our proprietary carbon capture technologies Econamine FG Plus (post-combustion) and Fluor Solvent (pre-combustion) amplify our offering and expertise in the hydrogen market.

Green Hydrogen – Electrolysis

Hydrogen production from electrolysis is a quickly growing market that provides an advantage over traditional hydrogen production, with the energy for electrolysis coming from non-hydrocarbon sources such as wind or solar. **Fluor's hydrogen experts can advise clients on the best-suited technologies for their objective based on operating and capital expenditure characteristics, leveraging our global experience in electrolysis facilities throughout design and integration of the project.**

Green Hydrogen – Gasification

By converting low-value carbonaceous material such as biomass and municipal waste to a hydrogen containing syngas, green hydrogen can be produced through gasification to meet the need for lower carbon energy. **On the forefront of gasification for nearly 50 years, Fluor has developed a comprehensive résumé that spans configuring projects and selecting technologies through full EPC services.**

Hydrogen Transportation and Storage

Hydrogen transportation has several special considerations including specialty compressors and stations, as well as corrosion. **Fluor combines our extensive hydrogen compression experience earned on refinery projects, with our metallurgy expertise and significant capabilities in midstream compressor station/pipeline projects to address these considerations.** Several types of green hydrogen carrier molecules are being studied (including green ammonia) to improve the efficiency and safety of hydrogen storage and large-scale transportation. Fluor's expertise can assist our clients in determining if these technologies are right for their projects.

As the hydrogen economy develops, Fluor can help analyze, plan, design, and build your next project to meet its economic and environmental needs.

FLUOR®

Renewable Fuels

Meeting the Demand for Lower Carbon Intensity Fuels

The world is moving toward lower carbon intensity fuels to decarbonize the transportation sector. Fuels such as renewable diesel and renewable jet fuel produced from fats, oils, and greases provide economic options to produce lower carbon fuels.

Applying Global Expertise and Experience to Local Projects

By applying our technology, services, and project execution capabilities, Fluor can help our clients successfully build their projects:

- Accelerated schedule to improve time to market
- Modular reference plant design for licensor hydrotreating unit, including a two-stage arctic diesel design, allowing faster time to market
- Licensor support from conceptual design through detailed design
- Pretreatment licensor comparison and selection
- Renewable diesel/jet licensor comparison and selection

Technology

Biofuels from Fats and Oils (HEFA/HVO)

- Hydrotreating fats and oils to renewable diesel and jet
- Fat and oil pre-treating and purification
- Grassroots and revamp plants

Biomass Preparation

- Bulk storage
- Biomass and municipal solid waste (MSW) handling
- Pretreatment and hydrolysis

Biofuels from Syngas

- Fischer-Tropsch with hydrocracking
- Methanol and dimethyl ether
- MTG and Topsoe integrated gasoline

Fuel Recovery and Purification

- Distillation and extraction
- Absorption and adsorption
- Ion exchange and membranes
- Filtration and centrifuges

Fermentation

- Fermentor modeling and scale-up
- Large-scale fermentor design
- Process design and optimization
- Large-scale steaming in place and cleaning in place

Syngas Production

- Biomass gasification
- Syngas cleaning and treating

Power Generation

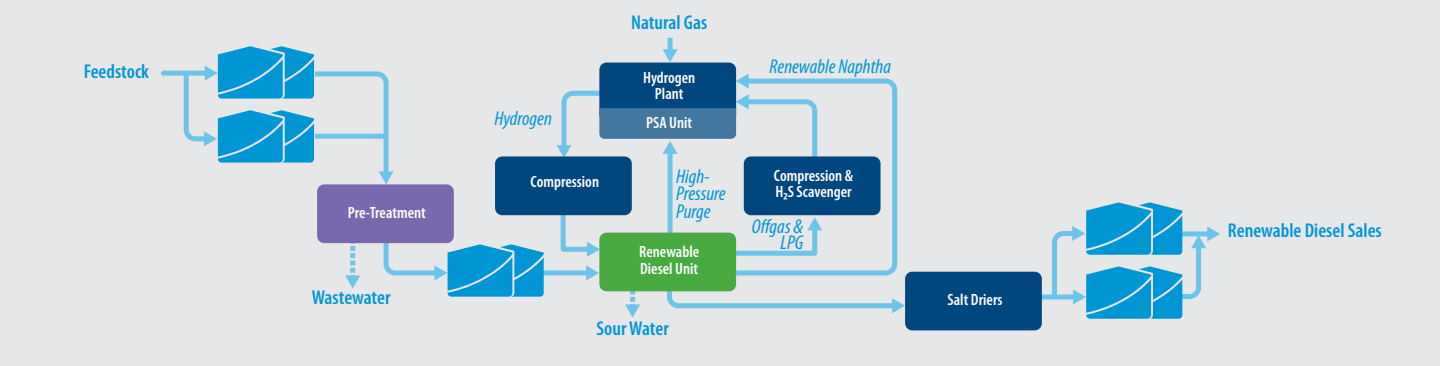
- Combined heat and power
- Fluidized bed boilers
- Fuel cells, biogas, and bio-H_2

Scale-up and Commercialization

- Pilot and demonstration plant strategy
- Conceptual design and economics
- Process optimization
- Pilot and demonstration plant design and EPC

Location Strategy

- Plant site location
- Strategic incentive negotiation



Fluor's experts have developed and implemented innovative ways to deliver schedule-driven renewable fuels projects.

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Renewable Fuels

Project Spotlight

Fluor is currently executing a project to modify a western-U.S. refinery to process refined, bleached, and deodorized soybean oil for renewable diesel production. With an estimated capital spend of approximately US$175 million and startup in early 2022, the project will generate an internal rate of return of 20 to 30 percent and is positioned to receive the U.S. federal Blender's Tax Credit.

