

# A Knowledge Based Decommissioning Alternative Selection System for Fixed Offshore Oil and Gas Platforms in Persian Gulf

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## ABSTRACT

Complexity and costly nature of operations involving in the decommissioning process require huge investments to be done during the lifetime of the field for its decommissioning phase of the total project. This work offers a knowledge-based decommissioning alternative strategy selection system for fixed offshore jacket platforms in the Persian Gulf. In this method, the alternative option of installing offshore wind turbines (OWT) as the most probable economic feasible alternative to decommissioning on an abandoned platform jacket structure in the Persian Gulf is proposed. In this regard, costs and benefits study between two strategies are considered; one total decommissioning and the other installing an OWT on the jacket structure of a local platform in the region. It is found that the second strategy is beneficial and saves near 9 million US dollars for company. Also, the company earns the technology and experiences with OWT installation and operations and would be a technical leader in the region for coming years. Moreover, this strategy contributes to reducing the rate of greenhouse gas emissions, improving environmental sustainability.

## 1. Introduction

The decommissioning process is constantly challenged with indeterminate risks associated with deteriorated structures and the practice of late-life decommissioning planning. Complexity and costly nature of operations involving in the decommissioning process require huge investments to be done during the lifetime of the field for its decommissioning phase of the total project. The issue is further complicated by the absence of a fit-for purpose decision framework. There are some optional alternatives to decommissioning which are depended on the availability of tourism, aquaculture or environmental energy potentials.

Traditional business priorities for oil and gas operators have always been securing new hydrocarbon reserves, embarking on greenfield projects and revitalizing brownfields. It is an important consideration that at the end of their commercial lives, these projects must be decommissioned in a sustainable and socially acceptable manner [1].

In Iran, there are more than 57 active jacket platforms and more than 150 wellhead jacket structures in charge of the National Iranian Oil Company as its offshore production segment in the Persian Gulf, which most of them are built more than 25 years ago. As the design life of these platforms is in the range of 20 to 30 years,

they are needed to be demolished or reused depending on their belonged reservoir conditions. In this regard by considering non-economical and insufficient reservoir conditions, “decommissioning” process would be necessitated.

Decommissioning is, by definition a complex undertaking by the operator of an offshore oil or gas facility which entails planning and implementing the method of dealing with disused facilities [2]. Decisions in decommissioning activities are bounded by governance from various international regulatory bodies and organizations, such as International Maritime Organization and United Nations Convention on the Law of the Sea. It is understood from such regulations that “abandoned or disused offshore installations are required to be removed, except where non-removal or partial removal is consistent with the guidelines” [3].

The oil and gas industry has been decommissioning structures in the U.S. Gulf of Mexico for over four decades. Since 1973, over 4500 structures have been removed in the GOM and the technologies and operational practices are well established [4]. In this regard, in 2009, U.S. Department of the Interior Bureau of Safety and Environmental Enforcement presented an overall report of decommissioning approaches and costs for removal of GOM US Outer Continental Shelf

oil & gas facilities in greater than 400 ft. water depth. The mentioned report provided a solid background in the variety and complexity of offshore decommissioning and the technology and methodology available. The cost sections allowed the reader to piece together various costs and get an understanding or a general estimate of the total cost for a particular type of structure with various specifications [5].

The removal of offshore platforms is generally perceived to be more complicated than newly built installations. Up-to-date information on the platform's in-situ structural integrity is critical for effective planning of a decommissioning campaign. In dealing with aged offshore facilities, there is an inherent uncertainty with the in situ structural condition which has been subjected to various extreme loads and accidents, which may not be documented thoroughly during its operation. Platform end-of-life dates are considered to be very dynamic in nature which adds to the complications of planning decommissioning activities and resources [6].

In 2010, the report "Decommissioning cost update for removing pacific OCS region offshore oil and gas facilities" presented a review of the decommissioning practices for oil and gas facilities and developed benchmark costs for decommissioning the facilities utilizing conventional technologies. This report included cost assessments specific to the Pacific region operations and included reviews of the availability and capability of derrick barges; support vessel services; well plugging and abandonment services; abrasive, mechanical and explosive cutting services; disposal options; and site clearance services available along the west coast of the country. The Pacific OCS decommissioning cost report was updated in 2017 [7]. ProServ Offshore has provided the work decomposition algorithms to estimate cost for well plugging and abandonment, conductor severance, and removal, pipeline abandonment, umbilical and flow line removal, and platform removal for 53 Deepwater fixed platforms and compliant towers in the Gulf of Mexico circa January 2013 [8].

In response to this evolving economic, technical, and legal/regulatory context, the California Natural Resources Agency has begun investigating the issues surrounding alternatives for decommissioned platforms in the state Tidelands and on the OCS from 2007. This project focused on collecting, organizing, and summarizing as much as possible of the available information about the implementation process and impacts (both positive and negative) of alternative decommissioning options for offshore oil and gas platforms in southern California and evaluation of economic and technical feasibility of a range of decommissioning options and prioritizing for more detailed analysis for those most feasible and most applicable to California platforms [9].

According to the considerable natural potential of offshore renewable energies such as wind, the application of offshore wind turbines on oil and gas jacket structures after the end of the predicted economic life of their belonged oil field can be as an alternative option to decommissioning. For example, in 2007, China National Offshore Oil Corporation used an offshore wind turbine on an abandoned jacket structure named as SZ36-1, located in the Liaodong Bay at a depth of 31 meters after the end of its economic life in order to generate power from offshore wind energy [10].

The objective of this paper is to evaluate the economic costs and benefits of two strategies; one considering the full decommissioning process assuming a jacket platform which its field economic lifetime is finished in the Persian Gulf by equalization of available decommissioning cost data for the most similar platform and environmental conditions in GOM provided by the U.S. Department of Interior Bureau of Safety and Environmental Enforcement for the current time due to lack of technical experiences and relevant decommissioning cost data in region; the other considering an alternative strategy to decommissioning process which is the application of an offshore wind turbine on the abandoned jacket structure of the mentioned platform in the Persian Gulf.

