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LANDSCAPE ARCHITECTURE MAGAZINE

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THE BIG BLOW

H+N+S designs a wind-powered future for the North Sea

—

JACK DANGERMOND

A life's work, now at maximum scale

—

THE EXPLORATORIUM

GLS takes a Bay Area favorite outside

—

STIMSON + BARGMANN

The cultivated wild in San Antonio

A tall blond man is walking a Russian wolfhound along a stream. The stream is moving through beach sand into a large lagoon off the Kijkduin promenade in a seaside suburb of The Hague, Netherlands. It's not quite beach season, and it's blustery. Over scudding clouds the sun coming up is bright, but the gray sea is running fast and flecked with white, and the wind blows foam up the beach. Over the man's shoulder are tall, reedy dunes and the tips of towering chimneys, billowing clouds of steam.

These chimneys, up to 575 feet high, rise from the Maasvlakte 2 harbor complex, where the Port of Rotterdam sits across from the Hook of Holland. This point is where some of the most important interactions between the North Sea and its neighbors are happening and will happen over the next three decades.

Maasvlakte 2 is a massive human intervention, another grand bargain between Dutch ingenuity and the sea: In exchange for not swallowing them in cold saltwater, the Netherlands promises the sea a modicum of foresight, hardheaded com-

MICHAEL DUMIAK

POWER PLAY 2050

A DUTCH VISION OF CLEAN ENERGY IN NORTHERN WATER. DOES IT HAVE A CHANCE?

BY MICHAEL DUMIAK

mercial instincts, and very good engineering. With 365 million cubic meters of sand, the Port of Rotterdam pushed its coastline two miles farther into the sea and created a new harbor for giant ships. One of the persons who dreamed up the 2,470-acre outer perimeter, the landscape architect Dirk Sijmons, is now turning his gaze away from land. He believes that the North Sea holds the key to Europe's meeting its ambitions of carbon-free energy and a curb on climate change: specifically, that offshore wind power can provide a lion's share of energy for the countries bordering the North Sea and their 190 million people.

Doing so will require, at some point over the next 35 years, the deployment of 25,000 offshore wind turbines of a size able to produce 10 megawatts (MW) or more each. That means anywhere from four to 12 turbines leaving harbors such as Maasvlakte every day for 10 to 20 years. Even ardent supporters of clean energy rarely put it in such concrete terms, at least to the ministers who would be essential to making this happen and the workforces that would absorb these changes. But Sijmons and his firm H+N+S, along with an unlikely team of government officials, business leaders, designers, and nonprofit groups, did just

ABOVE
Tall ships: The Port of Rotterdam and the Hook of Holland would be the scene for sending big turbine blades out to sea.

that as they explored the possibilities over the past 18 months in what Sijmons calls a vigorous exercise in "research by design."

We'll always have Paris

At the end of December 2015, the heads of state of 195 nations signed an agreement in Paris pledging to curb climate change and a set aim to keep the rise in average global temperatures below 2 degrees centigrade, or 3.6 Fahrenheit. As part of the Paris Agreement, the European Union, which at that point still firmly included the United Kingdom, set its own goals: to cut greenhouse gas emissions by 40 percent of 1990 levels by 2030, and by 2050 to reduce those same emissions by 80 to 95 percent. It set a target of 30 percent renewable energy by 2030 on the way to phasing out carbon emissions entirely by 2050 or shortly thereafter.

At the H+N+S studio in a renovated rail storage yard on Piet Mondrian street in Amersfoort, about an hour or so south of Amsterdam, Sijmons had been thinking about what this ambition would mean. The former professor of landscape architecture at Delft University of Technology's urbanism department has a similarly broad-minded colleague in the nearby university town of Utrecht. The political scientist and public policy expert Maarten Hajer had recently taken on a new role as the urban futures chair in geosciences at Utrecht University and, at nearly the same time, the Netherlands was due to take over the rotating presidency of the Council of the European Union. It is a largely ceremonial thing, but the European capitals do take it seriously. They organize and host political decision-making congresses and launch or highlight cultural events during the six months of a term, eager to be on the good foot in front of their peers from around the continent. Industrial Rotterdam, Holland's second-largest and often-overlooked city, the site of Rem Koolhaas's Office for Metropolitan Architecture and one of the largest container ports in the world, was due to produce its biennial architecture expo. Hajer got a call to curate it. The Paris Agreement happened as Hajer considered a climate-neutral economy as the dominant theme for the biennial. He decided to see what it would actually take to achieve these goals, to build a model and present it in the context of Paris, the historic climate deal. Sijmons would design the presentation. It would be something that would grab a viewer's attention.

Research in motion

"The predominant way we advise government on these issues is by handing them a report. This is a million euros worth of science, and I hand it to them, and something mysterious should happen," the tall, suave Hajer says while sitting in a glass-enclosed quiet cube in the middle of the

DOLLY HOLMES

LEFT
Noise-dampening earthworks from H+N+S and a sculptural touch at Buitenschot.