80+ YEAR OLD REFINERY

6,000 BARRELS PER DAY (BPD) RENEWABLE DIESEL CAPACITY

REVAMP OF **2** UNITS DHT & NHT

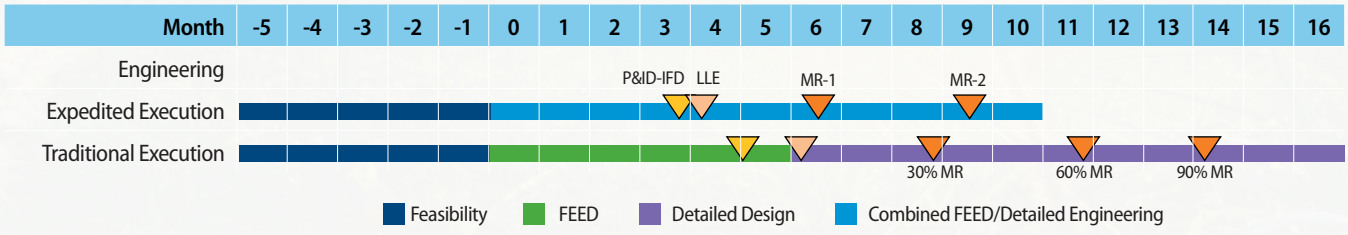
Scope of Services

Fluor is providing the feasibility, front-end engineering and design (FEED) for the inside battery limits (ISBL) and H2 plant, and detail engineering for the ISBL and interconnect facilities; the outside battery limits, H2 plant, rail, and construction is by others. Fluor is acting as agent for the client in procuring all ISBL materials, services, and equipment. The facility is not operational during construction (i.e., simultaneous operations (SIMOPS) is not required).

Schedule-driven Execution Approach

The client and Fluor aligned early on the optimal balance between schedule reduction, quality requirements, and capital investment. Developing high-quality deliverables that could be adapted for late changes was deemed the best approach to support safe and efficient construction, maintain the accelerated schedule, and support the client's economic model.

Driven by market forces such as rising product demand and government incentives, renewable fuels projects are often schedule-driven. The extent of schedule reduction that can be realized on such projects – regardless of a facility's capacity – depends on numerous factors, such as a new facility or revamp project, revamp complexity, licensor flexibility, cash flow, gate review requirements, and final investment decision timing. Fluor engages with clients in a collaborative and transparent manner to develop and implement strategies that meet a project's objectives.



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A creative and collaborative execution approach helped achieve a 10-month FEED/detailed engineering schedule, a 6-month reduction from the base case.

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Asset Decarbonization
Electrification

Why Electrification Matters in the Energy Transition

Electrification of industrial facilities is the design or retrofit of a facility to use electricity instead of steam or fuel gas. Most facilities can use electricity with lower carbon emissions than what is produced when using fuel gas or steam, thus reducing the facility's carbon footprint.

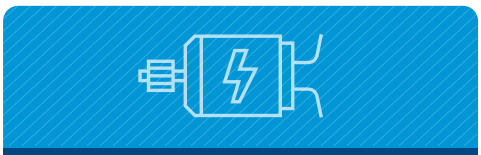
While electrification is simple in concept, there are many considerations that must be addressed for a successful project. For example, which equipment provides the largest reduction to carbon emissions if electrified, and does the facility's electrical distribution system have sufficient capacity and reliability for the potential changes in electrical loads?

Electrification Project Considerations

- Improved energy efficiency
- Lower emissions of NOx, SOx and particulates
- Reduced water consumption and water treating requirements
- Reduced operating costs
- Lower capital costs
- Increased reliability

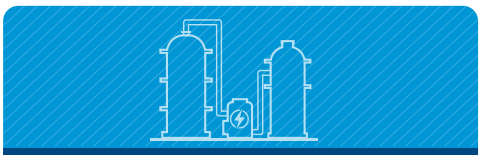
High-Impact Methods in Electrifying Industrial Facilities

From **Fluor's 30 years of experience performing electrification projects**, the following three electrification options provide the largest impact to emission intensity and energy efficiency in an industrial facility:



Electric motors instead of steam turbines

Electric heaters



Heat pumps on columns

Electrification methods with the largest impact to emission intensity and energy efficiency.

Reduced Fuel Gas Demand Opportunities from Electrification

Electrification typically reduces fuel gas demand of a facility, providing the following opportunities:

- Separate and sell propane and heavier material from fuel gas
- Combine an electrification project with a gas-to-liquids or syngas project
- Minimize or reduce outside fuel gas purchases

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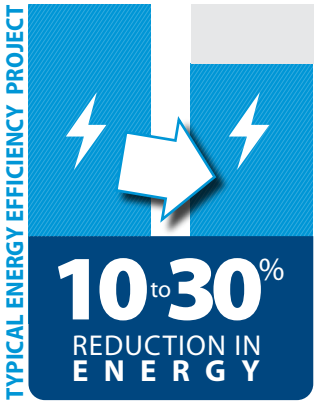
Asset Decarbonization
Energy Efficiency



Benefits of Energy Efficiency and High-impact Methods

Energy efficiency optimization reduces a facility's required energy consumption.

Reducing energy consumption mutually delivers decarbonization benefits and provides an economic return.

High-Impact Methods to Increase a Facility's Energy Efficiency

- Optimize heat recovery systems
- Select equipment and technologies based on their energy intensity
- Apply energy optimization best practices
- Compare designs to known benchmarks

Optimizing Projects' Energy Efficiency through Proven Tools and Practices

Fluor takes a systematic, rigorous approach to understand our clients' existing assets and needs. By leveraging our technical expertise in process and electrical engineering, we can readily determine the best options for each project and facility.

Process Design Enhancements

- Apply flare gas recovery, mechanical vapor recompression, high-performance heat transfer and distillation equipment, and optimum energy sources
- Design for recovery of waste heat and ideal integration of waste streams
- Implement effective process control strategies to achieve unit objectives while reducing energy consumption
- Work with equipment and technology suppliers to enhance their designs
- Use nested layers of optimization and proven, best available technology

Design Practices

- Execute value improving practices such as energy optimization, process intensity, and process simplification
- Design to an appropriate balance between operating cost and energy inputs versus capital expenditures, such as optimizing insulation thicknesses or pipe sizes
- Find potential energy efficiency value by modelling systems and using heat integration analysis software that develops composite curves and clearly shows pinch points
- Determine energy intensity by process unit and benchmark against best-in-class designs

Through proven tools, your project or facility's energy efficiency can be optimized to meet economic and environmental needs.

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Gasification

Gasification provides the ability to generate green hydrogen and other lower carbon intensity fuels and feedstocks from waste and biomass. This technology becomes particularly advantageous in regions with carbon taxes, incentives, or tipping fees.

Fluor's Gasification Differentiation

- Executed 30+ gasification projects globally, from conceptual design through EPC(M)
- At the forefront of gasification industry for 40 years
- Technology-neutral, allowing our experts to objectively evaluate multiple feedstocks, product configurations, and gasification technologies to design units that meets our client's needs

Gasification for Hydrogen Generation

Fluor applies decades of experience to the design of refinery hydrogen plants and the associated hydrogen purification systems.

One of the key challenges with gasification-derived hydrogen is achieving the required hydrogen availability. We have worked with our clients to develop strategies that maximize hydrogen availability, as demonstrated by our engineering and procurement services for the largest coke gasification-based hydrogen plant in the world.

