

# **ECONOMIC IMPACT ANALYSIS OF BLUE OCEAN ENERGY LAKE WORTH, FL**

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## **Executive Summary**

Through this analysis we examine the economic impacts of infrastructure investments to develop ocean current electrical connectivity; of start-up capital investments for research and technology development; and permanent economic impacts of energy production, research and technology jobs, which accompany the creation of a new business sector in renewable energy resources. The renewable energy industry being examined is that which derives and generates electrical power from the kinetic energy of strong ocean currents. In particular the kinetic energy associated with the Gulf Stream ocean current found off the southeast coast of Florida.

In order to access and develop this resource prototype turbines and generators must be developed which are suitable for deployment in offshore marine environment. In addition, electric transmission cable must be laid from these offshore generators to the land-side electric power grid. Once cable connectivity is established and equipment testing is complete, deployment of larger commercial-scale power generation facilities may be installed throughout the offshore cable service area. This analysis details the economic impacts associated with the cable infrastructure investment and the four phases of industry development; from Phase I Research & Development; Phase II Prototype Testing; Phase III Commercial Start-up; and Phase IV Commercial Build-out.

Table E1 describes the economic impact of the Cable Infrastructure investment. This investment will add \$40 million in one time impacts to the local economy.

**Table E-1. Economic Impact Cable Infrastructure Investment**

<b>Total Impact</b>	<b>Employment</b>	<b>Wages</b>	<b>Output</b>
<b>Direct Effect</b>	184	\$9,569,045	\$28,477,999
<b>Indirect Effect</b>	39	\$2,171,729	\$5,557,524
<b>Induced Effect</b>	48	\$2,193,966	\$6,359,376
<b>Total Effect</b>	271	\$13,934,741	\$40,394,899

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Over the research, testing and deployment phases private capital investment in plant and equipment will be undertaken. Capital investment will add a total of \$226 million to the local economy during the period of industry development.

Employment figures will be smaller in the early phases and larger in the later phases and during the period in which capital investment takes place, 371 persons will be employed each year, on average. Table E-2 illustrates the total capital impacts and average employment during the years of capital spending.

**Table E-2. Economic Impact of Private Capital Investment**

Cumulative	Employment	Wages	Output
<b>Direct Effect</b>	247	\$53,533,979	\$158,440,443
<b>Indirect Effect</b>	56	\$12,485,070	\$31,907,935
<b><u>Induced Effect</u></b>	<u>68</u>	<u>\$12,339,788</u>	<u>\$35,767,671</u>
<b>Total Effect</b>	371	\$78,358,837	\$226,116,049

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

The entire industry development may take a period of time from four to eight years. By the end of Phase IV, the Commercial Build-out Phase, it is estimated 545 persons will be permanently employed, with annual wages of \$42 million and total economic impact of \$92 million per year.

**Table E-3. Economic Impact of Ocean Current Energy Industry  
At the Commercial Build-out Phase IV**

Cumulative	Employment	Wages	Output
<b>Direct Effect</b>	315	\$30,426,463	\$59,993,983
<b>Indirect Effect</b>	82	\$5,155,159	\$12,776,121
<b><u>Induced Effect</u></b>	<u>148</u>	<u>\$6,708,880</u>	<u>\$19,443,512</u>
<b>Total Effect</b>	545	\$42,290,502	\$92,213,616

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Additional impacts and benefits will accrue over time. These include greater stability and availability of electric energy, potential cost savings from lower cost power generation, and first mover advantage for ocean current industry development, which may result in substantially larger ongoing local economic impacts. These additional impacts are possible because the ongoing operations analysis presented in this report represents approximately half of the presently existing global ocean current power industry. As the industry grows and the global presence of Lake Worth in industry development is known, a greater share capture of the global industry is possible at the local level.

