

# Floating good ideas

Having a power plant that can be moored near-shore or on a river has many advantages. With its new SeaFloat concept, Siemens has resurrected the idea of floating power plants but this time with the possibility of putting almost any of its high efficiency land-based gas turbine plants on a barge. Already, the first order has been secured for the Dominican Republic – a project that will also feature battery storage. **Junior Isles**

The idea of floating gas fired power plants is not a new one. But rising global population, many of which are moving to live in megacities, where land is limited and expensive, could see the resurgence of these mobile power plants. Certainly Siemens sees this as one of the key drivers behind the development of a new floating combined cycle power plant concept it calls SeaFloat.

According to Siemens, SeaFloat technology combines state-of-the-art combined cycle power plant technology with the mobility and flexibility required by the current and future energy market.

Explaining why he thinks the market is now right for SeaFloat, Hamed Hossain, Business Owner SeaFloat Power Plants, Siemens Gas and Power, said: “In the mid 90s, floating power plants were becoming popular. At the time, Westinghouse (later bought by Siemens) was building floating power plants with gas turbines operating in open cycle. However, we saw an increase in oil and gas prices, which meant it was not worth building these plants anymore because of their low efficiency.”

“Now it’s different. We are building state-of-the-art combined cycle power plants with really high efficiency,

which means if oil and gas prices increase even more then it’s still worthwhile, economically. And if prices fall, we can use open cycle plants. So we have all the technology that’s available for land-based power plants on a floating structure. This allows flexibility on plant configuration, since installations are less affected by fuel price.”

The real impetus to re-boot the idea of floating power plants, however, came about three or four years ago in response to market demand. Hossain said: “Customers were asking: ‘can you supply your technology on a floating device?’ So we decided to do it again. Two and a half years ago, when we saw that the market was really pushing for it, we set up an entity within Siemens to specifically focus on it.”

Hossain sees SeaFloat as a technology that essentially gives customers more options when it comes to locating power plants, i.e. they can be built on water when land is too expensive or unavailable, and in locations where there is a high country risk.

The technology has numerous applications, such as: powering up remote areas like islands; development of industrial areas on shorelines or major rivers (for example, chemical and desalination plants); the replacement of out-dated plants, allowing the existing plant to continue operating until the new one is in place and ready to be connected to the grid.

SeaFloat power plants, which can provide from 145 MW up to 1.3 GW, can also be used as emergency backup for existing power plants during peak loads or outages and to provide power supply in the event of a humanitarian disaster.

Another area where Siemens anticipates great demand is in the oil and gas sector. “We are in contact with all the oil and gas majors. Our portfolio is to put our power plants on FSRUs (floating storage regasification units),” said Hossain. “Looking at FPSOs (Floating Production Storage and Offloading vessels), traditionally they all use open cycle plants, which have higher emissions relative to power output compared to

combined cycle plants.

Installing a power plant for this application has its challenges, however. Although the SeaFloat power plant is compact and has a high power density, for an oil and gas platform, the weight and footprint has to be reduced even further. For a platform it should also be easy to install and have a high degree of modularisation.

“This is how we came up with the ultra-light floating combined cycle power plant, which is part of the SeaFloat portfolio,” said Hossain. “It’s a major game changer; we have reduced the weight and footprint of the power plant by more than 50 per cent compared to combined cycle power plants already installed on existing platforms.”

Installing a SeaFloat plant would certainly help oil and gas majors improve their green credentials and lower the cost of emitting carbon. In a country or industry where CO<sub>2</sub> prices are high, of the order of €50/t, the savings can be significant.

“Putting a combined cycle plant on an oil and gas platform or FPSO could reduce CO<sub>2</sub> footprint by 80 000-110 000 t/annum. This translates to high single digit millions of euros in savings from CO<sub>2</sub> taxes and certificates each year,” said Hossain.

Siemens currently offers SeaFloat power plants based on three main gas turbine technologies – the SGT-800, SGT-A65 and the SGT-8000H series – but says it is not limited to these machines. “In addition to these, we also have the SGT-750, SGT-A35 (formerly the RB211), which will be for the oil and gas market,” noted Hossain.

With the three initial technologies on offer, Siemens says it can address the majority of the market requirements it has seen so far. The turbines were selected following careful market analysis, an examination of the advantages of each turbine and according to feedback from customers and developers that have contacted Siemens.