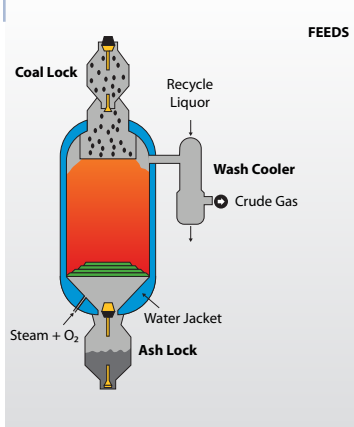
Carbon capture technology applied to the shifted syngas from gasification (e.g., Fluor Solvent) can reduce the carbon intensity of gasification-generated hydrogen to zero or lower, with minimum capital costs.

Gasification Technical and Professional Services

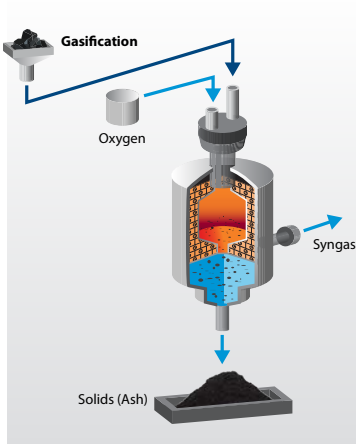
- Economic evaluation and cost estimating
- Feedstock, technology, and product evaluation
- Full-cycle EPC(M) services
- Technology integration
- Gasification and supporting technology expertise (gas treating, sulfur recovery, carbon dioxide capture and compression, combined-cycle power generation, and product synthesis)

Gasifier Types

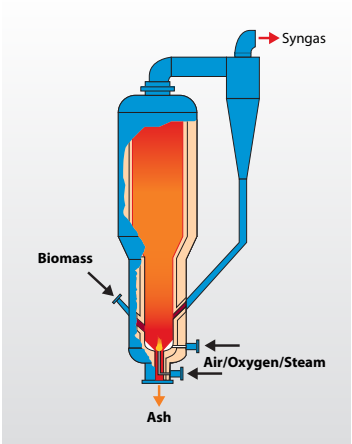
Fixed/Moving Bed



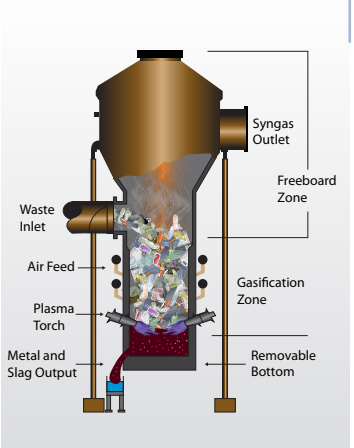
Entrained Flow



Fluidized Bed



Plasma



With 40 years of gasification experience, Fluor can help our clients plan, design and build the optimal gasification project to fit their needs.

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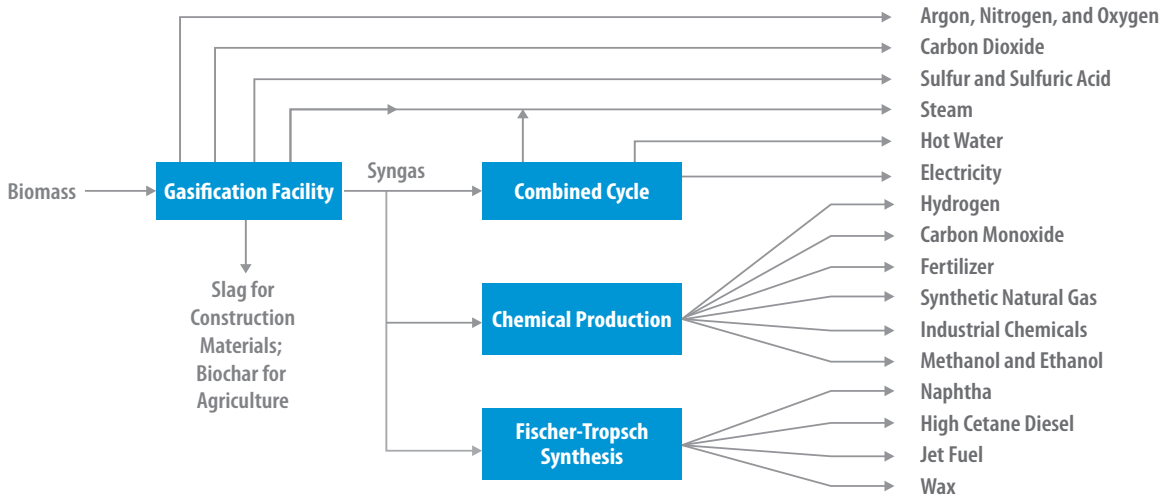
Gasification

Gasification for Synthetic Natural Gas and Chemical Feedstock

Gasification facilities are often designed to produce multiple products. For example, gasifier facilities can be configured to produce synthetic natural gas or chemical feedstocks like carbon monoxide, hydrogen, and sulfuric acid. This creates opportunities for design synergies and may provide additional operating flexibility.

Fluor provides experience and project execution capabilities for facilities utilizing gasifier products such as integrated gasification combined cycle for power generation and methanol, ammonia, and urea synthesis units.

With the right gasification feedstock, a product's carbon intensity can be reduced to meet decarbonization goals and can be further reduced with either pre- or post-combustion carbon capture technologies like Fluor Solvent or Econamine FG Plus.



Gasification product flexibility provides the opportunity for many lower carbon intensity end product options that can be optimized to fit the client's needs.

Economic Evaluations and Cost Estimating

Developing realistic cost estimates during the early execution stages is critical for a project's success. Through our global procurement experience, cooperation with suppliers of specialized equipment such as waste heat boilers and gas turbines, and our gasification plant and other construction experience, Fluor has an up-to-date estimating database for plant equipment and materials that is unmatched in the industry. Our significant international experience also provides us with a database for developing construction labor costs, indirect costs, and other project costs for any location worldwide.

RAM Analysis. The reliability and availability of a gasification plant plays an important role in the project's economics. Fluor has our own reliability/availability group that performs analyses to optimize the plant design. Using specialized software, the analysis can determine the most cost-effective sparing of trains or individual equipment items. Over time, Fluor has gathered data on the reliability/availability of an extensive catalogue of equipment, including data from operating plants. The analyses can be performed on an individual unit basis for projects in the early development stage or on a more detailed individual equipment basis for more advanced projects.