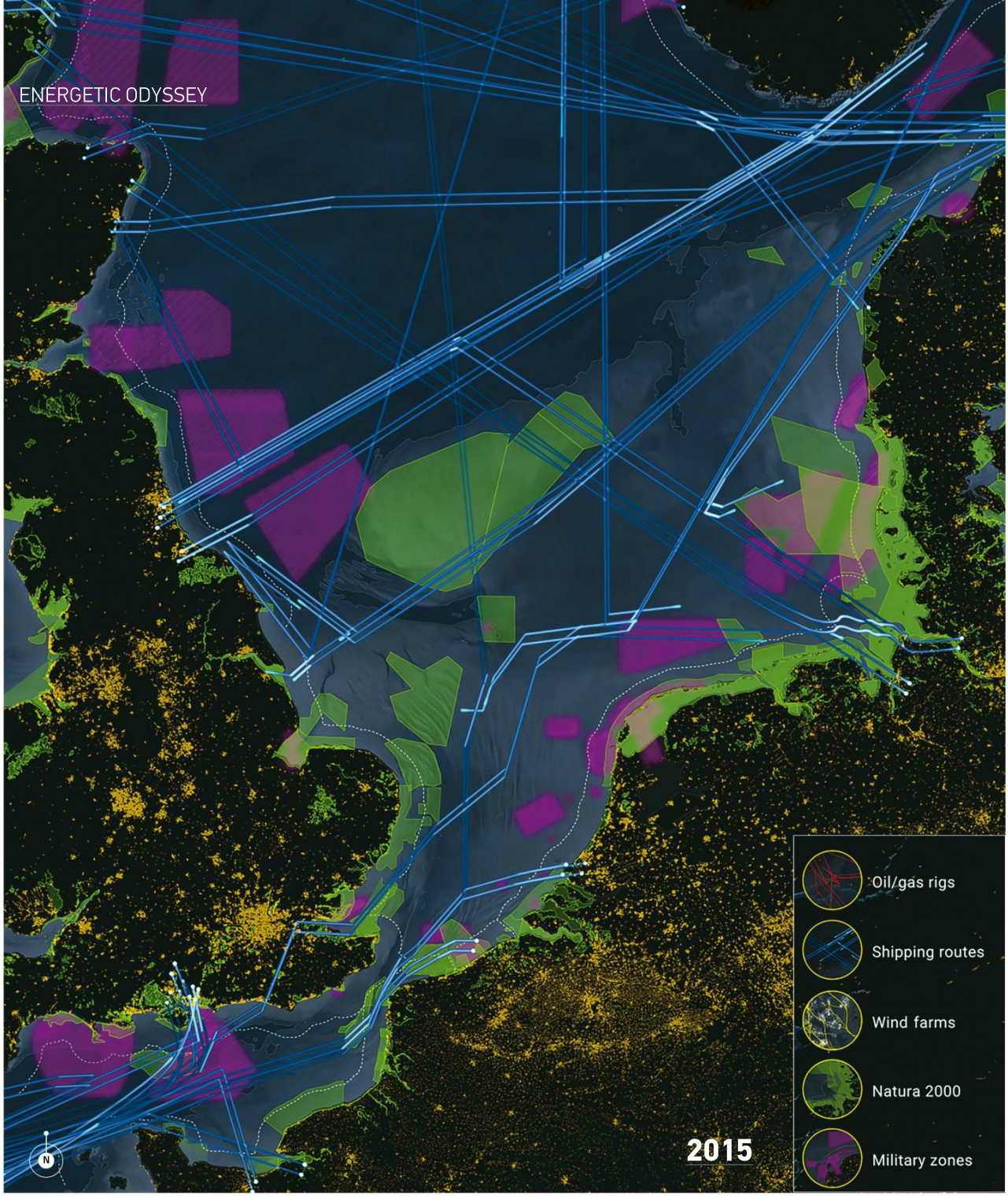
BELOW
A room-sized Odyssey exhibit at the Rotterdam biennial.

new urban futures lab, then under construction in Utrecht. Hajer is a former director general of the PBL Netherlands Environmental Assessment Agency, which advises the cabinet on climate change and urban planning issues. For a long time he's been interested in Sijmons's methods for short-circuiting and bypassing political impasse and building consensus among disparate interests involved in a problem or situation. Hajer even wrote a book with Sijmons called *A Plan That Works*.

This kind of talent is necessary in making any progress with climate change policy, where even solar- and wind-powered do-gooders might be at each other's throats at times. With its projects, H+N+S shows a kind of soothing creativity, compromising without being compromised. As Hajer says, it's not necessarily the boldest, like a Koolhaas lightning bolt, but H+N+S employs a difficult-to-pull-off subtlety that results in lasting solutions. A good example is in a field near the huge Schiphol airport, where a new runway was going up. Residents in the approach weren't happy about the anticipated noise. Spurred by findings about tilled fields and noise reduction, the H+N+S idea was to build a large park filled by sound-dampening earthworks: the Buitenschot. Now residents walk their dogs on dew-filled mornings in an extraordinary, grassy space. If they stroll up the side of these rod-shaped earthworks, it's just possible to see cargo 747s on their takeoff runs. On the housing sides of the park, though, you won't hear much of them.

Going back to his reports, Hajer says a tool that Sijmons employs well is delivering concepts in word and image. "A report is very clumsy. Especially with climate science, where you work with these forecasts in order to reach targets: 'Years from now, this is what you have to do.' It's very complex and cognitive," Hajer says. With Sijmons on board, they could create a vision of these complexities, displayed using design power. "It's about creating an 'imaginary' of a positive future. Look around you: Donald Trump, Brexit, everything is negative about the future. People are afraid of the future. This is a time we need to use design in a new context. For the biennial, I wanted to use the background study—the hi-res report—and make it an immersive experience. A thing that you could stand around."

MICHAEL DUMIAK, TOP; TUNGSTEN PRO, BOTTOM



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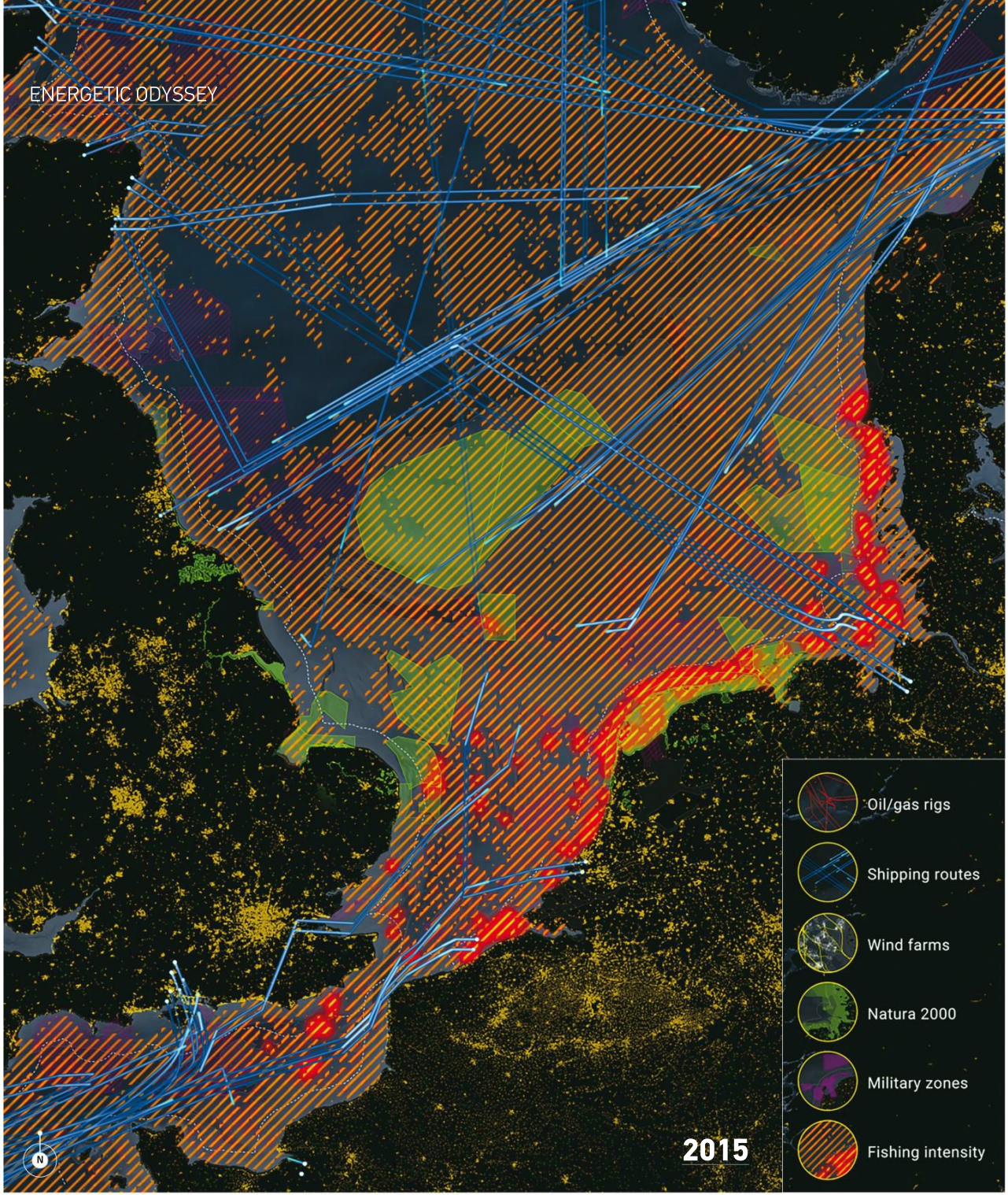