## 1.0 Introduction and Background

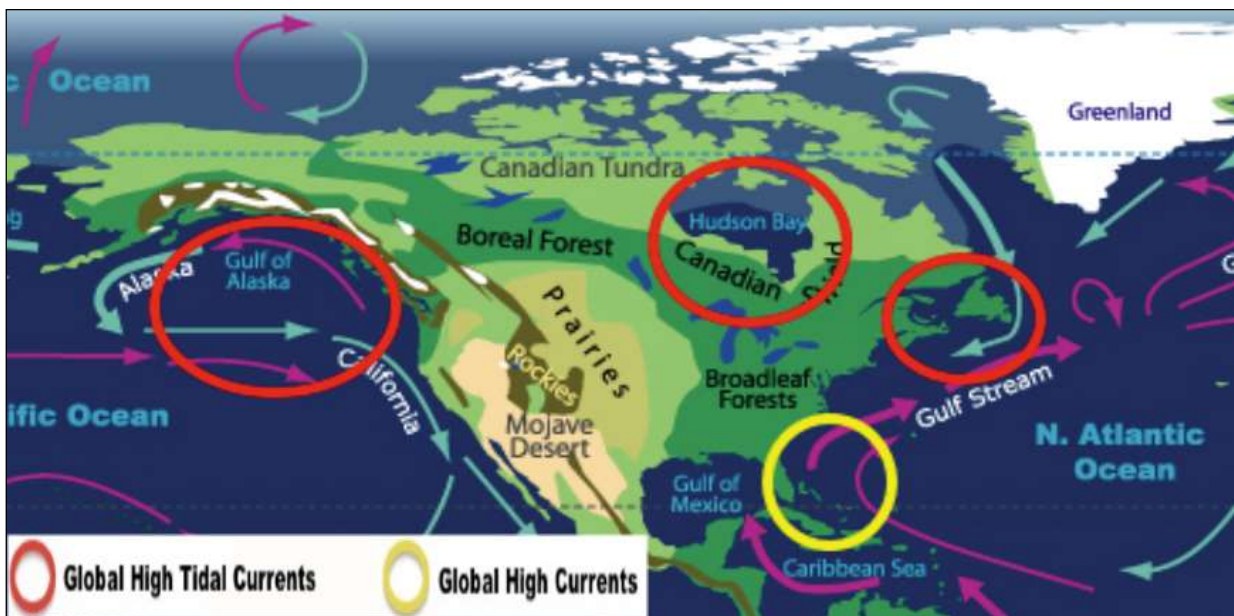
The City of Lake Worth has entered into a strategic partnership with the Southeast National Marine Renewable Energy Center (SNMREC), which is centered at Florida Atlantic University in Boca Raton, Florida. SNMREC is a US Department of Energy center which seeks to advance the science and technology of recovering energy from the oceans' renewable resources. The Center has special emphasis on those resources available to the southeastern US: particularly ocean currents and offshore thermal resources.

The partnership with the City of Lake Worth is driven by favorable natural resource availability and municipal infrastructure. From a natural resource standpoint, there is close proximity to predictable, high intensity, offshore ocean currents found in the Gulf Stream ocean current. Regarding municipal infrastructure: the City owns and operates the Lake Worth Utility and power generating station. The power station is located near the coast and has direct ocean access. Ocean access to the power station provides a mechanism to efficiently develop cable connectivity between off-shore ocean current technology test points and the electrical power grid. Power grid connectivity is the next step required for proof of concept testing and for long term commercial deployment and utilization of this renewable energy resource.

The City of Lake Worth is uniquely and strategically positioned to take advantage of the industrial development and jobs creation associated with this emerging sector. The City's advantage is due to a unique combination of its proximity to the Gulf Stream, existing municipal infrastructure and municipal ownership of the utility. Figure 1 illustrates generalized ocean energy resource locations in North America and high current location off the Florida coast.

This report highlights the economic impacts of ocean current energy resource development and utilization. Through this analysis we examine the economic effects of capital expenditures to develop ocean current electrical connectivity, of start-up investments for turbine equipment manufacturer research and development, and ongoing economic effects of energy. This accompanies the creation of a new business sector for renewable energy capture from offshore currents.

**Figure 1. Ocean Energy Resource Locations**



## 1.1 Economic Impact Analysis Overview

The analysis determines the economic impacts of the initial investment for cable and associated infrastructure to establish electrical connectivity between off-shore energy generation locations and the land side electrical power grid. The analysis also delineates the economic impacts of capital investment in equipment, research and technology development, undertaken by private companies developing both prototype and commercial ocean current energy recovery systems. Finally, the analysis describes the ongoing economic impacts in terms of office and industrial operations, jobs and economic output associated with commercial deployment of ocean energy turbines, and the establishment of a new industry and employment sector devoted to these activities. This study relies on data gathered from the following sources:

- Primary Data for infrastructure, capital investment and operational activity as provided by industry survey.
- Fishkind & Associates, Inc.
- Economic Impact Modeling using IMPLAN

A systematic analysis of countywide economic impacts is essential for effective planning in the public and private sectors. Fishkind & Associates,

Inc. used the IMPLAN analysis program for determining economic multipliers which give rise to indirect and induced multiplier effects for this analysis. The geography considered to measure these impacts is Palm Beach County. The county represents the catchment area from which employees are drawn. The economic impacts of construction/investment activity and permanent employment are illustrated in terms of impacts on Palm Beach County.