Each of the three gas turbine solutions has its own benefits. Hossain explained: “The SGT-800 solution is our frontrunner. Two thirds of the

market is desperately screaming for the SGT-800, not only because it is a technology frontrunner but because of the various configurations that are possible. You can use it for new power generation installations based on LNG, and expansion of industrial applications in remote coastal areas.

“For a peaker, or fast-start plant; i.e. start-up in less than five minutes in cold conditions or less than two minutes under hot conditions, the SGT-A65 is the right solution.”

Because of its size, the SGT-8000H would be best deployed in situations where a large amount of bulk power is needed, and space is limited but the grid is stable. Hossain said: “It’s not possible to take an H-class unit capable of 620 MW or 1.3 GW in a 2-on-1 configuration and feed it into a weak grid in a developing country but in these cases we could offer our transmission grid stability solutions. And the H-class would have advantages. If for example, you want to replace a large coal fired power plant in a region that has a more stable grid, with a more efficient, lower emissions plant, here the H-class is the right fit.”

He noted that customers in countries with labour challenges or those wanting to avoid the time and effort involved in obtaining permits to install land-based plants, are interested in installing SeaFloat plants.

Project risk resulting from brown-field activities such as demolition works, site levelling activities, relocation of existing structure, etc., can be avoided when replacing old plants. As the barges are built at modern shipyards, the project schedule does not depend on availability of qualified labour and infrastructure at the final location. According to Siemens, this can cut construction time by 20 per cent.

Siemens believes it is the simple plug and play, connect and go, possibility that makes SeaFloat plants so attractive.

The concept allows fast and easy installation at shipyards. A SeaFloat plant, with the SGT-800 in particular, has a high degree of modularisation, where delivery of pre-assembled and pre-tested plant modules minimises

**Hossain: Customers were asking, ‘can you supply your technology on a floating device?’**



## Special Technology Supplement

the manpower required at the construction yard and the hook-up time at place of operation.

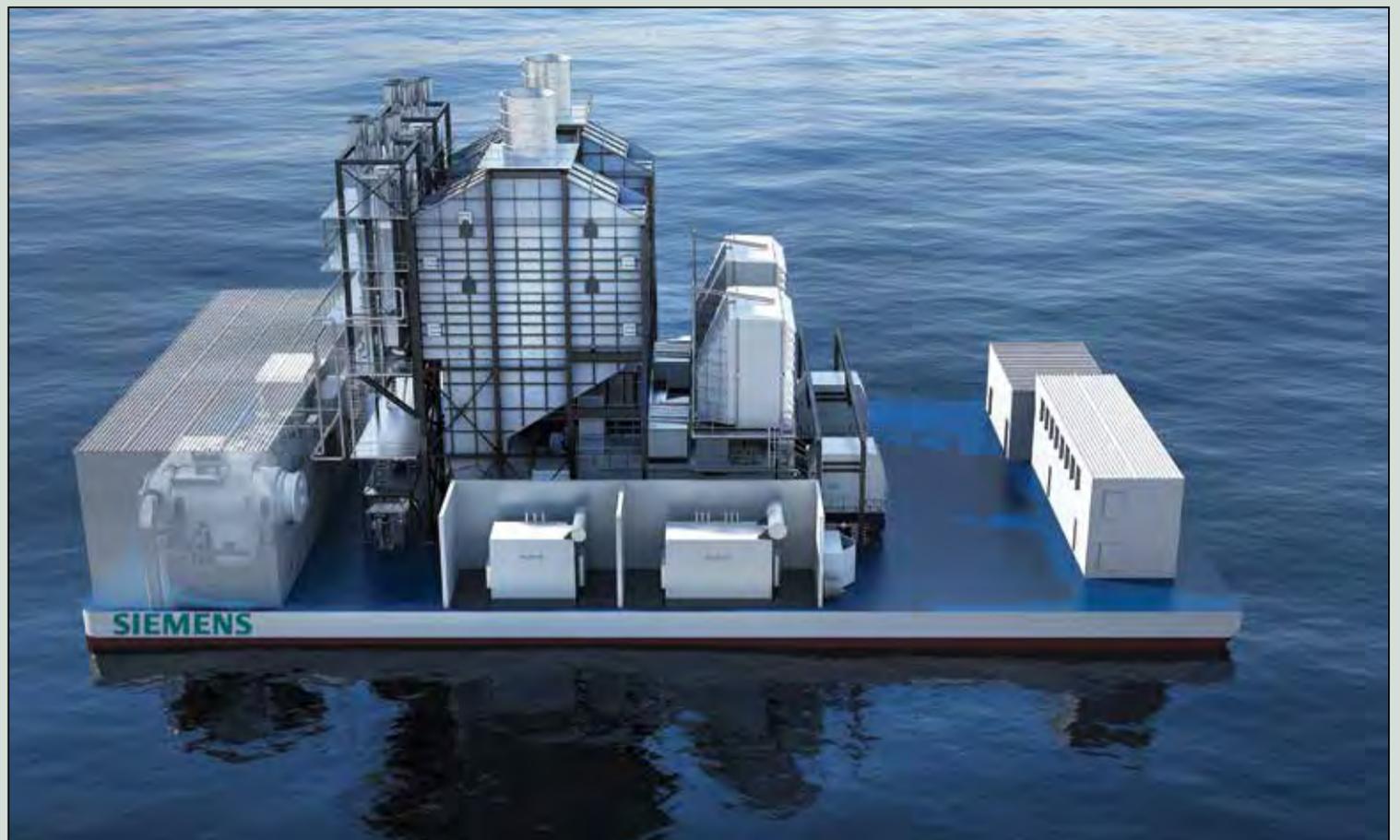
The SGT-800 combined cycle SeaFloat can be provided in SCC-800 2+1, 3+1 or 4+1 configurations to produce 150-450 MW. The SCC-800 2x1 has a length of 55 m and width of 30 m. According to Siemens, these plants are an excellent choice for providing baseload power to public or industrial grids, as well as for oil and gas applications. They offer broad flexibility in fuels, operating conditions, maintenance concepts, package solutions, and ratings.