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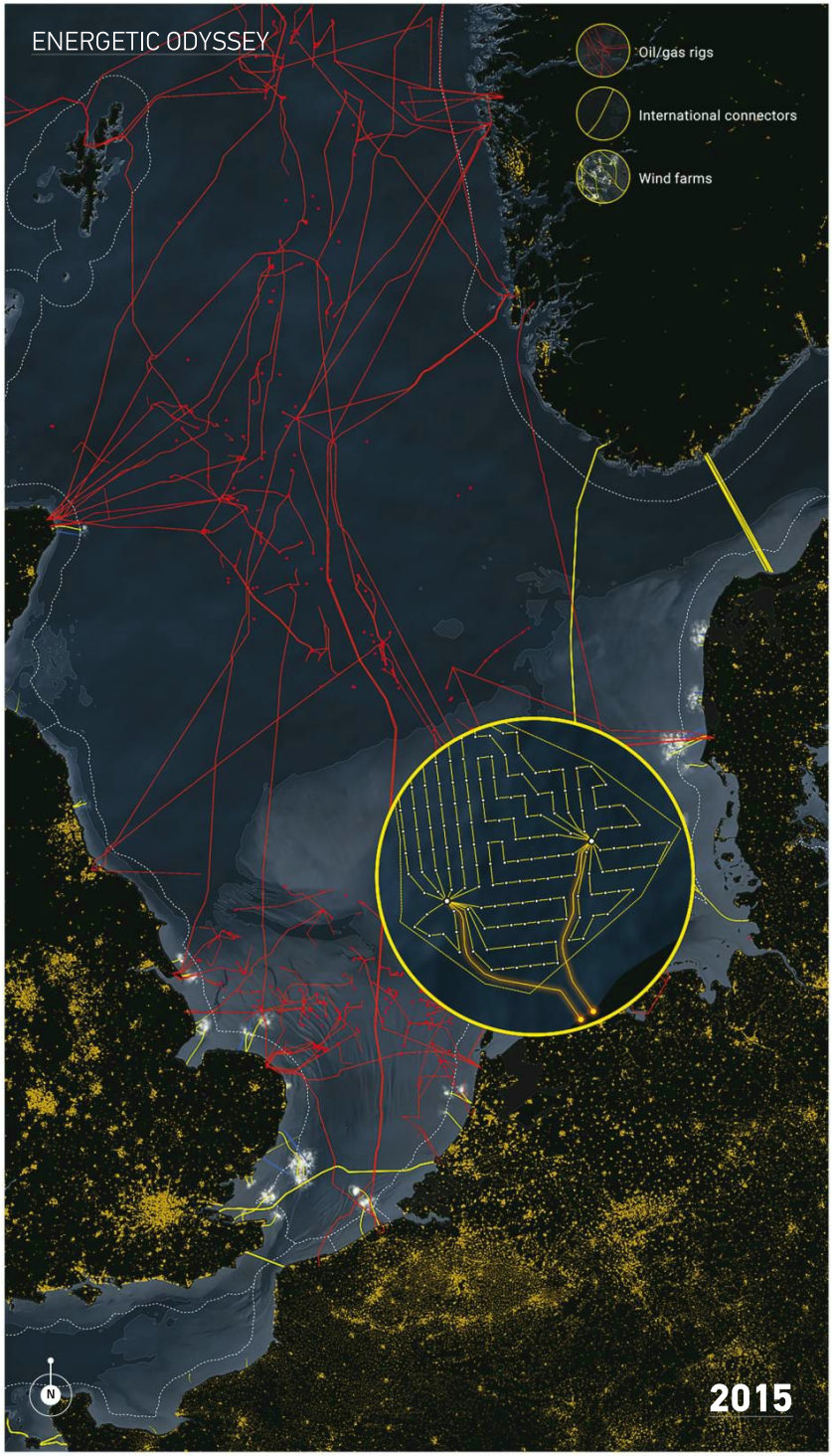


LEFT AND OPPOSITE
The Energetic Odyssey animates a vision of an entire clean energy infrastructure over decades.

Such an experience would give the public a benchmark from which to measure the future. Much of Europe accepts that humans are contributing to climate change and strongly supports (at least theoretically) measures to counter it. This would be a benchmark the public could see, and so could their elected or appointed representatives. So often large multilateral projects are made in the abstract. Then time slides by. The United Nations, for example, will still be pursuing its millennium goals two decades into the millennium.

The benchmarking project focused on the North Sea states: the Netherlands, Belgium, Denmark, Norway, the UK, and Germany. These six countries consume 5,500 terawatt hours (TWh) of energy every year in electricity, heat, and fuel. This sounds like a lot, and it is: It converts to roughly 518 million U.S. tons of oil, about 470 times what Kenya consumes in a year, and at a cost of about $175 billion. On the other hand, it is not astronomical: 5,500 TWh of energy is about the current total production annually of global renewables.