## 2. Theory and Methodology

This research proposes a model for the planning and management of fixed offshore structure decommissioning activities at the end of design lifetime, with joint consideration of various technicalities of decommissioning alternatives especially offshore wind turbines in the region. A specific case study on one of the platforms in the Persian Gulf is provided as a benchmark in this paper. The developed model presents a framework which is anticipated to guide business units and asset managers to plan ahead and optimize resources for a decommissioning campaign. This will result in faster and more effective decisions, taking into account the subjectivity of in-situ degraded structural conditions. The focus of the work is on the ranking of feasible decommissioning alternatives based on their input structural parameters and optimal project planning. The end product of this research is integrated as a conceptual decommissioning decision aid toolbox into existing platform databases.

### 2.1. A new paradigm in decommissioning decision making

Dealing with aging assets in mature basins requires up-to-date asset information as it is a key representation of decision making knowledge [11]. This does not only cover the existing structural conditions of the asset but also track records and relevant historical operating or modification repositories. Present models tend to place

more emphasis on cost and environmental factors which diminishes the consideration of in-situ conditions of existing structural elements during the decommissioning planning process.

The lack of foresight in structural conditions may lead to unforeseen operational glitches or setbacks during the campaign [1]. Essential information required for decommissioning, for instance, as-built drawings, construction sequence, repairs, and modifications, should be collected, maintained and revised throughout a structure's operational lifetime. This information and knowledge should be organized so that those pertinent to decommissioning are effortlessly identified and utilized. Asset information comes from various sources over the life cycle of the asset but needs niche attention to identify and manage decommissioning related risks [12].

Keeping track on the number of offshore assets and their decommissioning priorities has always been an intense task for many asset owners. A platform can generally be earmarked for decommissioning due to unfavorable economics or old age. The in-situ structural condition of an old platform is a highly multivariate problem incorporated into the decommissioning challenge which is impossible to be processed by a single human expert. This work develops a novel algorithm for embedding relevant structural parameter into the decommissioning model via an expert knowledge-based system.

The outcome is a localized, relative scale which provides asset managers a rational basis for decision making for decommissioning planning and management throughout the lifecycle of an offshore asset.

## 2.2. Decision making in decommissioning

Eventually, any field development will reach the end of its economic lifetime. The economic lifetime is introduced as the point at which the annual net cash flow turns permanently negative. This is the time at which income from production no longer exceeds the costs of production and marks the point when decommissioning should occur since it does not make economic sense to continue to run a loss-making venture. Technically, the production of hydrocarbons could continue beyond this point but only by accepting financial losses. Figure 1 shows the economic lifetime according to net cash flows of income and costs of a platform and belonged life-extending ways. There are two ways to defer decommissioning:

- Reduce the operating costs, or
- Increase hydrocarbon throughput.

Operating costs represent the major expenditure late in field life. These costs will be closely related to the number of staff required to run a facility and the amount of hardware they operate to keep production going. The specifications for product quality and plant up-time can also have a significant impact on running

costs. On the other hand, when production from the reservoir can no longer sustain running costs but the operating life of the facility has not expired, opportunities may be available to develop nearby reserves through the existing infrastructure. This is becoming increasingly common as a method of developing much smaller fields than would otherwise be possible.

At the end of the platforms economic lifetime, which any project is avoidably faced with, there are two options of different decision-making scenarios which are both different in concept and outputs. Decommissioning or leaving the platform/jacket structure in place for alternative applications are the two main options in front.

Total decommissioning of platforms located at shallow or intermediate waters and disposing of the topside and the jacket on shore or partial removal of jacket platforms located in deeper waters as part of the conversion to an artificial reef would be the most possible options from the traditional point of view. As it is obvious from Figure 2 there are other applications recently considered as brave alternative applications which are depended on the platform environmental, logistic conditions and potentials. These options include aquaculture, instrumentation and alternative power generation. Depended on the platform conditions, instrumentation as a diving platform or a tourism landmark might be from some attractive alternative solutions instead of the abandonment and decommissioning of the platform. Offshore LNG export terminal is another kind of abandoned platform application after its economic lifetime. There are some strong and hidden aspects of energy at oceans such as wind, wave, current and solar energy which would be a strong cause to claim the platform or its jacket structure for power generation applications as the default basement for the arrangement of some feasible energy converters.

## 2.3. Strategy selection model

Lowering total costs as well as increasing total income and decreasing environmental impacts are from those brave aspects of interests for all managing teams including governments, owners, contractors, and operators.

In the offshore segment; oil & gas platforms are designed for the nominal economical lifetime of the belonged field reservoirs and would be subjected to the decommissioning process finally. Making the decision to start the decommissioning process for a platform would be as the commencement of a massive costly and time-consuming phase in the last part of the platform life cycle. There are some Innovative Ideas which are considered as alternatives to decommissioning process in strategy selection phase before the decision making step. Innovations are suggested depending on different available potentials for each platform.