The plant is designed to withstand near-shore conditions, with equipment intended for on-board installations based on international codes and standards valid for power plants. Certain modifications are implemented to suit the marine environment with respect to, but not limited to air intake filters, materials, surface treatments and protection against water ingress and corrosion. Movements and deflection are addressed by particular technical modifications.

Hossain noted: "SeaFloat is not re-inventing the wheel; it's not rocket science for the Gas and Power business. It is the same technology we use on a land-based plant that has been optimised for a floating device. You could look at it as a power plant with a moving foundation. This means it has roll, pitch and acceleration; and the hull of the floating device has deflections. When you want to build a power plant on top of a foundation that is bending and moving up and down, you have to ensure your equipment can withstand the roll and pitch, acceleration, as well as the deflection."

As an example, he noted that the SGT-800 comes as a single-lift package on a 3-point mount frame, consisting of turbine, mechanical auxiliary systems, gearbox, generator and generator switchgear. It has a weight of about 265 t and comes pre-assembled and system tested with a dedicated electrical and control module.

"This means the solution stands on three legs, designed as a foundation to withstand the deflection of the hull. The gas turbine is almost the same [as



the land-based machine]; it's just the connection point to the foundation needs some smart solutions to really make it happen," noted Hossain. "Deflection must not be transferred to the gas turbine, so it has to be decoupled. For roll and pitch and acceleration, you have to address the lube oil systems. If the barge moves in one direction as a result of roll and pitch, you have to ensure the gas turbine bearings remain lubed."

The single-lift package concept enables 48 h core engine exchange for plants with highest requirements on availability. The easy 'roll-out' capability of the gas turbine core engine enables on-board maintenance and overhaul, with turbine inspections/overhauls, hot gas path inspection

(HGI) and major overhaul (MO) at every 30/60 000 equivalent operating hours (EOH).

The SST-600 steam turbine (ST) is also provided as a pre-assembled and system tested single-lift package on a 3-point mount base frame. It has a weight of about 475 t. The steam turbine single-lift package consists of steam turbine, condenser with evacuation systems, generator and generator switchgear. It has a size of 25 m x 7.0 m x 5.5 m (length, width, height).

The Once Through Steam Generator (OTSG) will be provided as a package with maximum modularisation. This modular approach has been applied in dozens of units worldwide and, says Siemens, results in safer and better quality fabrication

under optimised shop conditions. The arrangement enhances faster and smoother installation at the shipyard. The steel structure for the OTSGs is designed as one combined block, so a rigid structure is formed to withstand marine environment conditions.

The OTSG package has a weight of approximately 665 t. The SCC-800 2-on-1 plant configuration has a size for the OTSG combined structure of 14 m x 23.6 m x 28 m (length x width x height).