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NuScale Small Modular Reactor

Fluor's Energy Solutions group is chartered with project execution services and delivery to commercialize NuScale's small modular reactor (SMR) technology globally. As a majority investor in NuScale, Fluor enjoys exclusive rights for engineering, procurement and construction project delivery of NuScale and works with strategic partners such as Sargent & Lundy for nuclear island engineering, as well as JGC Corporation for international pursuits in Asia Pacific, Middle East, and Africa.

With demand for global power forecasted to add 5,200 GW by 2042, it is projected that nuclear SMRs could contribute more than 15 percent of this demand. While current build-outs of photovoltaic, solar, and wind renewable energy are very strong, they are intermittent sources and cannot replace retiring baseload power from aging coal and nuclear fleets in mature markets as well as provide grid stability.

Leading the Way into a New Frontier of Energy

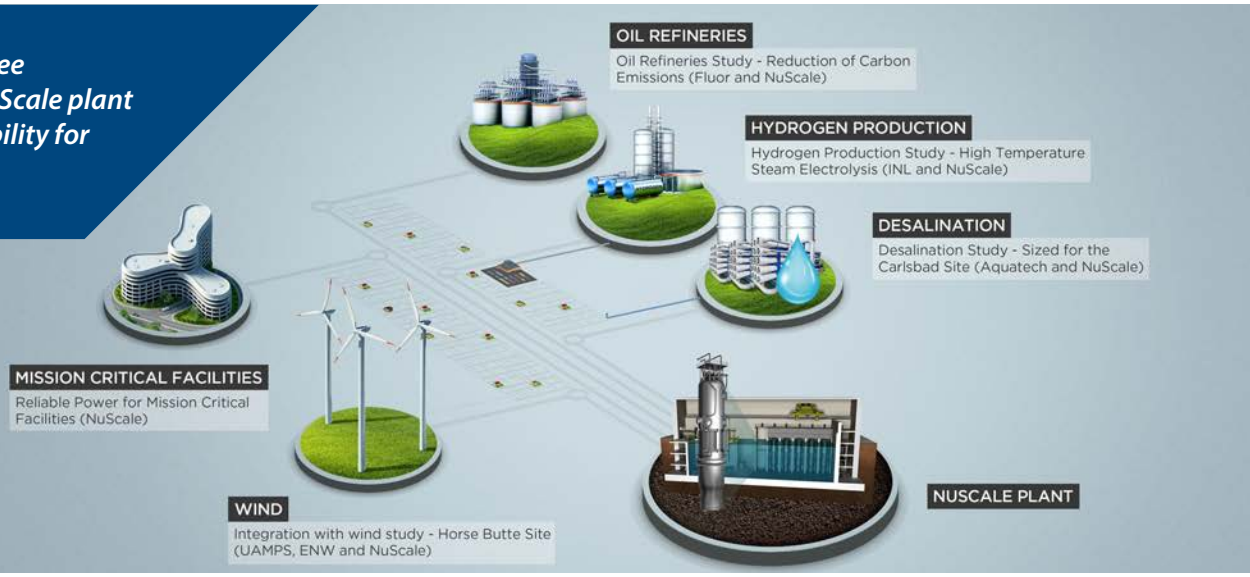
With the first ever SMR to receive U.S. Nuclear Regulatory Commission (NRC) design approval in 2020, NuScale is proud to bring the first ever SMR power plant online in the U.S. this decade.

The NuScale Power Module™ can generate up to 77 megawatts of electricity (MWe) or 250 megawatts thermal (MWt). This provides a total output of 924 MWe (gross) for NuScale's flagship 12-module power plant. NuScale also offers smaller power plant solutions in four-module (308 MWe) and six-module (462 MWe) sizes that are underpinned by the rigorous safety case of their NRC-approved SMR design. With this flexible array of power options, NuScale can support a variety of needs and geographic areas, including small grids, island installations, remote off-grid communities, and repurposing of smaller coal power plant sites.

Carbon-Free Power Alternative

Electric and steam power outputs of modules can be tailored to different functions, such as desalination, oil refining, or hydrogen production. These applications are traditionally powered by fossil fuels; the NuScale plant provides a reliable, carbon-free power alternative.

In addition to carbon-free baseload power, the NuScale plant offers operational flexibility for diverse applications.



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NuScale Small Modular Reactor

Beyond Delivering Always-on Baseload Power

Cost Competitive

Benefits of the NuScale power plant design:

- Design is simple (less expensive to build, operate, and maintain)
- Modules are built in clean, controlled factory setting (compared to a stick-built environment)
- Power island and balance of plant is not safety-related (allowing for use of off-the-shelf commercial turbines and other components)

Cleaner

The NuScale Power Module:

- Facilitates decarbonization of diverse electrical and non-electrical applications (including desalination, district heating, hydrogen production, and oil refining)
- Serves electricity customers that need reliable, secure power with the ability to load-follow wind, solar, and hydropower generation

Smarter

The NuScale Power Module:

- Uses the principles of buoyancy-driven natural circulation (no pumps are needed to circulate water through reactor)
- Eliminates many large components and complex systems found in other conventional nuclear power plants through its smaller, simpler design

A Fully Passive Safety System Design

The NuScale Power Module, with its innovative design, has created the new standard for rigorously proven safety through the Triple Crown for Nuclear Plant Safety™. The Triple Crown provides for safe shut down and self-cooling of the reactor indefinitely, with (1) no operator or computer action, (2) no AC or DC power, and (3) no additional water.

Black-Start and Island Mode Following Loss of Offsite Power

A single module can be black-started and can power the entire plant in case of loss of the grid; no operator or computer actions, AC/DC power, or additional water required to keep the reactors safe.

First Responder Power

On loss of the offsite grid, through variable (0% to 100%) steam bypass, all 12 modules can remain at power and be available to provide electricity to the grid as soon as the grid is restored.

Resilience to Natural Events

Reactor modules and fuel pool are located below grade in a Seismic Category 1 Building. (i.e., they are capable of withstanding a Fukushima-type seismic event, hurricanes, tornados, and floods).

Resilience to Aircraft Impact

Reactor building is able to withstand aircraft impact as specified by the NRC aircraft impact rule.

Cybersecurity

Module and plant protection systems are non-microprocessor based using field programmable gate arrays that do not use software and are therefore not vulnerable to internet cyber-attacks.

Electromagnetic Pulse

SMR is resilient to solar-induced geomagnetic disturbances and electromagnetic pulse events beyond current nuclear fleet.

FLUOR®

Green/Sustainable Chemicals

As a professional and technical service provider with EPC capabilities, Fluor assists clients with development and implementation of emerging technologies focused around renewable feedstocks.