The economic impact of the SNMREC/Lake Worth partnership includes the jobs, spending and multiplier effects of three components:

- Temporary construction impacts from infrastructure investment associated with cable connectivity
- Temporary impacts from capital investments made by private companies in proto-type, deployment and build-out phases
- Permanent economic impacts stemming from job formations and deployment of a commercially viable renewable energy resource industry in ocean current energy recovery.

## **2.0 Economic Impact Analysis of Infrastructure Investment**

Economic impacts are concerned with the amount of spending that takes place in the local economy (called the direct effect) and the impact of that spending when it is re-spent (the multiplier effect), by local businesses and workers throughout the Palm Beach County economy.

Infrastructure investment will consist of upgraded electrical cable from the Lake Worth power plant through piping conduit under the intracoastal waterway and the barrier beach island. The cable will extend some 12 to 15 miles into the Atlantic Ocean to bring electrical connectivity from off-shore test locations and ultimately from offshore current derived commercial power generating stations to the land-side electrical grid. It is estimated the cost of cable installation will reach \$40 million. Significant portions of these costs are spent outside the local area; for materials and services which may not be produced locally. As a result, the initial direct effect of project spending is estimated to reach only 70% of total project cost. The total infrastructure investment cost includes land side grid connections, marine installations, specialty cable and the cable installation across 12 to 15 miles of ocean floor. In addition, the new cable will bring upgraded electrical service to the barrier island. These costs are estimated to be \$40 million. It is estimated \$28.5 million will be spent directly in the local economy. Development and infrastructure construction will take place over a 12 to 18-month period.

Direct infrastructure construction spending gives rise to the multiplier effect when it is re-spent in the community. Table 1 provides the economic impact summary of the direct effect of construction activity and the resulting multiplier effect.

**Table 1. Economic Impact of Undersea Cable Investment**

Total Impact	Employment	Wages	Output
<b>Direct Effect</b>	184	\$9,569,045	\$28,477,999
<b>Indirect Effect</b>	39	\$2,171,729	\$5,557,524
<b>Induced Effect</b>	48	\$2,193,966	\$6,359,376
<b>Total Effect</b>	271	\$13,934,741	\$40,394,899

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Local impacts generated by the construction program will result in employment of 271 persons during the construction period. The cumulative economic impact of construction will reach **\$40 million**. Nearly \$14 million will be paid in construction and related employment wages.

Spending for cable construction and installation activity is reflected in local commercial and specialty construction firms, engineering services firms, plus restaurants and wholesale and retail establishments who will benefit from worker spending. A description of key industries benefitting from construction are found in Table 2.

**Table 2. Undersea Cable Investment – Economic Impacts to Key Industries**

Description	Employment	Wages	Output
Construction nonresidential structures	175	\$8,671,047	\$25,999,999
Wholesale trade	11	\$1,152,819	\$3,181,172
Real estate	6	\$137,191	\$1,011,814
Architectural, engineering, related svcs.	4	\$340,646	\$651,049
Full-service restaurants	3	\$93,625	\$177,521
Limited-service restaurants	3	\$59,719	\$234,150
Services to buildings	3	\$55,747	\$98,333
Employment services	2	\$108,955	\$196,852
Retail - Misc. store retailers	2	\$60,682	\$99,924
Hospitals	2	\$170,107	\$341,321
Subtotal of Key Industries	211	\$10,850,539	\$31,992,134
<b>Impact of Cable Investment</b>	<b>271</b>	<b>\$13,934,741</b>	<b>\$40,394,899</b>

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.