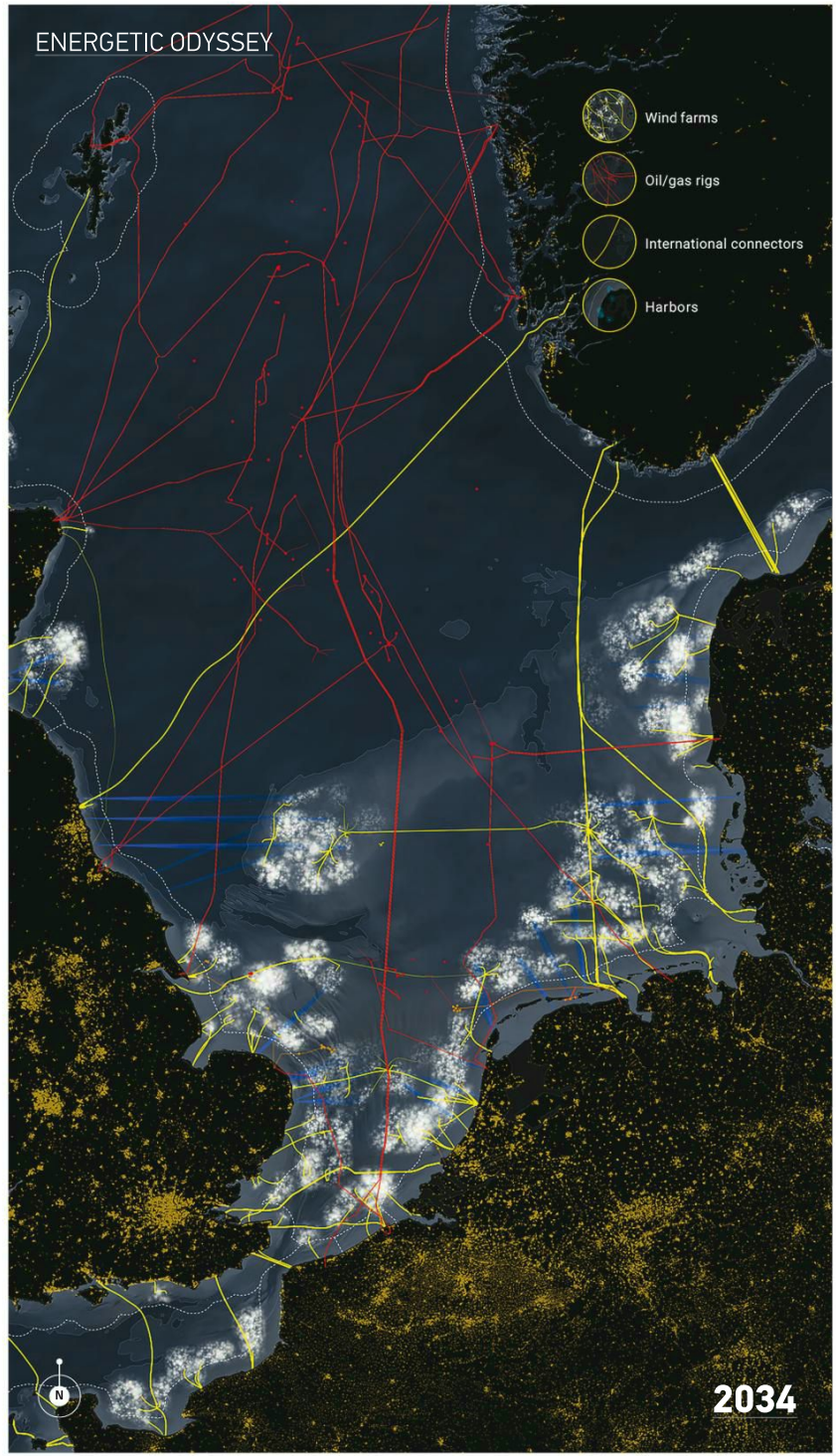
Ecofys, a Dutch think tank and consultancy that builds models for energy-use scenarios, compiled and delivered research for the scenario development. Hajer spent a year raising money for it from government and private sectors. "The provocation was this: Everyone talks about a green 'next economy' in terms of *Small Is Beautiful*," he says, referring to the influential writing of the

COURTESY IABR / H+N+S

late statistician and economist E. F. Schumacher. "But small is beautiful doesn't add up. Big is beautiful." Hajer thinks the big offshore fossil-fuel industries, the bad guys, should become the heroes. Only that, in his view, opens the possibilities of scale. Sijmons came in for his part and began designing animations based on the pool of information and expertise assembled. Hajer, by this time, was setting up workshops with the unlikely consortium that bought into the idea: firms like the oil and gas company Royal Dutch Shell, the contractor and engineering operation Van Oord, the big German power utility RWE, the ecological nongovernmental organization Natuur & Milieu, and the Port of Rotterdam. These players chipped in money, but Hajer also wanted their expertise to help detail the story. Energetic Odyssey took shape.

Incoming cables

An indeterminate English female voice intones over the long table at the H+N+S studios. Well-enunciated, curious, enthusiastic, and soothing, she could be a robot. She's the narrator of the Energetic Odyssey animation playing on screen, and she is talking about the journey that's going to happen. To tamp down CO_2, an entire energy system will be assembled and routed in wide-ranging environments: underneath the seabed, connecting with the coast, floating on the turbulent North Sea surface. Reaching the EU targets set at Paris requires nothing less than the complete transition from fossil fuels to carbon-neutral energy sources. The Energetic