Fluor supports clients with developing first-of-a-kind green technologies, from pilot-scale to a fully operational world-scale facility. Our team of professionals perform technology assessments of third-party licensors/partners for both existing and developing technologies, or for facility modifications to bio-based feedstocks.

Fluor has the experience needed in technology development and on unit operations to integrate and optimize a client's facility. Our technology leaders are available to work with clients on this, and other competitive green chemical markets.

Every year we execute hundreds of studies, including cost estimates, that provide the information needed for our clients to validate commercial and execution objectives. In the last decade for example, we collaborated with several clients and licensors to deploy green and/or blue carbon-free methanol and ammonia solutions.

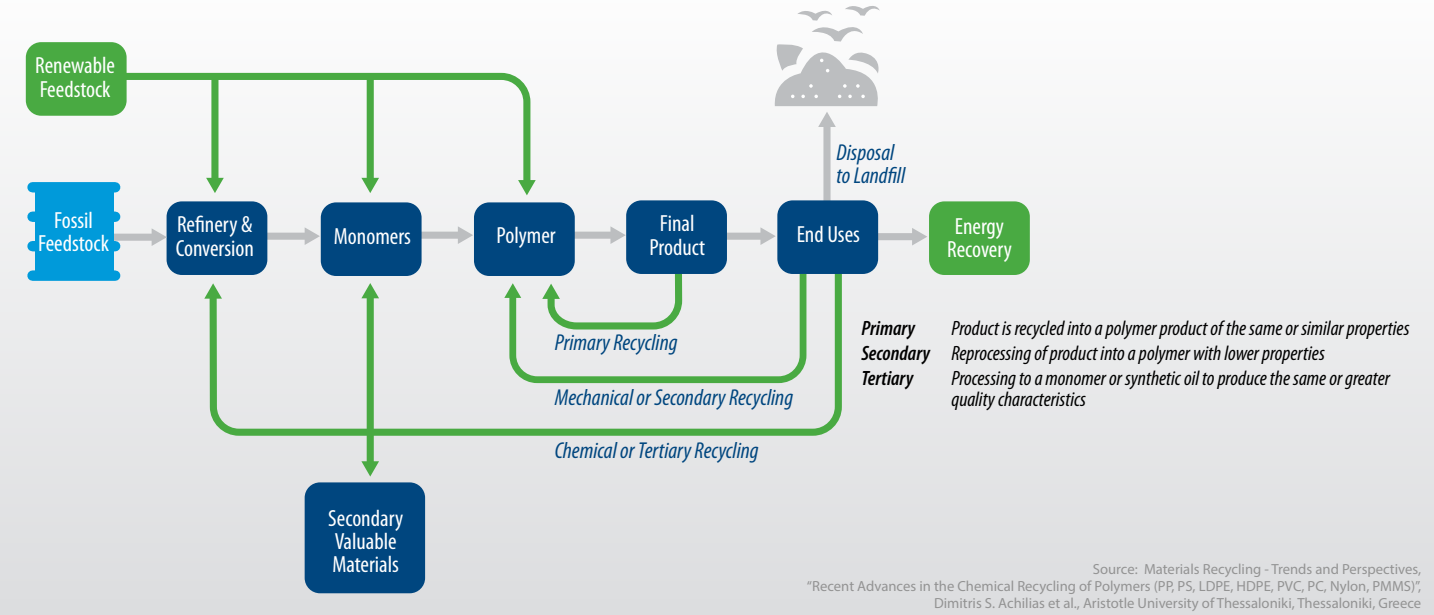
FLUOR®

Chemicals/Plastics Recycling

Fluor has been active in the chemicals and polymers market for more than 100 years. The expansion into chemicals/plastics recycling has been motivated by the modern world's reliance on plastics with a considerable amount of plastic ending up in landfills, oceans, or waste incinerators. We recognize our clients face not only environmental and legislative pressure, but also an inherent social responsibility to reduce this trend and increase recycling.

Fluor is able to support our clients in all methods of recycling. We can deliver exceptional value through our expertise in chemicals (tertiary) recycling, and by embracing the chemicals circular economy.

Fluor addresses the circular economy challenges via feedstock separation, recycle process, and the integration of recycle streams back into the refinery and petrochemical process.



Source: Materials Recycling - Trends and Perspectives, "Recent Advances in the Chemical Recycling of Polymers (PP, PS, LDPE, HDPE, PVC, PC, Nylon, PMMS)", Dimitris S. Achilias et al., Aristotle University of Thessaloniki, Thessaloniki, Greece

Recycling Solutions

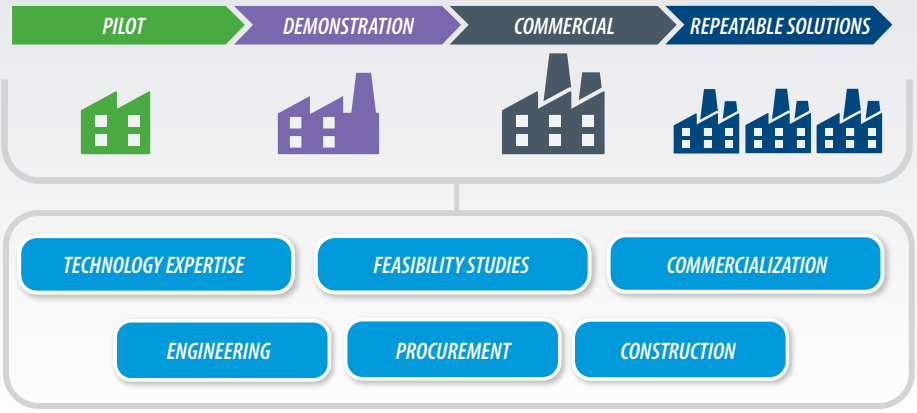
As chemical and plastic recycling technologies are further developed, Fluor can work with our clients to address scalability challenges to move from concept to commercial operations. Integrating Fluor's technical and professional expertise, we can assist clients to achieve the most efficient life-cycle costs by optimizing capital and operating costs.