The entire power plant can be installed under various commercial models, including straightforward sale and various lease options. "We are open to all options," said Hossain. "At the moment the market is asking more for sale options, where the

**SeaFloat gives owners more options when it comes to locating power plants**



**The SGT-800 gas turbine will be provided as a single-lift package and 3-point mount installation, consisting of turbine, mechanical auxiliary systems, gearbox, generator and generator switchgear**

## Special Technology Supplement

### Types of SeaFloat plants

	Length (m)	Width (m)	Area (m <sup>2</sup> )	Net power output (MW)	Efficiency (%)
2x SSC-A65 (50/60 Hz)	~50	~22	~1.100	147/151	55/55.3
SCC-800 2x1	~55	~30	~1.650	149.4	56.6
SCC-800 3x1	~65	~40	~2.600	224.4	56.6
SCC-800 4x1	~75	~40	~3.000	299.3	56.7
SCC5-8000H 1x1 (50/60 Hz)	~170	~60	~10.200	665/460	61
SCC5-8000H 2x1 (50/60 Hz)	~170	~90	~15.300	1330/930	61

Note: SSC = Siemens simple cycle; SCC = Siemens combined cycle

power plant is sold to the customer. Some are also asking for Siemens to operate the plant; so we can add an O&M contract to the sale. Others ask for a special purpose vehicle to be set up to own and operate the project and ask if Siemens is willing to take a share in the project as a stakeholder if a project is viable. We have done it for land-based plants – where we bring in equity or financing – and can also do it for sea-based applications.”

The economics of SeaFloat projects appear to be sound. According to Siemens, the SeaFloat concept completed in a shipyard will provide the customer with “a quality proven power plant” at a potentially 20 per cent lower CAPEX than a similar land-based plant.

A SeaFloat power plant could operate as a baseload power plant with the aim of selling electricity but with the owners also being paid a premium for having the ability to always stay

connected to the grid, providing frequency control when needed. This is made possible with a battery storage system. Here, Siemens can also deliver its hybrid SIESTART solution, combining a flexible (gas turbine) combined cycle power plant with a battery energy storage system.

The SeaFloat concept is already beginning to bear fruit. At the end of November 2018, Siemens and the marine arm of ST Engineering in Singapore jointly secured the first order for a project for a SCC-800 2x1C SeaFloat power plant from Seaboard Corporation subsidiary Transcontinental Capital Corporation (Bermuda) Ltd., an independent power producer (IPP) with operations in the Dominican Republic.

Under a turnkey plug and play concept, Siemens as consortium leader will provide a 145 MW SeaFloat combined cycle power plant known as Estrella del Mar III, along with its

SIESTART solution. ST Engineering will be responsible for the engineering design, procurement and construction of the floating power barge, the balance-of-plant and the installation of the floating power plant.

ST Engineering will receive the gas turbine as a pre-installed package, the steam turbine as a separate package and the boiler in three modules, where it will be erected and pre-installed at a controlled, highly skilled shipyard. It will then be towed to the final destination and connected to the grid.

For the SIESTART solution, Fluence Energy, a company jointly owned by Siemens and AES, is providing a 5 MW/10 MWh battery energy storage system to be integrated as part of the power plant for frequency regulation control. This will allow the plant to operate at full capacity with highest fuel efficiency.

The Estrella del Mar III plant will replace existing power barges based

on reciprocating engines at the customer’s location in the capital city Santo Domingo. Using combined cycle gas turbine technology will increase efficiency and lower emissions, which is especially important in built-up areas.