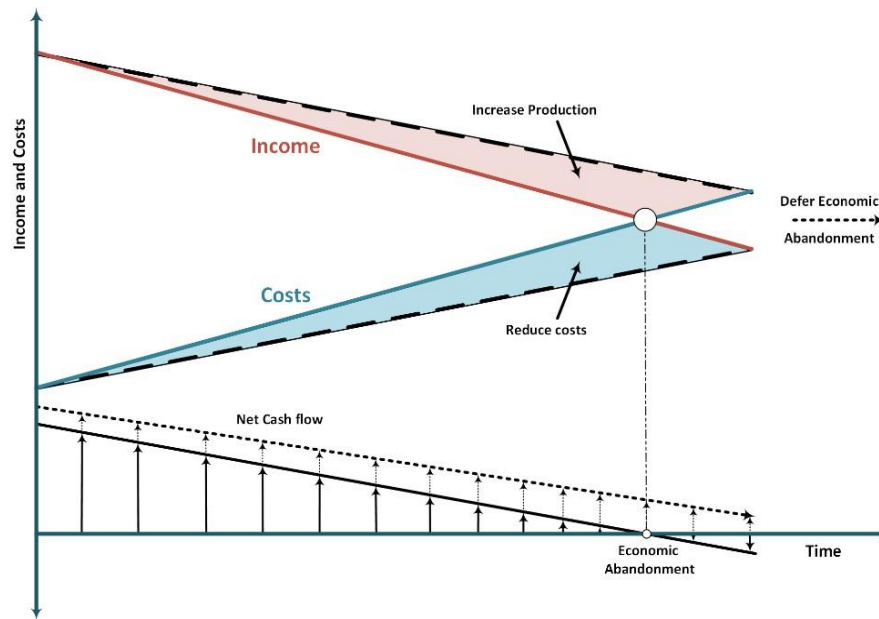


Figure 1. Representation of a Platform Economic Life Time

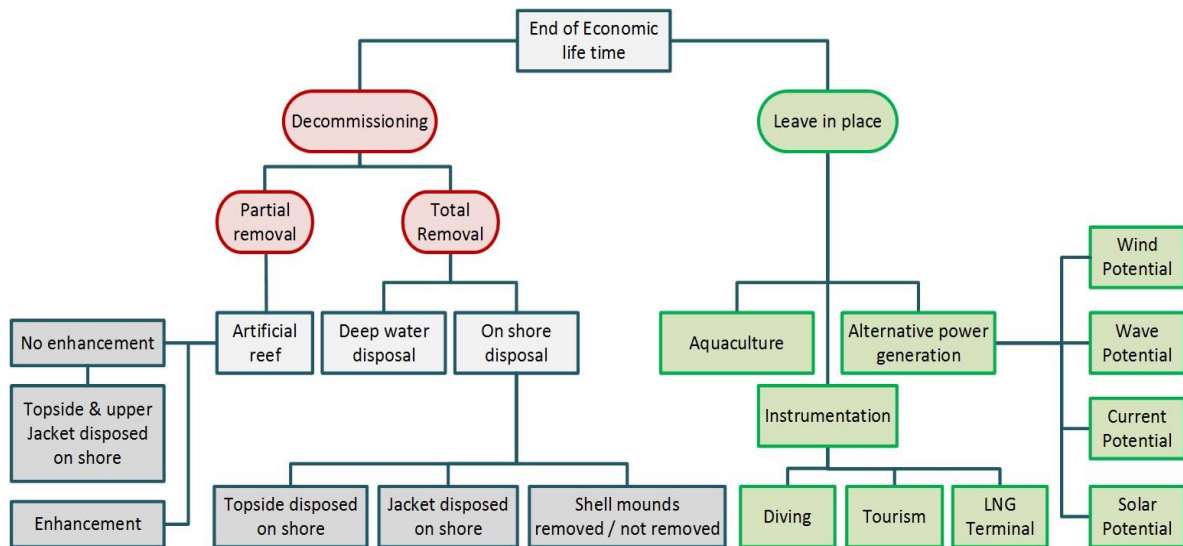


Figure 2. Summary of Decommissioning Strategies

An alternative decision related to any specific potential requires that special technological and economic feasibility study to be done.

The innovative strategy selection process starts right after the end of the platforms design life or even if any economical deficiency resulted from sudden field condition variation has been occurred. In some cases, a new potential field is discovered around or near the platforms belonged fields and its economic efficiency has been proved, so it may be worthy to rehabilitate the platform in order to extend its lifetime as much as the new economic lifetime of the discovered field would be. By the way, well plugging and abandonment are necessitated and the platform reaches to the point at which the final decision has to be made, whether to decommission or to change its application.

From the traditional point of view, the decommissioning process would unavoidably be the next decision, but from an innovative strategy selection point of view, this process can be avoided at the expense of some rehabilitation if needed and a new era of the platform economic life in an alternative application would be started. In order to reach the best result and to find the most appropriate solution, it requires an accurate study of the environmental potentials of the platform to be done. This assessment includes aspects of the economic viability of the potential alternative applications for jacket structure and for each alternative potential, required technological and economical rehabilitation feasibility if needed. Figure 3 shows a schematic overview of the mentioned strategy selection model for offshore oil and gas platforms.