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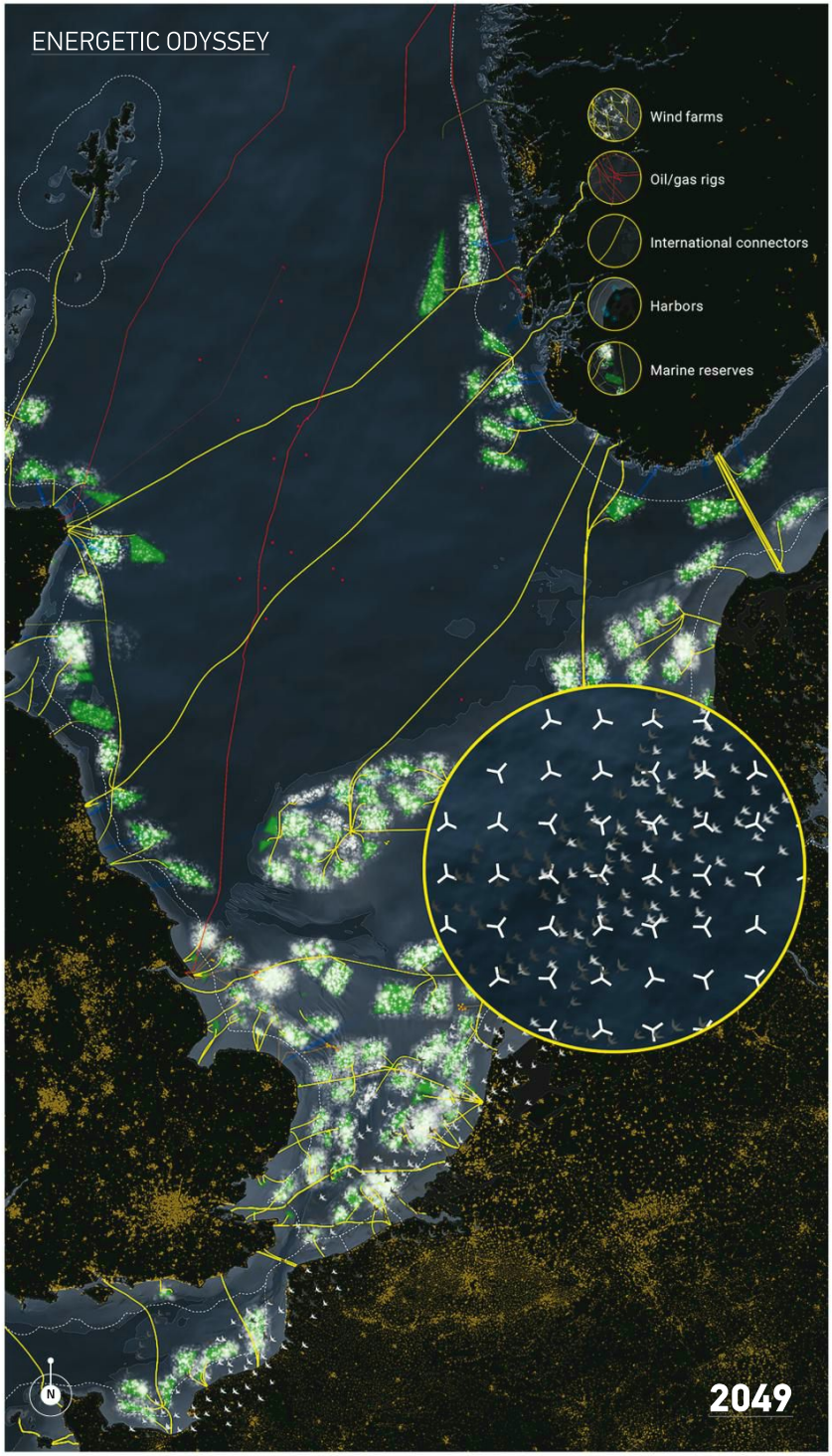


LEFT
As data projections roll through the presentation, graphics indicate where wind farms would grow. Note cluster over the Dogger Bank (center, to the left of enlarged portion).

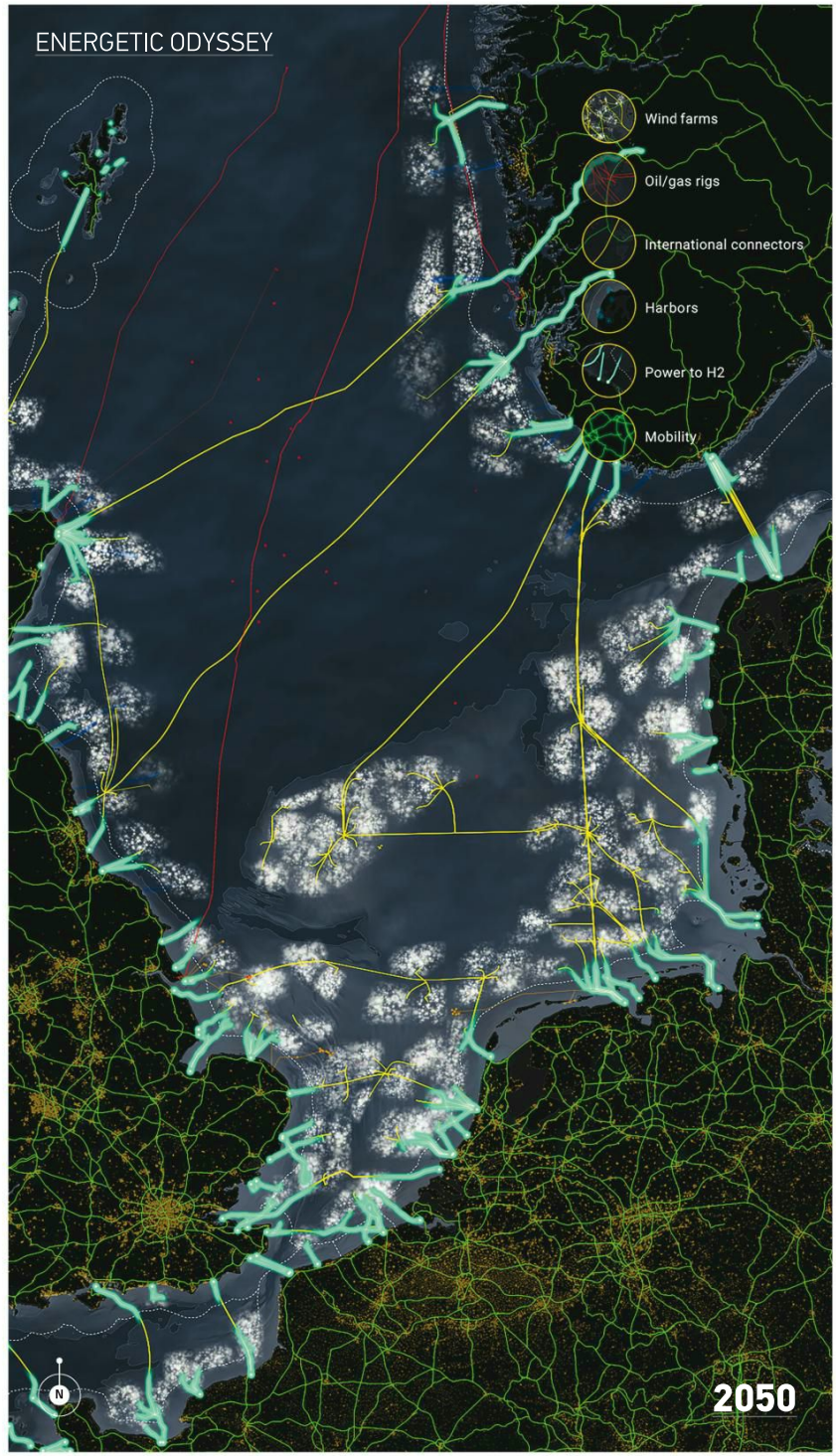
OPPOSITE
Wind farms get connected.