The cable installation is the catalyst which enables prototype testing of ocean energy capture equipment and later in the industrial life-cycle, development of offshore power generating stations. Initially, offshore power generating stations will be small scale. As energy capture capability is more fully developed it will evolve into full scale commercial deployment of offshore power generation through the capture of the kinetic ocean current energy of the Gulf Stream. The cable installation completed by this infrastructure investment project will accommodate both proto-type testing station output as well as large scale commercial power generation output. The cable will enable and facilitate the long-term development of the ocean current power generation industry. The cable project investment is needed at the outset of Phase II of industry development to facilitate growth of the industry.

### **3.0 Economic Impacts of Ocean Energy Sector Development**

The ocean current power generation industry is in its nascent stages. Renewable energy resources, technology, and commercial applications are being developed across the globe, at a very rapid rate. These resources include solar power, wind power, tidal current power and ocean current power. Large scale electric power generation derived from water action has a long history, particularly with hydro-electric power generation developed from reservoirs and river dams. Tidal current and ocean current power is the next step in the evolution of renewable hydro-based electric power generation. There are significant existing projects and producers across the globe where tidal power is already being harnessed.

The ocean current industry has been slower to develop. This is due to the technological challenges of working in offshore marine environments, gaining access to currents in deeper waters, the infrastructure and electrical grid connectivity requirements and the design requirements of generation equipment. The southeast coast of Florida offers a unique set of conditions which makes development of the ocean current energy industry possible. These conditions include: comparatively near-shore and very strong ocean current of the Gulf Stream, which runs parallel to the Florida's southeast Atlantic coast. A second condition is the City of Lake Worth which owns the municipal utility and an electric power generating station, which is close by to the shore. Further the Lake Worth Power Station will serve as the connection point from off shore power generation to land side electrical grid. The electrical grid connection allows for on-going, real time, proto-type

testing of ocean current power generation. As these power generation technologies are proven and enhanced, the ocean current power generation industry will grow and expand, become commercially viable and have connectivity to the land-side electrical grid. The industry can be expected to evolve first with new turbine concept research and development, technological research, product development in terms of turbine, turbine design and generators, as well as marine platforms and power station modifications. Cabling, to allow for electrical grid connectivity, ongoing power generation and testing is a necessary component which will allow the commercial scale ocean current power generation industry to develop, evolve and expand.

Because of the unique conditions at Lake Worth conducive to industry development, and because of the infrastructure investment to be made in the cable connection project, and because of the Southeast National Marine Renewable Energy Center's efforts to grow the sector at FAU, the ocean current energy industry is developing and evolving in and around the City of Lake Worth. This Economic Impact Analysis describes the phases of industry development and presents the anticipated effects in terms of jobs, investment and multiplier effects of the ocean current power generation industry in and around the Lake Worth economy.

The economic impact analysis is based on what is known about the industry to date. It is based on direct industry survey responses detailing employment and investment. Responses were provided by five private firms, who are currently in testing and development phases of ocean current power generation and equipment. Globally, there are 10 prominently active firms at present. Thus, if all ten firms undertook local activity, the industry potential could be far greater than what is described in this analysis. These data are real world based and represent a reasonable expectation of what the economic benefits of this sector could look like under a likely scenario of the industry's development in Lake Worth, and a reasonable capture of global activity based on industry activity in and around Lake Worth today.

The industry outlook has been segmented into four phases; Phases I-IV. Each Phase has a specific set of goals and milestone accomplishments as well as associated employment and investment levels. For the purposes of this analysis, each Phase is expected to run approximately from one to two years in duration. In practice, Phases may last longer, or shorter, or overlap with other Phases, but this analysis is representative of industry expectations and economic impacts, in our view. This economic impact

analysis details the employment and investment, known as direct impacts, plus the economic multiplier effects, known as indirect and induced effects, of each Phase of ocean current industry development, as communicated by the current industry leaders and herein organized.

### **3.1 Phase I Research & Development Investment & Ongoing Operations**

Phase I is the research and development phase. At this phase the industry is small and in very early development stages. It is characterized by environmental research, technological turbine research and ocean current research. Some off-shore resource measurement and environmental monitoring also accompanies this work. Each phase includes two components of spending. The first component consists of one-time capital investment in plant and equipment. The second component reflects ongoing employment and spending from operations.

Phase I industry capital investment is estimated to reach one-time spending of \$730,000. Of this amount \$548,000 is estimated to be spent locally in the Lake Worth economy and immediately surrounding area. This capital investment will generate combined direct and multiplier effect employment of five (5) persons and bring a total economic impact, including multiplier effects of \$807,760. Table 3 details the employment and economic impact of the direct and multiplier effects.