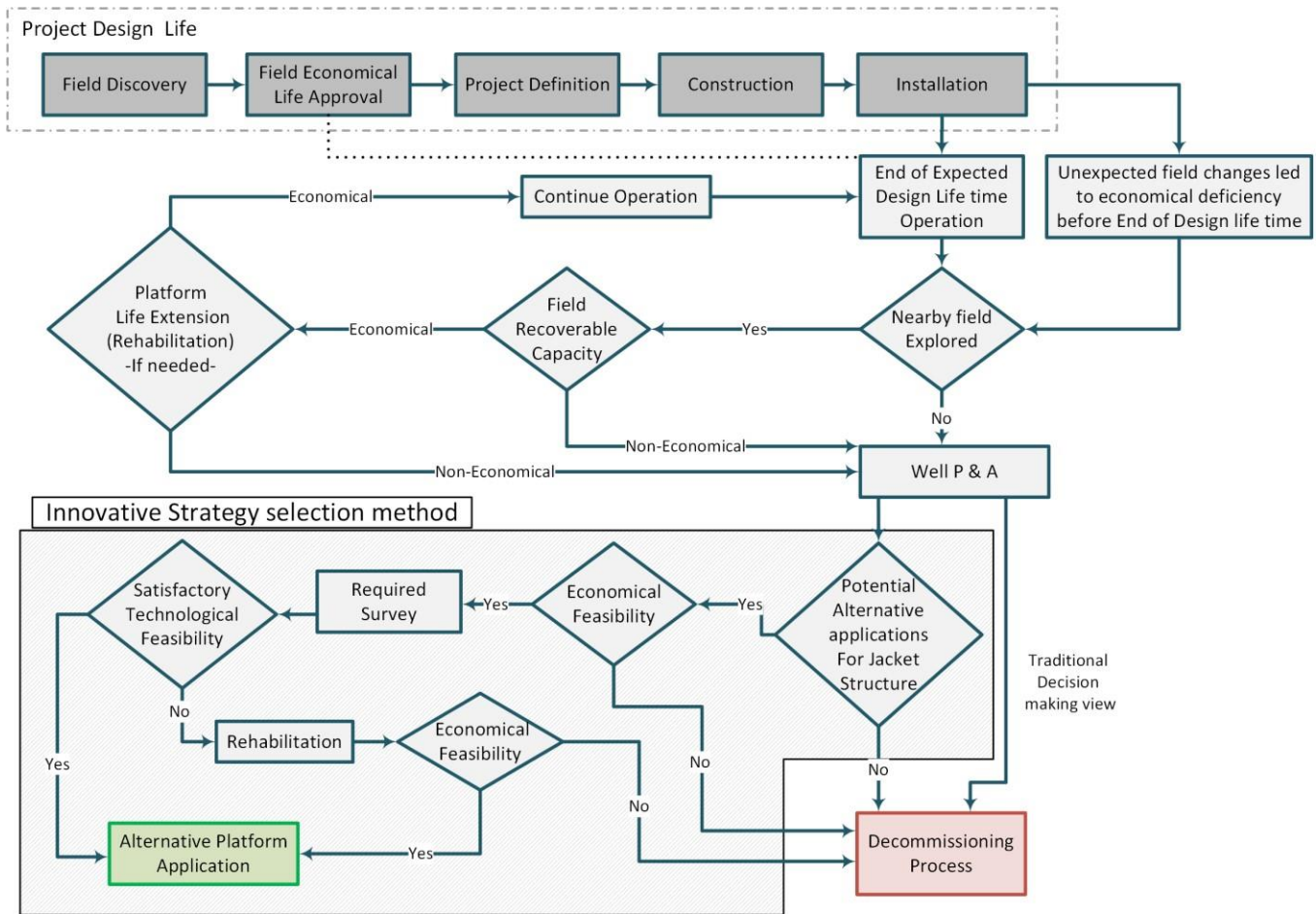


Figure 3. Strategy Selection Model at the End of Design Lifetime

#### 2.4. OWT as an alternative to decommissioning in the Persian Gulf

Among all other alternatives mentioned above offshore wind will make a substantial contribution in Iran's energy policy requirements and similarly there is an extensive increasing worldwide trend for offshore wind turbine power generation field installations as well as an active proved tendency to develop their green energy production capacity. Potentially in addition to less turbulence and no visual or auditory annoyances, offshore wind turbines generate power more than onshore types because of the higher relative wind speed and zero roughness of the interface between the sea and the wind surface. Depending on water depth and environmental conditions offshore wind turbines are designed with different base and foundations such as mono-piles, tri-pods, and jackets for relatively shallow water fields and floating foundations for deeper potential wind fields. Installed offshore wind turbines in the world almost use mono-pile foundation and less than 20% use jacket substructure. Undoubtedly, this is due to the prevalence of shallow water locations and the maturity of this proven design, which has been almost the default choice in water depths up to 25 m with a firm seabed. But as seabed infirmity, turbine size and water depths increase, mono-pile support structures become less attractive due to rapidly

growing hydrodynamic loads around large pile diameters, increasing structural flexibility at deeper water depths and complicated manufacturing with time-consuming installation processes.

Many works have investigated different solutions for the support of OWTs in general locations. For turbines over 5 MW and medium water depths of 30-60 m, jacket support structures are a coherent evolution of mono-pile that, in the last years, have evolved from prototypes to fully commercial deployments. With the development of technology in offshore oil and gas industries, jacket foundations are regarded as an alternative for the intermediate water depths (30-90m). Using jacket foundations for offshore wind turbines has the advantages of having lower ultimate loads and employing mature technologies from the offshore oil and gas industries.

The upper foundation components (column and nacelle) have the same design for each case and the only difference would be the dimensions of the turbine. As deeper the water and far from the shore; more the obtainable wind energy and consequently desirable larger turbine dimensions. Considering the situation of an oil & gas platform economical life abandonment time, the idea of using its well designed and already installed platform jacket for another application such as offshore wind turbine foundation glints. Of course,

there would be required lots of precautions before strategy selection to use the jacket as the base for the turbine or not, such as sub-sea inspections, geotechnical analysis of soil-pile interactions and structural resistance analysis considering special wind turbine loadings on an old jacket. In case of satisfactory analysis results, there is no need for some extra costs for the jacket and cable removal from the seabed. Nowadays offshore wind turbines have reached to an obtainable power capacity of more than 8 MW per tower, of course, depending on the wind speed. General dimensions of an offshore wind turbine with mentioned capacity are about 220m height and 160m blade diameter [13]. From the available environmental potentials at the Persian Gulf and feasible technological industries in Iran, using the platform jacket as the foundation for wind energy converters would be the most probable economic feasible alternative to the complex and costly process of decommissioning either total or partial removal.

Due to the absence of installed or operating offshore wind projects in Iran, the offshore reference project data are estimated from proposed U.S. projects and market data from the existing international offshore wind industry. As domestic and global wind markets mature, information about component-level costs is increasingly available. To manage and organize this component-level cost data, U.S. National Renewable Energy Laboratory has developed a system cost breakdown structure to break an entire wind project into smaller, more specific components [14]. It provides a standardized approach to characterizing total lifetime expenditures for wind projects at the component level, including both physical (e.g.,

materials, labor, and equipment) and financial costs (e.g., insurance, construction financing, profit, and carrying charges). Mentioned developed breakdowns for Capital Expenditures are shown in detail in Figure 4.

By application of an abandoned platform jacket as the substructure for OWT as an innovative strategy, three costly stages of Electrical Infrastructure, Site Access and Foundation, and sequentially their share in other fractions of CAPEX for a reference wind plant project such as Construction Finance, Contingency, Development, Engineering and Management should not be considered.