FLUOR®

Battery Chemicals

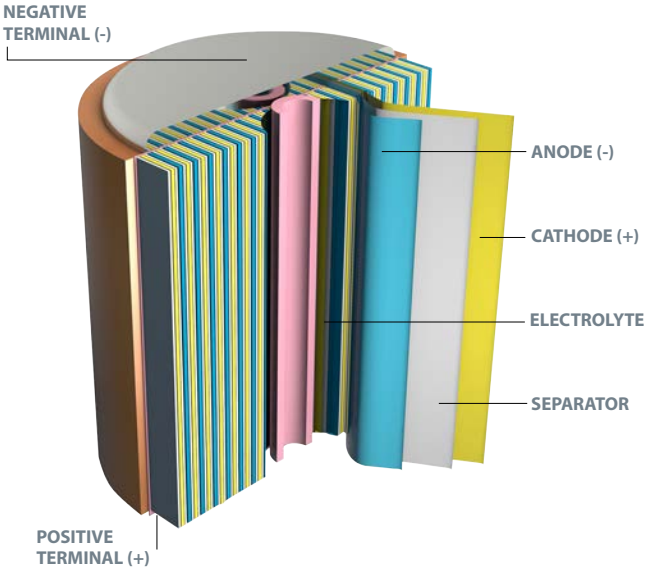
Driven by the demand for energy efficient electric vehicles and consumer goods, batteries are playing an increasingly important role in decarbonizing the economy by enabling mobilized electrification. **Fluor has the technical expertise to assist clients with emerging technologies such as lightweight material alternatives, and the proven project execution abilities needed to address current and growing markets.**

Fluor offers clients the innovation, flexibility, and the required technical expertise to meet the challenges of developing first-of-a-kind technologies. We partner with clients from small-scale pilot projects through commercial plants with repeatable cost-effective solutions.



Technologies and Materials Involvement

LITHIUM-ION BATTERY



Anode. Graphite, synthetic graphite, silicon, crystalline silicon, activated carbon, carbon black, lithium titanite, and carbon additives

Cathodes. High-nickel, lithium nickel cobalt manganese, lithium nickel cobalt aluminum, lithium nickel oxide, low-nickel NMC and lithium iron phosphate, lithium cobalt oxide, and lithium manganese oxide

Electrolyte. Lithium salt, additives, and solvents

Cathode and electrolyte precursor materials. Lithium hydroxide monohydrate and lithium carbonate

Separators. Microporousfilm or membranes commonly made of polyolefins: polyethylene, polypropylene, polybutylene, polymethylpentene, mixtures thereof and copolymers; ceramic coated separators, polyvinylidene fluoride

Fluor brings our technical expertise from chemicals, mining and metals, and advanced manufacturing to support development of various advance materials and processes to suit our client's needs and objectives.

FLUOR®

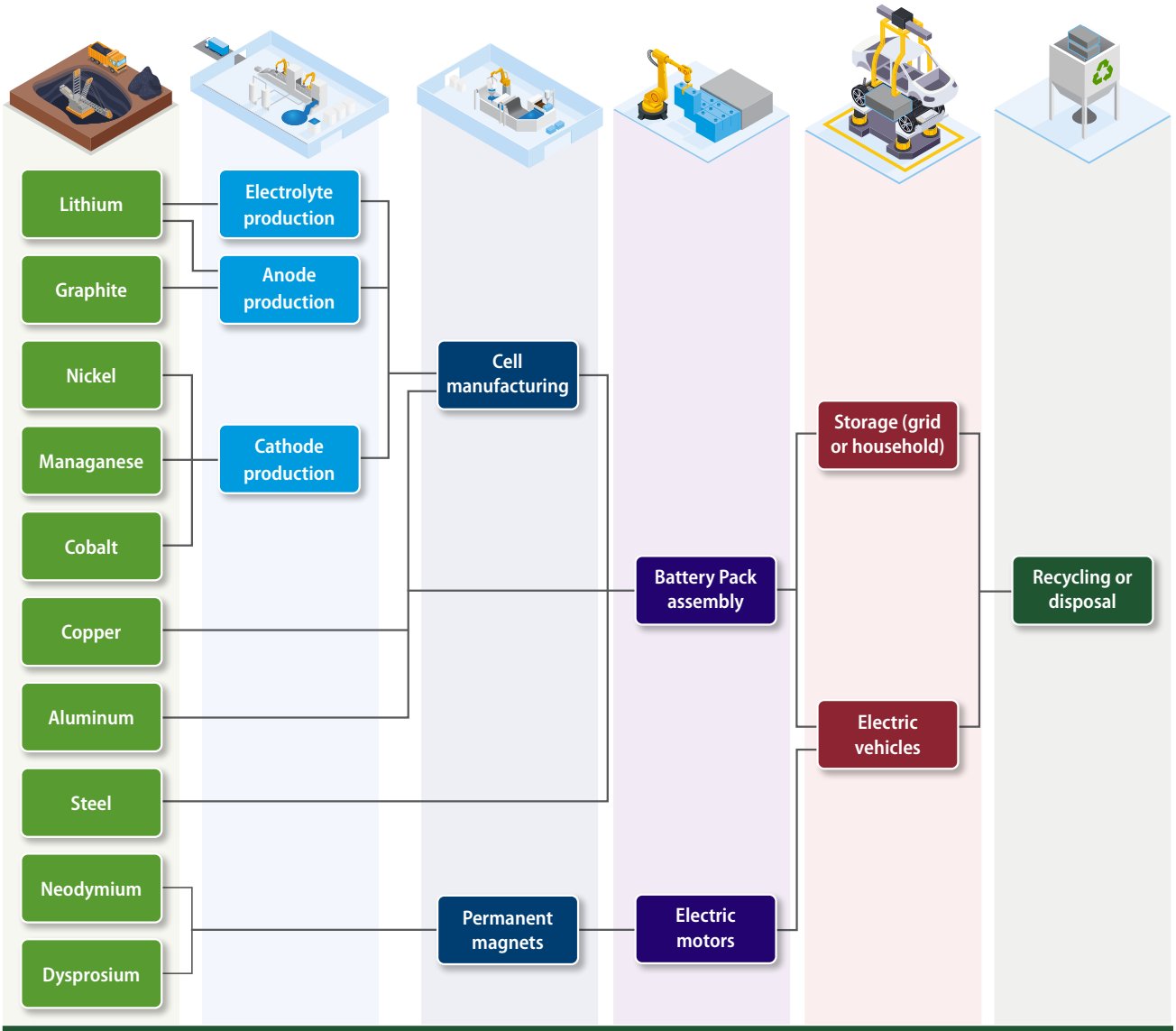
Battery Chemicals

Production of Battery Materials

The production of cathode and anode active materials involve proprietary processes developed by key players in the Lithium-ion battery value chain.

Fluor provides comprehensive professional and technical services to execute capital projects, define project scopes with accurate cost estimates and project schedules, minimize environmental impacts, reduce life-cycle cost of client facilities.