**Table 3. Economic Impact of Phase I Capital Investment**

<b>Phase I Capital</b>	<b>Employment</b>	<b>Wages</b>	<b>Output</b>
<b>Direct Effect</b>	3	\$190,683	\$548,026
<b>Indirect Effect</b>	1	\$50,694	\$128,804
<b>Induced Effect</b>	<u>1</u>	<u>\$45,172</u>	<u>\$130,930</u>
<b>Total Effect</b>	<b>5</b>	<b>\$286,549</b>	<b>\$807,760</b>

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

With the one-time capital investment in place, Phase I operations will get underway. Phase I activities will include the testing, research and development and analysis work. Direct Phase I industry employment is anticipated to reach 19 persons. Supplementing this employment will be specialty subcontractors and community support personnel characterizing the indirect and induced employment. Based on the level of operational spending, total Phase I employment will reach 37 employees. Spending in the local economy flowing from business spending and employee wages

will have beneficial ongoing, permanent annual economic impacts. Table 4 depicts the Phase I economic impacts of permanent employment produced by Phase I activity of the ocean current energy industry.

**Table 4. Economic Impact of Phase I Ongoing Operations**

Phase I Operations	Employment	Wages	Output
<b>Direct Effect</b>	19	\$1,550,028	\$2,756,148
<b>Indirect Effect</b>	9	\$495,957	\$1,192,618
<b>Induced Effect</b>	8	\$383,257	\$1,110,858
<b>Total Effect</b>	37	\$2,429,243	\$5,059,624

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Permanent Phase I economic impacts are projected to reach **\$5 million per year** during this initial phase. With employment of 37 persons including direct and multiplier related employment, \$2.4 million will be paid in annual wages.

### **3.2 Phase II Additional Capital Investment and Prototype Operation**

Phase II of industrial activity is the prototype operation phase. This includes off shore testing of newly designed equipment, additional research and development and technology refinement as well as further capital investment in plant and equipment. Many of the aspects of Phase I will be ongoing and expanded in this phase. Expansion and ongoing resource and product development are included in the employment and spending described in the Phase II impacts.

Phase II industry capital investment is estimated to reach one-time spending of \$39.7 million. Of this amount \$29.7 million is estimated to be spent locally in the Lake Worth and immediately surrounding area's economy. A substantial portion of the capital spending will be for marine supplies. Because these supplies are not manufactured locally the total impact of capital investment is reduced due to non-local materials and services spending leaking out of the local market. This capital investment will generate combined direct and multiplier effect employment of 164 persons and bring a total economic impact, including multiplier effects of \$25 million. Table 5 details the employment and economic impact of the direct and multiplier effects. Once the capital investment and construction activity is complete, the economic impacts and jobs associated are also ended. Generally, after completion, one-time economic effects of capital investment are largely replaced by ongoing impacts of operational activity.

**Table 5. Economic Impact of Phase II Capital Investment**

Phase I Capital	Employment	Wages	Output
<b>Direct Effect</b>	109	\$5,913,447	\$17,503,388
<b>Indirect Effect</b>	25	\$1,378,430	\$3,522,921
<b>Induced Effect</b>	<u>30</u>	<u>\$1,362,937</u>	<u>\$3,950,561</u>
<b>Total Effect</b>	164	\$8,654,814	\$24,976,870

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

During Phase II operations, with capital expenditures in place, staff will undertake further testing, development and analysis work. Test generation equipment will be deployed. Direct Phase II industry operational employment is anticipated to reach 93 persons. Supplementing this employment will be specialty subcontractors and community support personnel characterizing the indirect and induced employment. Based on the level of operational spending, total Phase II employment will reach 172 permanent employees. Spending in the local economy flowing from business spending and employee wages will have beneficial ongoing, permanent annual economic impacts. Table 6 depicts the Phase II economic impacts of permanent employment produced by the ocean current energy industry.

**Table 6. Economic Impact of Phase II Ongoing Operations**

Phase I Operations	Employment	Wages	Output
<b>Direct Effect</b>	93	\$7,999,415	\$15,871,123
<b>Indirect Effect</b>	37	\$2,153,189	\$5,395,959
<b>Induced Effect</b>	<u>42</u>	<u>\$1,915,192</u>	<u>\$5,550,522</u>
<b>Total Effect</b>	172	\$12,067,796	\$26,817,605

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Permanent Phase II economic impacts are projected to reach **\$26.8 million per year** during this phase. With projected employment of 172 persons, \$12 million will be paid in annual wages.