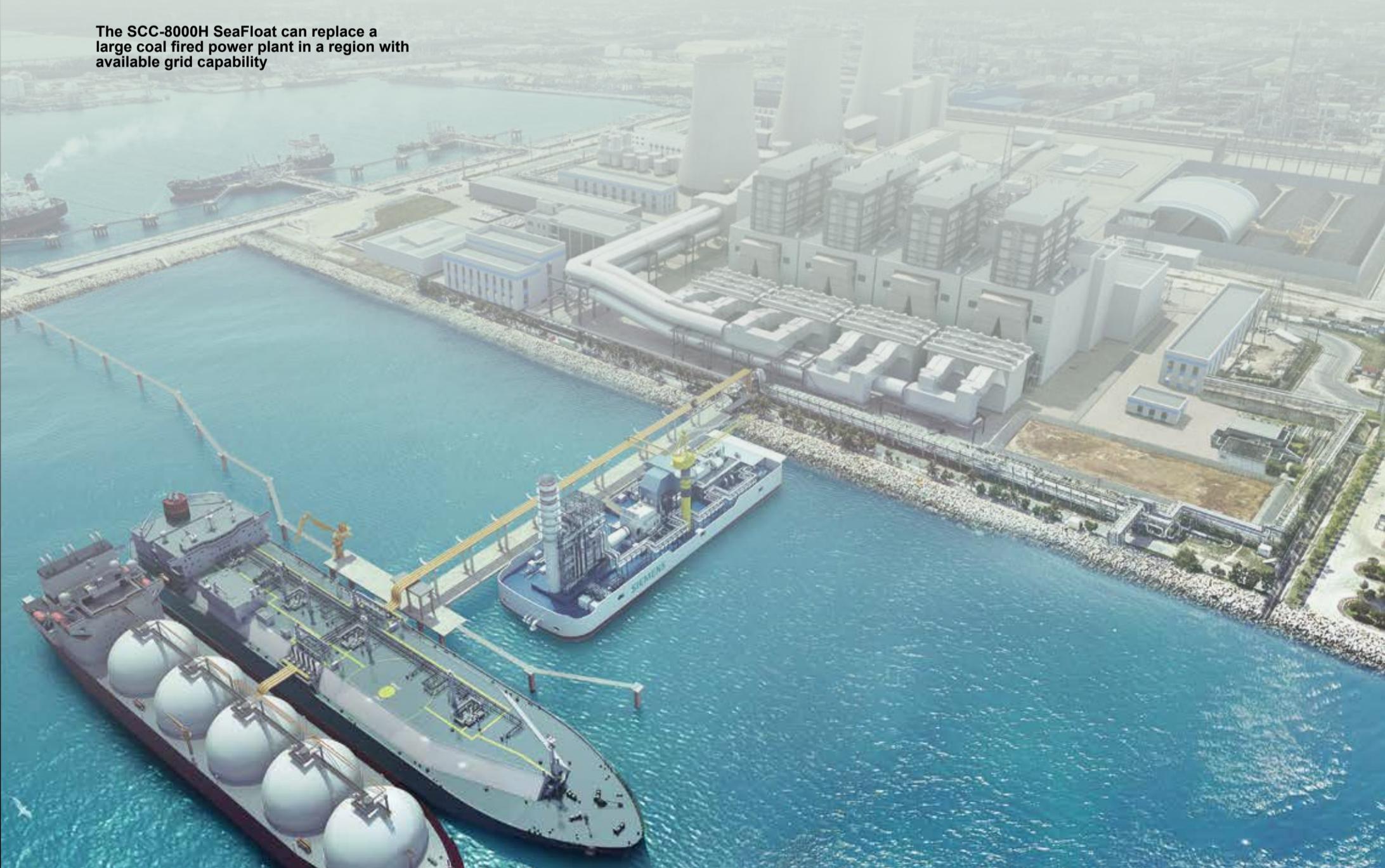
Due to site constraints with limited free land and Seaboard’s experience with previous power barges, the plant owner selected a SCC-800 2x1 SeaFloat concept with two Siemens SGT-800 gas turbines and one SST-600 steam turbine.

This first SeaFloat project is advancing smoothly. Power plant equipment is expected to leave Siemens’ manufacturing facilities shortly so that erection at the shipyard can begin soon after. The plant will be connected to the grid of the Dominican Republic in the spring of 2021.

And with the first order secured, Siemens expects others will follow soon. “We are involved in many activities all around the world. There could be orders from any country – from the US to Asia, where we are currently supporting customers. We are not limited to any specific country; there are a lot of opportunities.”

Siemens will also continue to develop the technology. As Hossain concluded: “Siemens always takes an evolutionary approach as opposed to a revolutionary approach. So we are continuously checking our design, receiving feedback from execution teams – both land-based and those that will be in the Dominican Republic – and feeding it back into our team. This will allow us to continue improving our solution, so that each customer can expect the highest quality SeaFloat application based on the experience of our fleet.

The SCC-8000H SeaFloat can replace a large coal fired power plant in a region with available grid capability





**SIEMENS**

*Ingenuity for life*



Reliable technology –  
dependable partner.

Since 1990, Siemens has completed over 500 turnkey power plants with total output exceeding 155,000 megawatts. With more than 7,000 installed gas turbines in over 100 countries, we are the leading original equipment manufacturer – not only for this technology but for all plant needs throughout the lifetime of the asset. With the right ideas, innovations and know-how we are the dependable partner of our customers.

Reliable energy for today –  
and for generations to come.

[siemens.com/power-generation](https://www.siemens.com/power-generation)