Odyssey, 14 minutes of flowing lines for wind currents, moving maps, NASA carbon data imaging in rusty reds and yellows projected at gym floor size, essentially names the components of a regional energy system based on renewables rooted deeply in the sea.

There are wind farms. There are cables within these farms through which electricity is transported. There are connectors at sea where the cables from the wind farms converge. There is the landing cable that leads to the coast, ending at a point where electricity can be tapped. "There are pipeline corridors that currently transport gas and will subsequently take carbon monoxide to underground storage facilities," the voice says cheerily. The ports and industrial estates where wind turbine components are manufactured and then shipped out to sea also feed into the system, plugging in at the periphery.

All of these things (and more) are already mobilized in the North Sea, some fledgling, some weather-beaten and proved by years spent breaking the waves. Where the Energetic Odyssey begins breaking with convention, as Hajer alludes, is in terms of scale. The Odyssey presented here has countless links to the coast but largely takes place in deeper water, the connections unseen. One result might be that a dog-walking beachgoer looking out to sea would have an unspoiled view. The turbines needed for large-scale offshore wind energy will be wound and hugely torqued by massive blades, and that means they will not be

COURTESY IABR / H+N+S



anchored close to shore. This answers a common complaint about wind power, that the structures ruin the look of a place. Here the turbines would be in fields 12 miles off the coast, showing as just a far-off white mist as the tips of wind blades peek over the horizon.

Big energy, in its clean iteration, will be well out into the water. The real production will come on line over the next three decades. If the six North Sea countries consume 5,500 TWh a year, renewables are going to need to make a quantum leap in production to come anywhere near clearing the bar agreed to in Paris. Renewables currently supply about 8 percent of the energy in North Sea countries. Offshore wind will need to become much more muscular, and soon. At the same time, as our Odyssey narrator purrs (perhaps a little sotto voce), reduction in energy consumption must be part of the picture.

Big turbine makers such as Vesta, Arwen, and Siemens are expected to build larger and larger; contract players, like MacArtney in Denmark and Prysmian in Milan, to push advances in cabling such as better seabed linking and higher-voltage lines. Ports such as Rotterdam and Hull must all build, destroy, and deploy. Long cables must carry direct current instead of alternating current. That means transformers and more. Odyssey nods to CO_2 sequestration (as well as a stable and well-accepted cap-and-trade-and-tax system for carbon). Both of these items pose intense challenges: Germany scrapped an EU-backed

COURTESY IABR / H+N+S

ABOVE
The Bligh Bank wind farm off the coast of Zeebrugge, Belgium.

effort on sequestration in 2013. Energy savings on a large scale, for its part, has all the charm of requiring any savings on a large scale. The Odyssey has obstacles everywhere it looks.

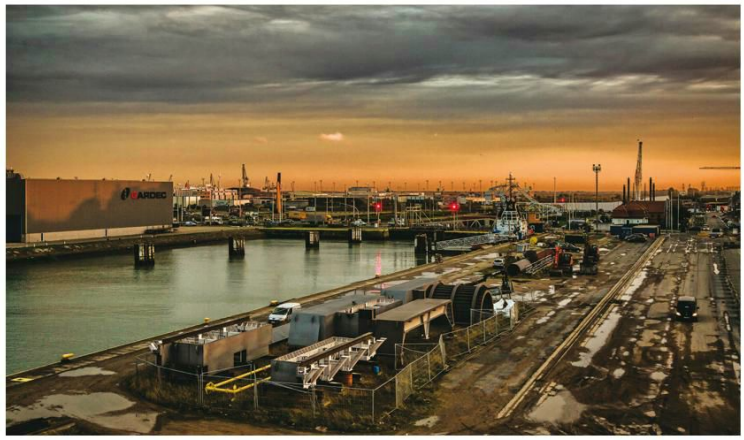
To make construction and deployment of the turbines easier, someone's going to need to build an island.

In the North Sea.

On Dogger Bank.

Preexisting conditions

The North Sea arrived slowly in Europe, but once there it made an outsize impression. There used to be tundra between England and the Netherlands and Jutland, and a land bridge called Doggerland. Mammoth and elk and bison roamed. Flooding put that to rest at the end of the last Ice Age, first rising to leave low-lying islands and archipelagos, then putting the shelf under for good in the glacial flood that created the English Channel. The North Sea covers 220,000 square miles and is shallow compared with other seas, with its 13,000 cubic miles of water ranging from



ABOVE
The Zeebrugge port dates from medieval times. Its challenge would be to keep up with a clean energy future, powered by offshore wind.

the Norwegian trench at 2,300 feet deep to an average of 300 feet and to the moraine shallows of 50 to 100 feet over sandbanks and glacial pileups.

It has always seen human traffic, trading and harvesting, transport and war. Some of the busiest shipping lanes in the world are in the North Sea. The Vikings came to Scotland, the British and Norwegians came for oil and gas fields, the U-boats came to hunt for cargo convoys and the Royal Navy for cruisers, and everyone came for cod, herring, mackerel, and haddock from the thriving fisheries spinning off from the 160-mile sandbar called Dogger Bank. In his recent book *The Naked Shore: Of the North Sea,* Tom Blass describes the water as saturnine and quick-tempered. Maybe it's under the influence of hard-sounding words like *Skagerrak* or *Humber* or *Sylt* or a ferry-crossing experience on an ill-chosen night. The North Sea wields a mercurial reserve of power, with much going on beneath the surface. If the place is going to be the beneficial heart of a powerful clean energy system connecting six countries and supplying the energy needs of 200 million people, it's pretty busy already. There used to be rock-covered plains and cold-water reef in the now mostly sandy sea, says Nathalie Strookman, the energy project leader at Natuur & Milieu, in Utrecht. Although there are still more than 200 species of fish, three species of seal, and 16 species of whale calling it home, and 10 million seabirds including skua and puffin and auks and terns on any given day, this is also one of the most industrialized environments in the world.

"The North Sea is one of the crucial areas in Europe where we will win or lose the battle for renewable energy," the Odyssey voice asserts. "But the North Sea is not empty. Our story is set in the most intensively used coastal waters in the world. With fishery and shipping routes cutting right across, it contains designated nature reserves and military zones, oil rigs the size of skyscrapers, countless oil and gas pipelines, and there are already several wind farms. Moreover, the North Sea is used as a sink for pollutants and residual heat from our industries."