### **3.3 Phase III Additional Capital Investment and Commercial Startup**

Phase III marks the beginning of commercial startup operations. This includes most of the aspects of Phases I and II as well as initial deployment of small scale commercial generating facilities. Expansion and ongoing resource and product development are included in the employment and spending described in the Phase III impacts.

Phase III industry capital investment is estimated to reach one-time spending of \$101 million. Of this amount \$76 million is estimated to be spent locally in the Lake Worth economy and immediately surrounding local economy. A substantial portion of the capital spending will be for marine supplies. Because these supplies are not manufactured locally the total impact of capital investment is reduced, due to this spending leaking out of the local supplier market. To the degree manufacturers and suppliers co-locate in the Lake Worth area, the impacts of one-time capital investments will be larger than illustrated in this report. Based on a conservative view of supply chain co-location, Phase III capital investment will generate combined direct and multiplier effect employment of 419 persons and bring a total economic impact, including multiplier effects of \$64 million. Table 7 details the employment and economic impact of the direct and multiplier effects.

**Table 7. Economic Impact of Phase III Capital Investment**

Phase III Capital	Employment	Wages	Output
<b>Direct Effect</b>	279	\$ 15,099,434	\$ 44,693,267
<b>Indirect Effect</b>	63	\$ 3,519,693	\$ 8,995,449
<b>Induced Effect</b>	77	\$ 3,480,133	\$ 10,087,390
<b>Total Effect</b>	419	\$ 22,099,260	\$ 63,776,106

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

During Phase III operations, with capital expenditures in place, staff will undertake initial deployment of small scale commercial generating facilities. Direct Phase III industry operational employment is anticipated to reach 194 persons. Supplementing this employment will be specialty subcontractors and community support personnel characterizing the indirect and induced employment multiplier effect. Based on the level of operational spending, total Phase III employment will reach 345 employees. Spending in the local economy flowing from business spending and employee wages will have beneficial ongoing, permanent annual economic impacts. Table 8 depicts the Phase III economic impacts of permanent employment produced by the ocean current energy industry.

**Table 8. Economic Impact of Phase II Ongoing Operations**

Phase I Operations	Employment	Wages	Output
<b>Direct Effect</b>	194	\$19,323,460	\$43,254,168
<b>Indirect Effect</b>	56	\$3,531,194	\$8,742,258
<b>Induced Effect</b>	95	\$4,307,145	\$12,482,956
<b>Total Effect</b>	345	\$27,161,799	\$64,479,382

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Permanent Phase III economic impacts of operations associated with small scale commercial deployment are projected to reach **\$64.5 million per year** during this phase. With projected employment of 345 persons, \$27 million will be paid in annual wages. Initial industry projections indicate total land requirements to support Direct activity are expected to reach 15 to 20 acres with 50,000 square feet of building space.

### **3.4 Phase IV Additional Capital Investment and Commercial Deployment**

Phase IV reflects the industry growth reaching the level of commercial deployment operations. As with each subsequent Phase, this Phase of operations replaces the earlier phases and represents the growth and expansion of the industry.

Phase IV industry capital investment is estimated to reach one-time spending of \$216 million. Of this amount \$95.7 million is estimated to be spent locally in the Lake Worth economy and immediately surrounding local economy. A substantial portion of the capital spending will be for marine supplies and for wholesale spending which has limited pass through economic impact. To the degree manufacturers and suppliers co-locate in the Lake Worth area, the impacts of one-time capital investments will be larger than illustrated in this report. Based on a conservative view of supply chain co-location, Phase IV capital investment will generate combined direct and multiplier effect employment of nearly 900 persons and bring the total economic impact of Phase IV capital investments, including multiplier effects, to \$136 million. Table 9 details the employment and economic impact of the capital investment direct and multiplier effects for Phase IV activity.