Battery Value Chain



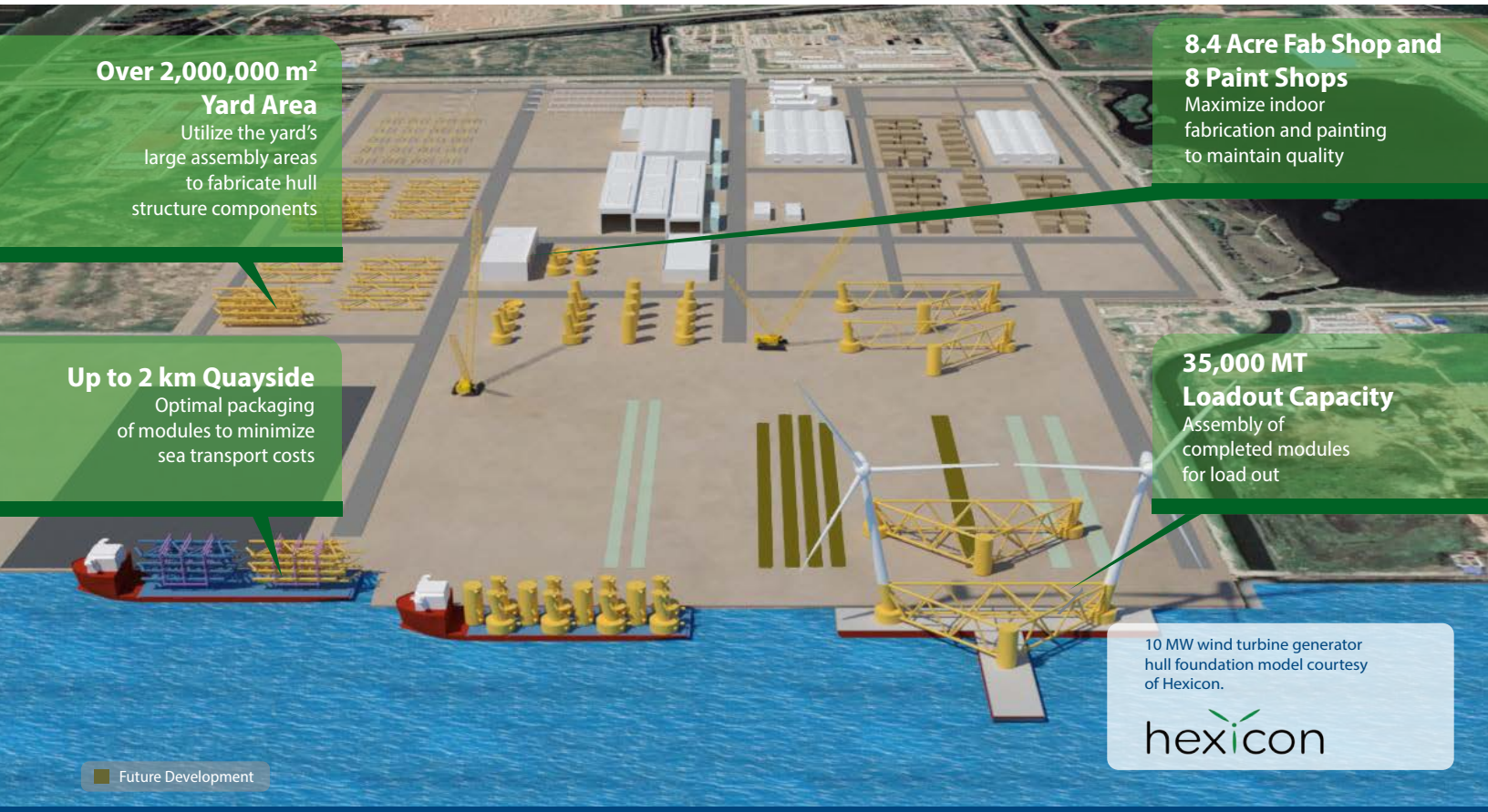
Fluor is experienced with licensor technologies and working with clients in a combination of projects ranging from proven technologies to technologies that are under development and/or proprietary to others.

FLUOR®

Offshore Wind Energy

As many countries strive to achieve a sustainable energy industry and meet international environmental requirements, Fluor's fabrication assets and EPC capabilities provides a unique platform to enable large-scale offshore wind (OSW) projects to move from concept to reality.

With assembly areas and production capacities that rival the world's largest mega factories, the COOEC-Fluor Heavy Industries Co., Ltd. yard in China is unique in its ability to industrialize the production of foundations for OSW farms through a manufacturing-driven mindset that drives down total project costs.