On the other hand, although there are some different steps for the innovative strategy especially in parts related to the jacket, power cable, and OWT, there are other common steps with the whole decommissioning strategy that should be considered in total CAPEX. Figure 5 shows two mentioned strategies in steps of common and different elements. For strategy number one, the total decommissioning process is implemented as it was discussed before. Strategy number two includes Project Management, Engineering & Planning, Inspection & Permits, Well P & A, Topside preparation, Pipeline abandonment, Conductor removal, Mobilization & Demobilization of Derrick Barges for topside, Topside removal and disposal, OWT assembly and installation, Power generation for at least 20 years, Mobilization & Demobilization of Derrick Barges for OWT, Removal & disposal of OWT, Mobilization & Demobilization of Derrick Barges for jacket, Removal & disposal of jacket and finally site clearance.

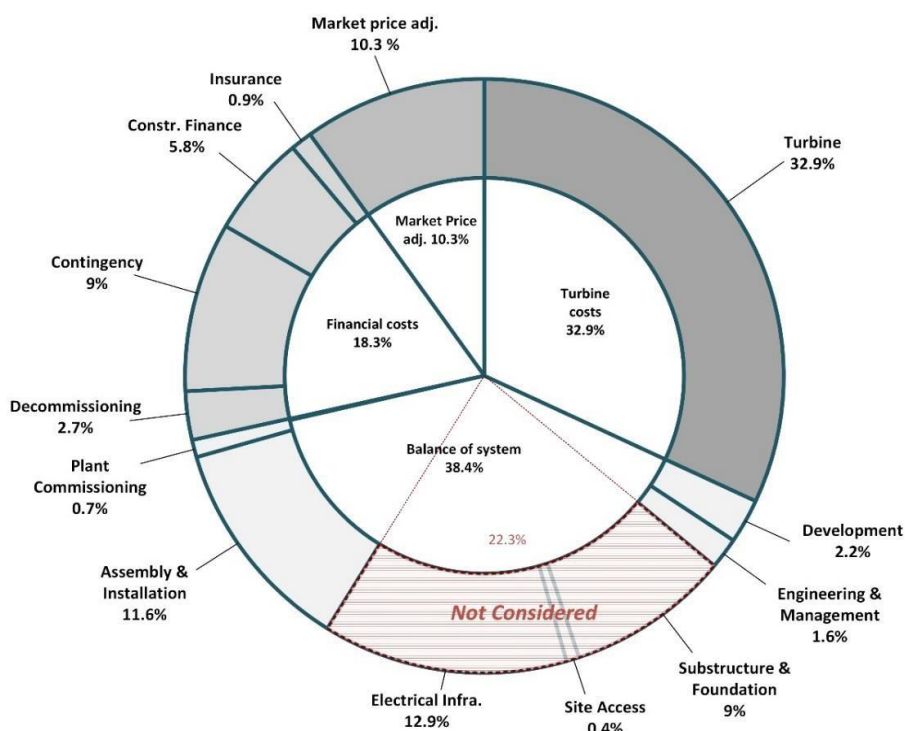


Figure 4. Capital Expenditures for the Offshore Reference Wind Plant Project [14]