The North Sea also touches roughly 7,000 miles of coastline, from Zeebrugge, Belgium, and the Maasvlakte flats around the Hook of Holland to steep goe canyon inlets along the far north Scotland coast around Wick and the Orkneys and the rugged rocks north of Stavanger, Norway. If there are to be 25,000 10-megawatt-plus turbines taken to sea in what would be the latest of North Sea flotillas, all of these interlocking parts, blustery beach and Dogger Bank alike, will feel it.

Blow, wind

There are already nearly 40 wind farms in the North Sea, nearly all of them in about 40 feet of water or shallower. There are slightly more than 2,300 turbines with a capacity of about 6.4 gigawatts (GW), enough to power a million households at an installation cost of about $24 billion.

It's difficult to measure in any simple way the potential capacity and patterns of wind blowing across the North Sea. It seems impossible to say there's *x* amount of wind over *y* portion of sea, therefore deploying *z* turbines in that place should produce an expected amount of energy. Thomas Winkel, a Paris-based energy and sustainability consultant and a former member of the Ecofys team on Energetic Odyssey, says the European Commission draws on wind speed variation data and long-term surveys to estimate the North Sea's potential for wind power. The Odyssey team based its findings on this commission data as well as previous Ecofys reporting. Engineering research probes further with common factors such as barometric pressure as well as the more exotic, such as mesoscales and Monin-Obuhkov length, making calculations using meters per second, regional changes, and standard deviations on a given day.

Industry is optimistic about the near-term future for this kind of North Sea power. The European Wind Energy Association sees production increasing by about four additional GW of wind power annually, with 40 GW capacity reached by 2020 and 150 GW by 2030. That would move North Sea wind power to about 7 percent of the total electricity pie for Europe. It's a step forward, but not certain to be big enough to help the region reach the 2050 goals from Paris.

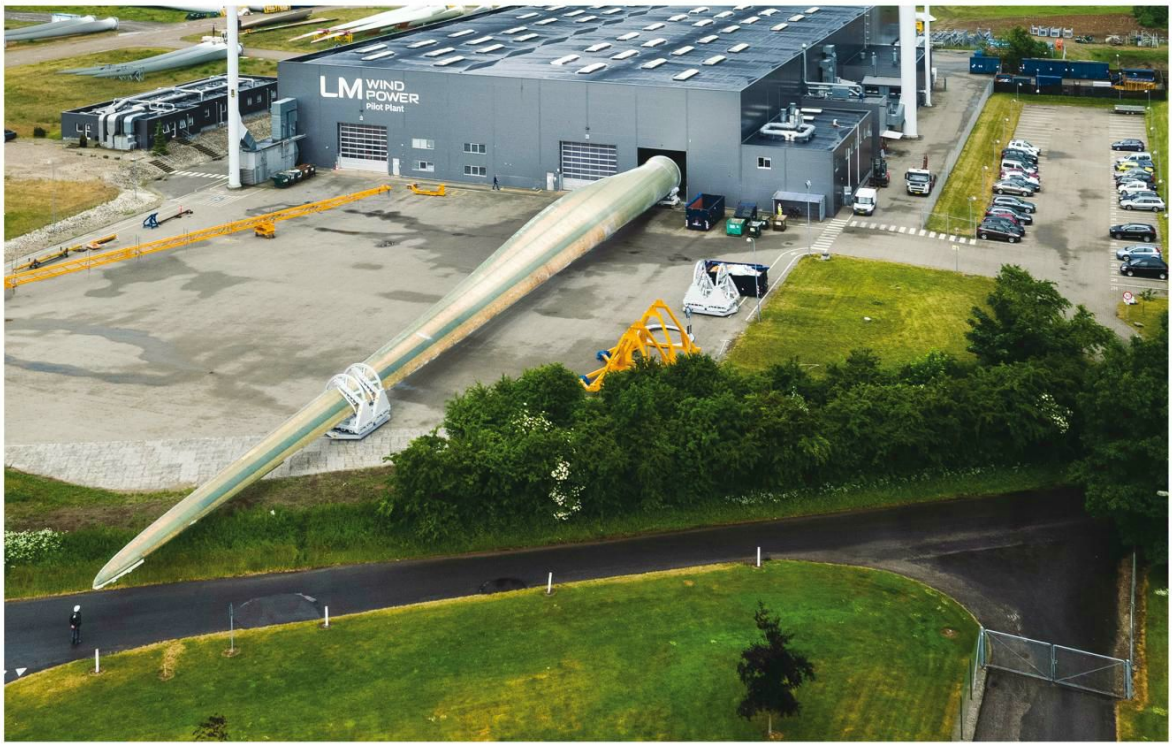
"In the context of substantial greenhouse gas reduction by 2050, renewables play a pivotal role and would need to supply at least 75 percent of all the energy that we consume," says the voice of Energetic Odyssey. That breaks down like this: With 10 percent of North Sea national power already coming from renewables, energy savings need to be part of the picture. She's marked this at a 30 percent reduction relative to 2015: a savings of 1,500 annual TWh of energy. The research also indicates it is feasible—with the right ambition—to generate 1,200 TWh of energy annually using offshore wind. That's 90 percent of the electricity used by all six North Sea countries and a third of all energy they consume. This is what adds up to the 25,000 turbines at 10 MW. That means turbines covering an area of 22,000 square kilometers, or 8,500 square miles, which is the size of Lake Erie or Massachusetts.

Is that even possible?

In a test bed near the German coastal city of Bremerhaven, the French-Spanish wind energy company Adwen is putting its new giant through trial paces. Last summer, Adwen's production partner in Denmark produced the turbine's blades at a fabrication hub in Lunderskov. At 288 feet

OPPOSITE
View from the captain's deck: The 100-yard-plus *Volantis* is tasked with cable transport, creating connections in this case to Bligh Bank.


DEEPOCEAN
DEEPOCEAN



ABOVE
Adwen's big new turbine blades come on line from Danish partner LM's factory in Lunderskov.

long and weighing 35 tons, a finished blade nearly stretched over the fab's perimeter fence. Each blade needs an escort to be transported on the highway, and it can't be taken everywhere.

The turbine, also a monster at about 80 tons and an absurd level of torque capacity, is new on the block as well. A production model debuted at the end of last year. Together they are being kitted and having the kinks ironed out by research and development experts in Bremerhaven.

This is an 8 MW turbine.