Manufacturing-Driven Mindset at COOEC-Fluor Fabrication Yard

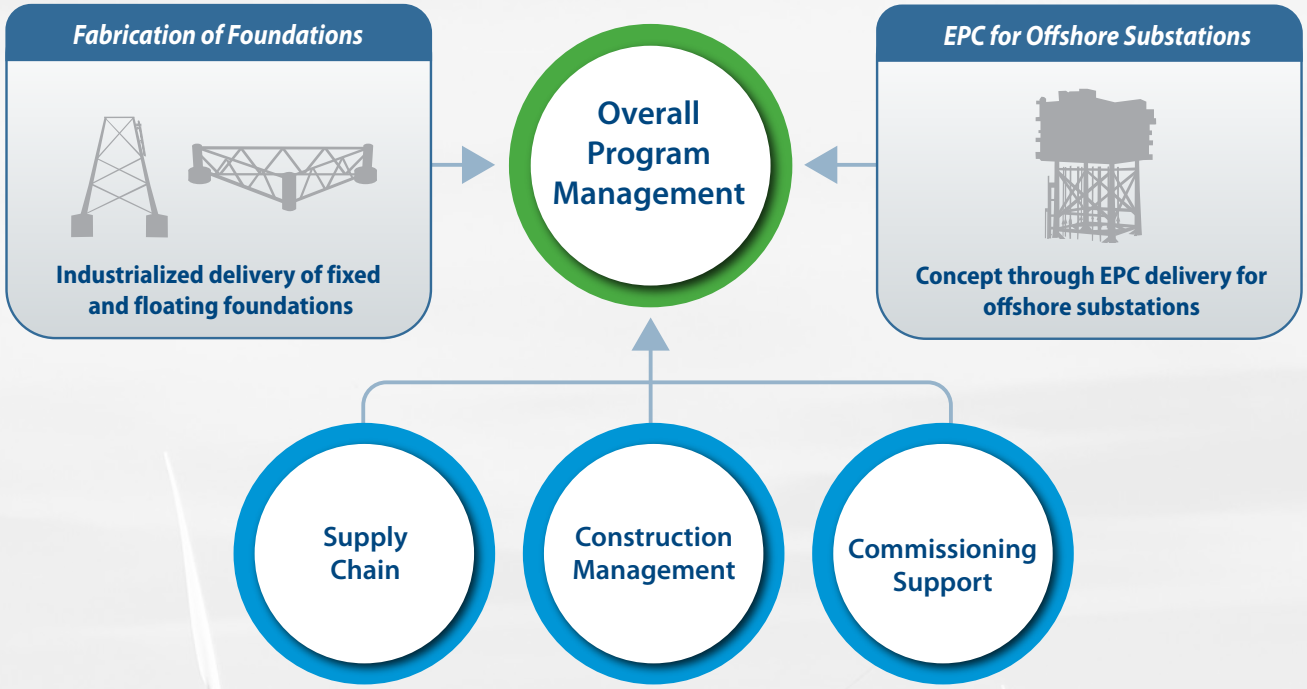
20 *years*
OSW Project EXPERIENCE

- Jacket and suction caisson fabrication at the COOEC-Fluor yard for the Seagreen offshore wind farm project in the United Kingdom (UK)
- Jointly owned and developed two major wind farm projects in the UK, the Greater Gabbard and the Seagreen 1, up to final investment decision (FID)
- EPC for the Greater Gabbard Balance of Plant (BOP) offshore of the UK, which comprised of 140 monopiles and associated transition pieces, as well as the substation platform

FLUOR®

Offshore Wind Energy

Fluor brings our expertise to OSW projects in two main areas: offering fabrication of offshore wind turbine foundations and EPC delivery of offshore substations. With this and our legacy supply chain, construction management, and commissioning expertise, we have the ability to provide an **overall project management approach** to OSW projects.



Strategic Assets For Americas OSW Market

Fluor also jointly owns and operates two yards in the Mexican Gulf and a pipe fabrication shop in central Mexico, which can reduce overall project risk by providing fabrication and logistics options for the growing OSW market.

Mata Redonda

Annual capacity: 25,000 MT
Outdoor fabrication area: 23 acres
Covered fabrication shop area: 45,260 sq. ft.
Pipe fabrication capacity: 12,500 DI/mon
Skidways: 4
Piled and dredged water front: 1,377 ft.

Tula

Fabrication area: 18.5 acres
Covered fabrication shop area: 64,000 sq. ft.
Sandblast and paint area: 18,000 sq. ft.
Pipe fabrication capacity: 136,000 DI/mon
Six production lines with 6- and 9-ton overhead cranes
Access to highways and railways

El Empalme

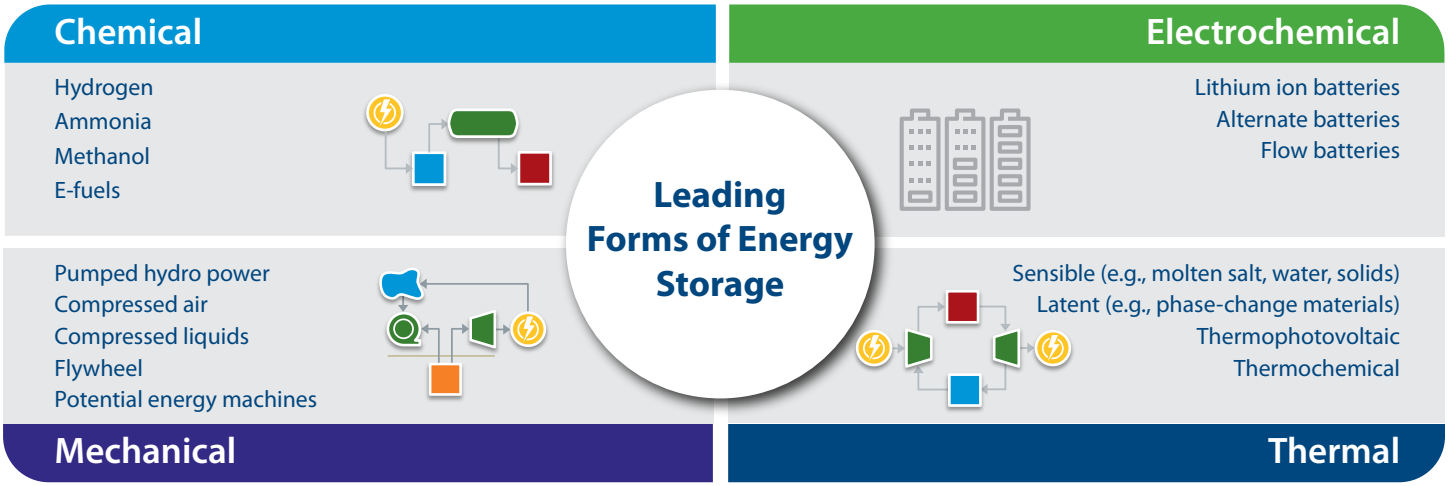
Annual capacity: 20,000 MT
Outdoor fabrication area: 32 acres
Covered fabrication shop area: 113,000 sq. ft.
Pipe fabrication capacity: 30,000 DI/mon
Skidway: 1
Piled and dredged water front: 918 ft.

FLUOR®

Energy Storage

As the cost of solar, wind, and other renewable sources of energy becomes more competitive with traditional fossil fuels, a major barrier remains: the ability to cost-effectively store the energy generated from these intermittent renewable sources. While batteries, pumped hydro, and other solutions to store energy have existed for years, new ways to store energy for longer durations and with the ability to respond rapidly to demand are needed to support rising grid capacity and to create a more sustainable energy future.

From the energy-producing facility through the utility and end-user, Fluor provides engineering expertise, technology evaluation, and balance-of-plant requirements to deliver reliable energy storage solutions.



Integrating Long Duration Energy Storage

Fluor's decades of energy production and storage experience across all industry segments – paired with our engineering ingenuity – makes us a strong partner for projects of the future. We analyze power profiles and techno-economic conditions for our clients, continuously scanning the horizon for solutions best suited for a particular project.

Our long legacy of successful concept-to-in-service project execution helps first-of-a-kind technology providers scale and integrate technology with existing facilities. In addition, our fabrication and modularization capabilities and expertise can help clients quickly build energy storage solutions with repeatable designs.

Experience Meets Expertise

Well versed in thermodynamics, Fluor has more than 100 process engineering experts ready to tackle today's energy storage challenges. These experts have performed numerous energy storage project studies and provide clients with the technical and professional services they need to make their projects a success.

Fluor's Energy Storage Expertise

- Process design packages
- Emerging technology reviews
- Electrical stability analysis
- Metallurgy consulting and selection
- Fabrication
- Techno-economic analysis
- Scale-up
- Balance of plant and grid integration
- Simulation modeling
- Computational fluid dynamics analysis

FLUOR®

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