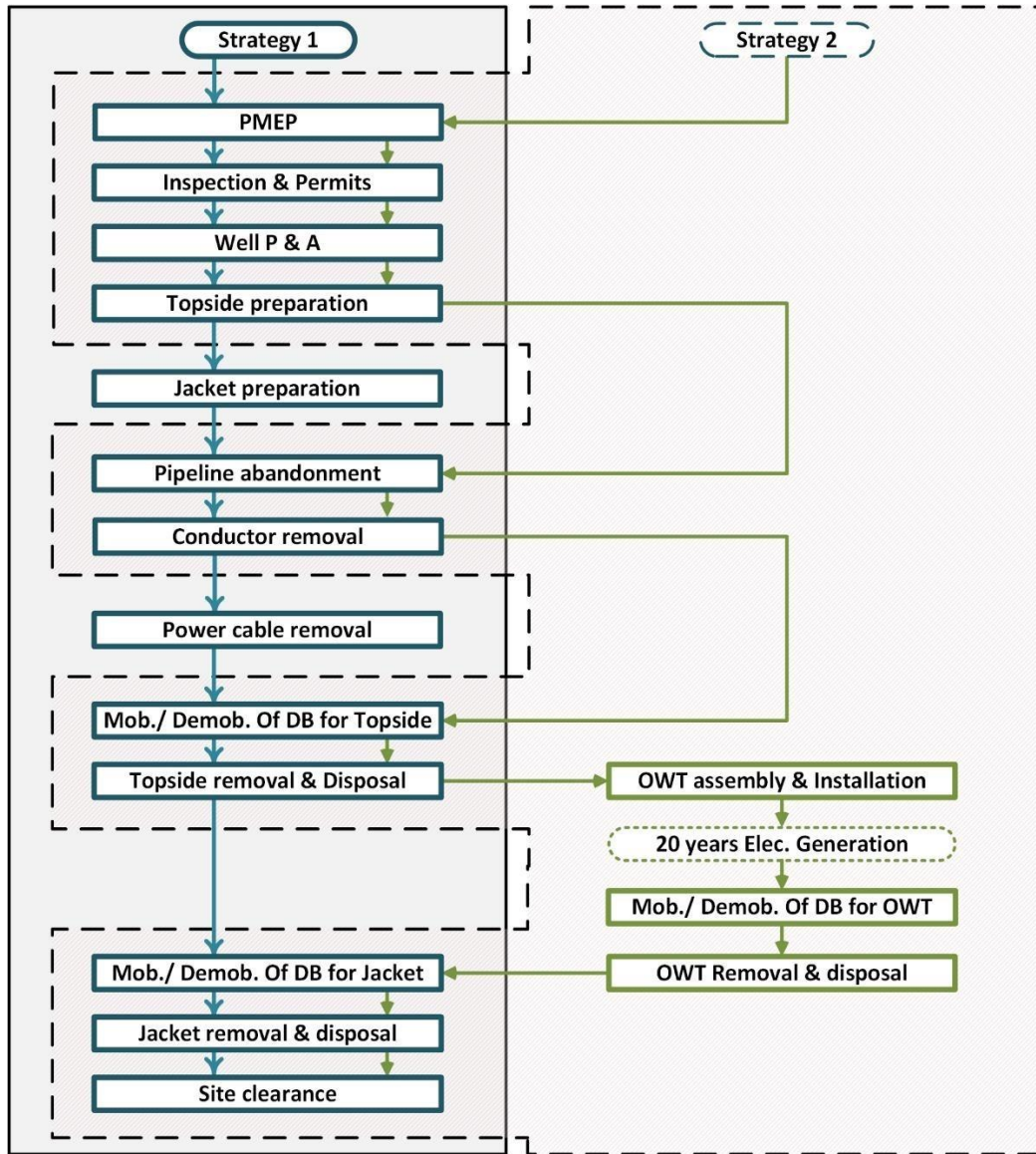


Figure 5. Common and Different Sequences of Both Strategies

### 3. Results and Discussion

The scope of this paper is to evaluate the economic costs and benefits of two strategies; one considering the full decommissioning process for a jacket platform in the Persian Gulf named “Ilam” which its field economic lifetime is assumed to be finished. Due to lack of technical experiences and relevant decommissioning cost data in region, this process is done by equalization of available decommissioning cost data for “Houchin” the most similar platform and environmental conditions in GOM; provided for the current time by the U.S. Department of Interior Bureau of Safety and Environmental Enforcement; the other considering an alternative strategy to decommissioning process which is the application of an offshore wind turbine on the assumed jacket structure of the Ilam platform in the Persian Gulf. Houchin is a production platform located in 50m water depth on “Carpinteria” field which has been developed late in the 60s, 1.15 kilometers far from its host platform. This field has 35 production or injection wells and conductors. Houchin

exports its products to its host via four 1.15km length pipelines of different diameters and is connected to the same length power cable to the host platform [15]. Ilam is a production platform located in 50m water depth on Esfand field in the Persian Gulf which has been developed late in the 60s, 18 kilometers far from Sirri island in the southeast. The field has 4 other offshore platforms including 3 well platforms and one flare. This field has 29 production or injection wells and conductors. Ilam exports its product to Sirri island via an 18km length, 16-inches diameter pipeline and is connected to the same length power cable to the island. One of the most important applications of its production is to supply the required feeds for power plants in “Kish” and “Qeshm” islands. The arrangement of the field and mentioned islands are shown in Figure 6.

In order to compare that how much value the investment on each project adds to the company a comparative financial indicator is required for both strategies.