**Table 9. Economic Impact of Phase IV Capital Investment**

<b>Phase III Capital</b>	<b>Employment</b>	<b>Wages</b>	<b>Output</b>
<b>Direct Effect</b>	598	\$32,330,415	\$95,695,762
<b>Indirect Effect</b>	135	\$7,536,252	\$19,260,762
<b>Induced Effect</b>	164	\$7,451,547	\$21,598,789
<b>Total Effect</b>	897	\$47,318,214	\$136,555,313

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

During Phase IV operations, with capital expenditures in place, staff will undertake large scale commercial deployment of ocean current electric generating facilities. Direct Phase IV industry operational employment is anticipated to reach 315 persons. Supplementing this employment will be specialty subcontractors and community support personnel characterizing the indirect and induced employment multiplier effect. Based on the level of operational spending, total Phase III employment will reach 545 employees. Spending in the local economy flowing from business spending and employee wages will have beneficial ongoing, permanent annual economic impacts. Table 10 depicts the Phase IV economic impacts of permanent employment produced by commercial deployment of facilities of the ocean current energy industry.

**Table 10. Economic Impact of Phase IV Ongoing Operations**

Phase I Operations	Employment	Wages	Output
<b>Direct Effect</b>	315	\$30,426,463	\$59,993,983
<b>Indirect Effect</b>	82	\$5,155,159	\$12,776,121
<b>Induced Effect</b>	<u>148</u>	<u>\$6,708,880</u>	<u>\$19,443,512</u>
<b>Total Effect</b>	545	\$42,290,502	\$92,213,616

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Permanent Phase IV economic impacts of operations associated with large scale commercial deployment are projected to reach **\$92.2 million per year** during this phase. With projected employment of 545 persons, \$42 million will be paid in annual wages. Industry projections indicate total land requirements to support Direct activity are expected to be maintained at 15 to 20 acres with 50,000 square feet of building space. Co-located supply chain firms will require additional land and building space.

Table 10 impacts represent the industry outlook for a young industry nearing maturity. The average annual wage within the industry is projected to reach \$96,500 per year. Wages generated through multiplier effect jobs are projected to reach \$51,500. Average direct industry wages will be more than 85% higher than the average annual wage in Palm Beach County and almost 150% higher than the average wage in the City of Lake Worth, which currently stands at \$39,114. Wages paid in jobs created by the spinoff effects are expected to be equal to the average wage countywide.



### 3.5 Economic Impact of Ocean Current Electric Generation Industry on Key Industries

The impacts of the Ocean Current Electric Generation Industry can be described and illustrated among the different industries and areas of business affected by the spending and employment activity in the regional economy. Table 11 illustrates the effects of business spending and employment among key benefitted industries as of full operations. The distribution of business spending and employment effects across industries include; boat repair, boat building, wholesale services, retail, restaurants, and hotels.

**Table 11. Ocean Current Electric Generation Industry  
Economic Impacts to Key Industries at Phase IV Operations**

Description	Employment	Wages	Output
Motor and generator mfg	140	\$12,398,810	\$25,000,092
Power, distribution, specialty transfrmr mfg	110	\$11,577,876	\$24,998,343
Scientific research and development svcs	66	\$6,523,693	\$10,212,809
Real estate	18	\$440,256	\$3,246,992
Full-service restaurants	9	\$259,451	\$491,938
Wholesale trade	8	\$849,851	\$2,345,139
Employment services	8	\$358,263	\$647,286
Limited-service restaurants	8	\$180,093	\$706,112
Services to buildings	7	\$154,848	\$273,138
Hospitals	7	\$523,225	\$1,049,853
Subtotal of Key Industries	381	\$33,266,365	\$68,971,704
<b>Annual Economic Impact</b>	<b>545</b>	<b>\$42,290,502</b>	<b>\$92,213,616</b>

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Note: Employment is permanent; Wages and Output are annual

## 4.0 Summary of Economic Impacts and Conclusions

There are significant benefits to the Lake Worth/Palm Beach County economy resulting from development of the Ocean Energy Industry. Economic impacts flow from a) infrastructure investments, b) private capital investments and c) ongoing operations of businesses involved in research, development and deployment of electrical power generation derived from kinetic ocean current energy.

Benefits begin with infrastructure investment in the cable connection from off-shore generating facilities located at deep water ocean currents to the land-side power grid. This investment will employ 271 persons and create local economic impacts of \$40 million. Most importantly it sets the stage and facilitates design, testing and deployment of offshore power generating facilities. Without this investment the development of the ocean current industry cannot take place.