The engineering multinational Siemens also has plans for a new 8 MW engine, as does Vestas, which is already installing some in Liverpool Bay in the UK. Siemens officials have already said they plan a scale-up to 10 MW in the next four years.

"It's challenging, but not orders of magnitude away from where we are now," says Henk Polinder, an electrical engineer and assistant professor of electrical machines and drives at Delft University of Technology. He's part of a long-term EU research project called INNWIND, which with several partners in Denmark, Germany, Greece, Italy, the UK, Spain, Belgium, and the United States is providing fundamental research into better design of large-scale wind machines. Results are continuously encouraging, Polinder says, in terms of materials, torque, stability, connections, weight, and output. But getting bigger does mean getting bigger. Polinder expects to see turbines topping 440 tons, with 300-foot blades, heavy concrete anchoring, and deep shafts. Designing floating platforms for deeper water is considered the industry answer for big turbines. There's only one right now in the North Sea, a prototype operated by Norway's Statoil, anchored in 600-foot waters off the Stavanger coastline. The firm does plan on launching five more platforms 15 miles off Scotland by the end of this year, and a floating farm off Block Island, Rhode Island, came online last December.

LM WIND POWER

But getting to a point where every day four or five 10 MW assemblies leave European harbors bound for the North Sea is pretty ambitious.

The Odyssey would have these bound for a new artificial island, to be specially constructed on Dogger Bank. The island would be outfitted for assembling wind turbines and distributing them for installation. It would also provide support services and voltage conversion.

It's a natural place to consider, because Dogger Bank is the North Sea switchboard, a Grand Central sandbank where all lines converge. The ancient land bridge is the least submerged here, with waters shallowing from 120- to 50-foot depths. Even so, the world's largest artificial island, the crescent of Palm Jumeirah in Dubai, United Arab Emirates, sits in 35-foot water at its deepest, though at least one experimental drilling island rose in 38 feet of Arctic water in the early 1980s.

The Dutch engineering company Boskalis recently started work on one of the largest island-building projects in the world, the Marker Wadden restoration in Markermeer Lake, which lies between Amsterdam, the outer IJsselmeer, and the North Sea. It's an impressive feat, but it's in sheltered waters at 15 to 20 feet, tops.

Dogger Bank, though shallow, is deeper than that. As a central space, it's already the site of a planned 5 GW wind farm, scaled down from 10 GW, to be owned by UK and German utilities SSE and RWE, Statoil of Norway, and the Norwegian state hydro/wind company Statkraft.

It also was the epicenter of the UK's only serious earthquake.

Before shipping to the artificial island, the big turbines will need to travel to harbors after manufacture. A place like Maasvlakte will need to handle the traffic. Rommert Dekker, a logistics professor at Erasmus University in Rotterdam, thinks it could. "Inland barges can be 400 feet long on the Rhine. They should build these blades along a river," Dekker says. "It is still a lot. There are not that many ships. Even if we take 20 years to build them, we need four of those ships per day, and as they would make a round trip of I guess seven days, we would need 28 of them. That is a large number, also because the North Sea would not allow working year around. So my first impression is that if it takes three years to build just one wind park of now 100 MW, we really need to scale up, and I have some doubts whether we can

ABOVE
Enough blades of this size would be needed for five new turbines every day on the way to the North Sea.

BELOW
A new island rises in the Markermeer. Dredgers would need to make new land on Dogger Bank for wind farms.

LM WIND POWER. TOP: ROYAL BOSKALIS WESTMINSTER. BOTTOM

OPPOSITE
Thanet Wind Farm, seven miles off the coast of Margate, UK, is one of the world's largest. With 100 turbines and 300 MW capacity, the farm switched on in 2010.

Sijmons sees placing real numbers in front of decision makers in a comprehensive manner as a way to break through a "crisis of the imagination" that obscures the vision of decision makers, even on the side of clean energy.

"This is not a plan. It is a narrative," he says. Sijmons is pursuing something here he calls "research by design," and H+N+S has been relying on it for a long time. It's why a 30-year-old project to restore stork habitat in southern Holland, one of the first projects produced by the landscape architects that founded H+N+S, reminds him of the task at hand. The Plan Ooievaar, as it was called, viewed a river area as an object of design, where artificially created environments spurred new nature (and in this case, the return of the black stork to southern Holland). The approach guides Sijmons to let geography steer the planning of interventions or structures, which then create new environments on their own.

In this case, the will to create meshed grids, the basic but complex electric infrastructure that would route power among the North Sea nations, and the show of collaboration among even a subset of fractious European countries can and will develop organically. At least that's the idea. "Actually the political climate in Europe is advantageous," says Winkel, the energy consultant and former Odyssey team member for Ecofys. "Countries don't do this to fulfill their climate change targets, but because they see they can actually make money with it." Offshore wind is becoming more competitive. "Climate change targets are under pressure and will always be so. But from an economic perspective it starts to make sense here," Winkel says. "In that case it doesn't matter what the United States will do. If Trump pulls out of the climate change agreement, it will not matter so much for renewable energy here."

Building a sense of urgency—what Sijmons calls the "Chinese building speed"—is hard. But the meshed grid among North Sea nations will happen, Sijmons contends, because it's the best way to make wind farms work. Already there is a 360-mile-long power cable linking Norway and Holland. When the Netherlands produces too much energy, the overflow goes through the cable to the coast near Feda, Norway. If Norway has too much on its grid, the extra can flow to Eemshaven, Netherlands.

It's natural enough that Sijmons should name-check Jan Bijhouwer, a pioneering landscape architect who was instrumental in designing another Dutch landmark, the long dike on the IJsselmeer that opened a new generation of the polders, those quintessentially Holland plots of protected, reclaimed land. The structure worked. Sijmons has more than one of these to his credit.

Dog-walkers are normal at the Dutch seaside, but the beach lagoon near Kijkduin is an unusual feature. It opens up as the beach itself becomes a wider, delta-shaped expanse edging into the sea.

This is the Zandmotor. It is something of a companion piece for Sijmons to the Maasvlakte. Here as elsewhere coastal sands are always migrating and moving around, eroding the strands up the coast near The Hague and Scheveningen. Every few years the government has to restock the sand on the coast. Sijmons and his crew created an artificial peninsula widening into the waves as a delta-shaped sandbar holding 71 million cubic feet of the stuff. The Zandmotor, or sand engine, works by managing that migration, currents and waves directing granules to where they need to go, no restocking required. This process happens by itself, powered by the energy of the North Sea waves, every other second. ●

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MICHAEL DUMIAK, OPPOSITE