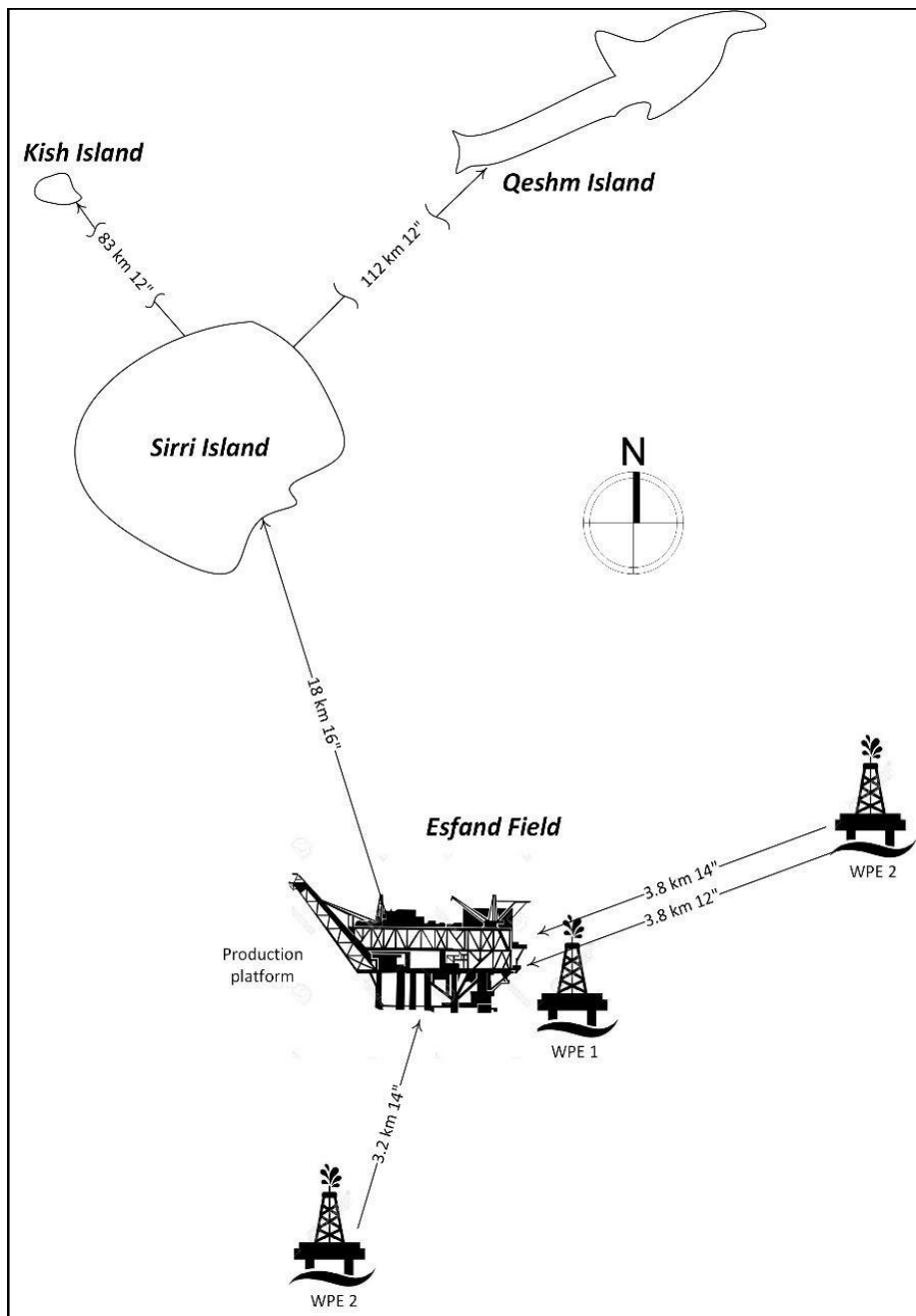


Figure 6. The Arrangement of Esfand Field in the Persian Gulf

The economic evaluations are based on the Net Present Value method. NPV is calculated considering the system lifespan, the interest factor, the total investment cost, annual income and the Weighted Average Cost of Capital. In finance, the NPV or Net Present Worth is a measurement of the profitability of an undertaking that is calculated by subtracting the present values of cash outflows from the present values of cash inflows over a specified period of time. Initial costs are included in cash outflows. Outgoing and incoming cash flows can also be described as cost and benefit cash flows respectively. Each cash inflow/outflow is discounted back to its present value then summed and the NPV is the sum of all the present values for each investment step. The rate used to discount future cash flows to the present values is the Weighted Average Cost of Capital

considering risk and opportunity cost of the capital for the company. The Net Present Value of a project is calculated from the following formula as Eq. (1).

$$NPV = CF_0 + \sum_{t=1}^n \frac{CF_t}{(1+i)^t} \quad (1)$$

Where  $CF_0$  is the cash flow at the year zero (Initial Cost),  $CF_t$  is the Project's Cash flows,  $t$  is individual year of lifetime (1a, 2, ..., n),  $i$  is the Weighted Average Cost of Capital in percent (here = 10%) and  $n$  is operational lifetime in year.

Table 1 lists the cost categories of a total decommissioning process converted to the current time for the platforms "Houchin" and "Ilam". Cost values

for “Ilam” are scaled from available data of its similar platform “Houchin” considering Persian Gulf location. As it is evident in table 1; if the company selects the first strategy at the end of the economic life of the field “Esfand”, total decommissioning of the platform will cost around 40.5 million US dollars for the current time.

**Table 1. Strategy Number 1**

Total Decommissioning Costs by Category			
Categories	Platform Name		
	Houchin	Ilam	
1	Platform Removal	6,881,370\$	6,634,943\$
2	Platform Preparation	1,146,335\$	1,146,335\$
3	Well P&A	6,893,125\$	5,711,447\$
4	Conductor Removal	2,828,527\$	2,343,637\$
5	Pipeline Decommissioning	668,025\$	2,614,013\$
6	Power Cable Removal	358,156\$	5,756,077\$
7	Site Clearance	923,780\$	923,780\$
8	Weather Contingency	1,845,511\$	1,845,511\$
9	Miscellaneous Work Provision	2,768,267\$	2,768,267\$
10	Permitting & Regulatory Compliance	2,076,918\$	2,076,918\$
11	Mobilization & Demobilization of DBs	7,759,125\$	4,914,112\$
12	Materials Disposal	2,215,039\$	2,189,392\$
13	PMEP	1,575,945\$	1,575,945\$
Total Decommissioning Cost (NPV)		37,940,122\$	40,500,377\$

$$NPV = CF_{01} + \sum_{t=1}^{20} \frac{CF_{t1}}{(1 + 0.1)^t} = -40,500,377\$$$

On the other side, by selecting the other strategy the company saves near 9 million US dollars in comparison to the first strategy; as listed in table 2, the costs of the yearly operations and maintenances (OPEX), yearly revenue earned from electricity exporting from the platform (ElecR) and saved fuel required for the generation of the same amount of power (FuelR), are included and converted to the current time considering constant prices for electricity and fuel during the whole length of the project, Eq. (2). Furthermore, the company earns the technology and experiences with OWT installation and operations and would be a technical leader in the region for coming years as well as improving the total rate of greenhouse gas emission production in the region.

**Table 2. Strategy Number 2**

OWT as an Alternative to Decommissioning		
Categories	Platform Name	
	Ilam	
1	Platform Removal (Topside)	3,544, 487\$
2	Platform Preparation (Without Marine Growth Removal)	586,890\$
3	Well P&A	5,711, 447\$
4	Conductor Removal	2,343,637\$
5	Pipeline Decommissioning	2,614,013\$
6	Power Cable Removal	0\$
7	Site Clearance	0\$
8	Weather Contingency	1, 489,142\$
9	Misc. Work Provision	2, 233,714\$
10	Permitting & Regulatory Compliance	2,076,918\$
11	Mobilization & Demobilization of DBs (Topside)	2,624,137\$
12	Materials Disposal (Topside)	1,162,915\$
13	PMEP	1, 271,630\$
14	Alternative Decommissioning Cost (NPV)	25,658,930\$
15	Total Capital Expenditures (CAPEX) of a 3.39 MW OWT <sup>1</sup>	14,773,510.2\$
16	Total Annual OPEX <sup>2</sup>	467,820\$/year
17	Net Annual Produced Electricity Revenue for a 3.39 MW OWT <sup>3</sup>	1,510,952.832\$/year
18	Net Annual Saved Fuel Revenue for the Same Capacity	33,026.2\$/year
Total Cost (For 20 years) (NPV)		31, 270, 491\$
<sup>1</sup> Without Considering the Costs of Substructure & Foundation, Site Access, and Electrical Infrastructure		
<sup>2</sup> Operational & Maintenance Expenditures of Jacket & 3.39MW OWT		
<sup>3</sup> According to Iran’s Electricity Guaranteed Purchasing Base Rate [16] (With Considering Turbine Net Capacity Factor of 42.4%)		

$$NPV = CF_{02} + \sum_{t=1}^{20} \frac{CF_{t2}}{(1 + 0.1)^t}$$

$$CF_{02} = -25,658,930\$ - 14,773,510.2\$ = -40,432,440.2\$$$

$$CF_{t2} = OPEX_t + ElecR_t + FuelR_t \quad (2)$$

$$OPEX_t = \frac{-138\$}{kW.year} \times \frac{1000kW}{MW} \times 3.39MW = \frac{-467,820\$}{year}$$