**Table 12. Economic Impact Cable Infrastructure Investment**

Infrastructure	Employment	Wages	Output
<b>Direct Effect</b>	184	\$9,569,045	\$28,477,999
<b>Indirect Effect</b>	39	\$2,171,729	\$5,557,524
<b><u>Induced Effect</u></b>	<u>48</u>	<u>\$2,193,966</u>	<u>\$6,359,376</u>
<b>Total Effect</b>	271	\$13,934,741	\$40,394,899

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Note: Employment is permanent; Wages and Output are annual

With necessary infrastructure in place the ocean current industry will invest in capital plant and equipment for marine facilities, turbines and prototype generator designs. Over the development life cycle of the industry employment from one-time capital investment will reach 371 persons, representing \$226 million in economic impact. Over this investment period \$78 million in wages will be paid.

**Table 13. Economic Impact of Private Capital Investment**

Capital Investment	Employment	Wages	Output
<b>Direct Effect</b>	247	\$53,533,979	\$158,440,443
<b>Indirect Effect</b>	56	\$12,485,070	\$31,907,935
<b><u>Induced Effect</u></b>	<u>68</u>	<u>\$12,339,788</u>	<u>\$35,767,671</u>
<b>Total Effect</b>	371	\$78,358,837	\$226,116,049

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.

Note: Employment is permanent; Wages and Output are annual

Once capital investments are completed and in-place the associated one-time jobs will end. This investment sets the stage for ongoing operations and permanent industry employment. The permanent industry development is estimated to take place over a four to eight year period and is currently underway. Within this short period the total industry employment and related spinoff effects will employ 545 persons, paying average salary 85% higher than the countywide average and add \$92 million annually in total economic output.

**Table 14. Economic Impact of Ocean Current Energy Industry  
At the Commercial Build-out Phase IV**

Ongoing Operations	Employment	Wages	Output
<b>Direct Effect</b>	315	\$30,426,463	\$59,993,983
<b>Indirect Effect</b>	82	\$5,155,159	\$12,776,121
<b><u>Induced Effect</u></b>	148	<u>\$6,708,880</u>	<u>\$19,443,512</u>
<b>Total Effect</b>	545	\$42,290,502	\$92,213,616

Source: Fishkind & Associates, Inc.; Copyright 2018 Minnesota IMPLAN Group, Inc.  
Note: Employment is permanent; Wages and Output are annual

Additional impacts and benefits will accrue over time. These include greater stability and availability of electric energy, potential cost savings from lower cost power generation, first mover advantage for ocean current industry development which may result in substantially larger ongoing local economic impacts. These additional impacts are possible because the ongoing operations analysis presented in this report represents approximately half of the existing global ocean current power industry. As the industry grows and the global presence of Lake Worth in industry development is known, a greater share capture of the global industry is possible at the local level.

## 5.0 Economic Impact Methodology - IMPLAN

The economic impact methodology utilized to determine the multiplier effects is IMPLAN (IMpact Analysis for PLANning).

*IMPLAN's Social Accounting Matrices (SAMs) capture the actual dollar amounts of all business transactions taking place in a regional economy as reported each year by businesses and governmental agencies. SAM accounts are a better measure of economic flow than traditional input-output accounts because they include "non-market" transactions. Examples of these transactions would be taxes and unemployment benefits.*

### Multipliers

*Social Accounting Matrices can be constructed to show the effects of a given change on the economy of interest. These are called Multiplier Models. Multiplier Models study the impacts of a user-specified change in the chosen economy for 440 different industries. Because the Multiplier Models are built directly from the region specific Social Accounting Matrices, they will reflect the region's unique structure and trade situation.*

*Multiplier Models are the framework for building impact analysis questions. Derived mathematically, these models estimate the magnitude and distribution of economic impacts, and measure three types of effects which are displayed in the final report. These are the direct, indirect, and induced changes within the economy. Direct effects are determined by the Event as defined by the user (i.e. a \$10 million dollar order is a \$10 million dollar direct effect). The indirect effects are determined by the amount of the direct effect spent within the study region on supplies, services, labor and taxes. Finally, the induced effect measures the money that is re-spent in the study area as a result of spending from the indirect effect. Each of these steps recognizes an important leakage from the economic study region spent on purchases outside of the defined area. Eventually these leakages will stop the cycle.*