$$ElecR_t = \frac{120\$}{MWh} \times 3.39MW \times \frac{8760hr}{year} \times 0.424 = \frac{1,510,952.832\$}{year}$$

$$FuelR_t = \frac{932,415.5kg}{year} \times \frac{0.023\$}{m^3} \times \frac{1.54m^3}{kg} = \frac{33,026.2\$}{year}$$

$$NPV = -40,432,440.2\$$$

$$+ \sum_{t=1}^{20} \frac{-467,820}{(1 + 0.1)^t}$$

$$+ \sum_{t=1}^{20} \frac{1,510,952.832\$}{(1 + 0.1)^t}$$

$$+ \sum_{t=1}^{20} \frac{33,026.2}{(1 + 0.1)^t} = -31,270,491\$$$

By using the 3.39 MW NREL offshore wind turbine as an alternative to jacket decommissioning of the mentioned platform, the total cost of the process is decreased by 22.78%, retrieving more than 9 million US dollars for the company. Figure 7 shows the cost comparison between both strategies. The cash flow percentages against different cost categories of decommissioning work breakdown and the cost of yearly operations, yearly revenue earned from electricity exporting and fuel saving are presented in details.

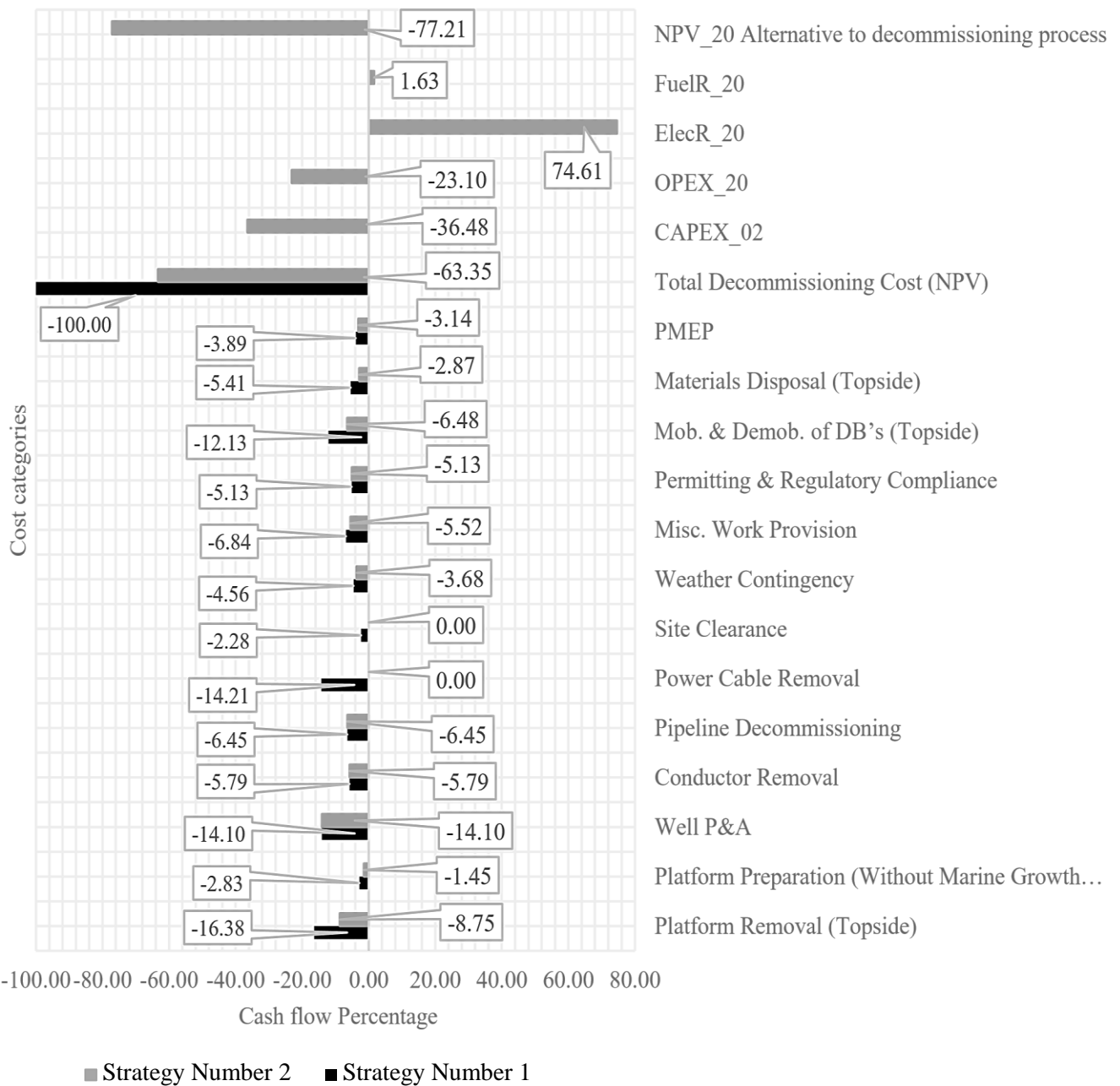


Figure 7. Strategy No.2 Costs Compared to Strategy No.1 (in percentage)

#### 4. Conclusions

A knowledge-based decommissioning alternative strategy selection system for fixed offshore jacket platforms has been introduced in this study. The economic costs and benefits of two strategies were evaluated; the first strategy involves the full decommissioning of a jacket platform (Strategy Number 1), and the second strategy proposes the installation of an offshore wind turbine (OWT) on the existing jacket structure in the Persian Gulf (Strategy Number 2) as an alternative to decommissioning. The results show that the second strategy reduced the total decommissioning costs by 22.79%, saving the company over 9 million dollars. In addition to the economic advantages, adopting the OWT installation strategy equips the company with advanced technology and operational experience, positioning it as a technical leader in the region for the foreseeable future. Furthermore, this strategy contributes to reducing the overall greenhouse gas emissions in the region, enhancing environmental sustainability.

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