1  Bora and Aura at Nilchi Energy

Bora was pensive while waiting for his single carry on luggage at the Amarillo airport luggage pick up carousel. He packed only a small luggage for his short trip to Amarillo and wanted to take the luggage into the aircraft cabin, but the small American Eagle aircraft did not have any overhead luggage bin; so he checked the luggage at the Dallas - Fort Worth airport. It was about 8:50 pm, he had to pick up a rental car and a late dinner on his way to his hotel. The flight from Dallas took more than usual 70 minutes and arrived slightly late. The pilot mentioned strong eastward winds for causing the delay. Initially, he did not like the delay but then, recalling the reason for his trip to Amarillo, he appreciated the strength of the wind. He wanted the wind to blow and blow strong to fill up the sails of his business plans. Who would control the wind better than the wind god Boreas, after whom he was named as Bora.

Bora was eating his turkey sandwich while looking at the flat screen TV at his hotel room. Although 10 pm news was on, his mind was reviewing the events of the day: picking up the luggage, renting a car, getting a sandwich, calling his wife in Dallas, and checking in the hotel. Then he had flashbacks of the last year’s events: his previous job as a reservoir engineer at a leading oil exploration company, the financial troubles in the conventional energy sector, his interests in renewable energy, meeting with his classmate Aura at a reunion party. Later Aura helped Bora to transition his career from a reservoir engineer to a “wind engineer” by introducing him to partners at Nilchi Energy.

Nilchi energy was established only a few years ago in Dallas to capitalize on the fast-growing wind energy trend in Texas. The company initially started with funding from a few Dallasite equity investors, two of whom chose to become partners to run the company. Later Nilchi obtained some loans from the Department of Energy and invested them into wind farms in Texas. Nilchi could only do small projects in the beginning and these projects hardly required more than $30-40 million. Even at this level, the projects had to be leveraged with money borrowed from local Texas banks. The partners at Nilchi were planning to lease land from Native American Reservations in Texas and Oklahoma to house their wind farms. With this in mind, they chose the Navajo term nilchi for wind/soul as the company name and the Native American symbol of flat diamond <> as the company symbol. The company also cherishes Native American philosophy that is articulated by (or attributed to) Chief Seattle:

– Man did not weave the web of life, he is merely a strand in it. …You must teach the children that the ground beneath their feet is the ashes of your grandfathers. …If men spit upon the ground, they spit upon themselves. …We do not inherit the world from our ancestors; we borrow it from our children.
– If we sell you our land, remember that the air is precious to us, that the air shares its spirit

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with all the life it supports. The wind that gave our grandfather his first breath also receives his last sigh. The wind also gives our children the spirit of life. So if we sell you our land, you must keep it apart and sacred, as a place where man can go to taste the wind that is sweetened by the meadow flowers.

However, as shown by the paragraph above, the concepts of wind and soul are intertwined in the Native American philosophy. Hence, Nilchi Energy has not succeeded with leasing land from reservations.

While Bora’s mind was processing all these events and thoughts, his mouth was falling behind. He finally ate the last bite of his sandwich and started flossing his teeth. The local channel was showing tomorrow’s weather predictions: temperature, sun exposure, wind speed. His mind once more wandered away from the TV and took him to the MERIT course he took with Aura at the Energy Management program at UTD (University of Texas at Dallas). He joined the program to learn finance and economics aspects of energy industry. Aura was just the opposite as she had a finance degree and wanted to learn operational and technological aspects of the industry through the Energy Management program. She was also more senior and experienced than Bora. But they got along well and worked together in their MERIT project. At that time Bora had not thought that he would work with Aura at the same company in a few years. Now he was glad that he got to know Aura through the program, kept in touch with her over LinkedIn and eventually met her again at the UTD alumni reunion party. He liked and benefited from Aura’s positive and constructive approach. The first time she presented him to the Nilchi partners, she said:

Here is my smart and hard-working friend Bora. He currently investigates flow of oil under the ground but, from now on, wants to entertain opportunities in the flow of air over the ground.

That was a good way to put a spin on my experience, Bora thought: “there really is not much difference between the flow of oil or the flow of air. It helps to have a good professional network and friends like Aura.”

2 White Deer Wind Farm

The GPS showed the exact location where Bora and Neewd decided to meet at the intersection of routes 60 and 207 in Panhandle; see Figure 1. Bora parked his car, came out and looked around while waiting for Neewd. Neewd was a local, born-and-raised in Texas panhandle, where he liked the dry wind and blue skies. Nobody knew his real name, maybe he did not either. He knew very little of his father who worked as a roughneck at drilling platforms and was constantly on the move. The rumor had it that his name was Newton but sounded too snobbish to him and he roughened it up a bit as Neewd. Some argued that he was partially Native American and was named as Sweet Weend. He dropped the Sweet part and reorganized the letters of Weend to make up the name Neewd. That is all Bora heard from a Nilchi partner who set up this meeting.

Last night Bora arrived in Amarillo. He had a good sleep at his hotel and a breakfast. He was ready to check out some site locations for a proposed wind farm. Before coming to Amarillo, he talked to Neewd on the phone and they decided on a few locations between Amarillo and the town of White Deer. Three potential locations are encircled in Figure 1. These locations are mostly in Carson County and the county clerk’s office is in the town of Panhandle. While driving from the airport on Route 60, Bora passed the signs

2 http://www.co.carson.tx.us
Neewd came with a brand new pick up truck, quickly and firmly shook hands with Bora, and the two drove off to see the potential locations with their own eyes. These three locations were north (of Panhandle), west (of Panhandle) and south (of Route 60). Bora was not sure how much land Nilchi would exactly need. But he wanted to approximately find out the cost of the land in Carson County. Neewd had some childhood friends that owned significant land and he arranged for them to meet with Bora over a coffee in the afternoon. At the end of the day, when Bora returned to his hotel, he made Table 1 to summarize the prices quoted. The land was expensive in the North, which received strong winds. West and South locations received weaker winds. Relative to the wind speed of North, the wind speed in the West and South were given in Table 1. Neewd remarked in the afternoon that lands in the West region were close to the Pantex plant and could not be qualified for natural or organic agriculture, so the farmers tended to lease their lands at a lower rate.

### Table 1: Lease costs and wind speeds around White Deer.

<table>
<thead>
<tr>
<th></th>
<th>North</th>
<th>West</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ per sqm per year</td>
<td>0.12</td>
<td>0.08</td>
<td>0.10</td>
</tr>
<tr>
<td>Wind speed factor</td>
<td>1.00</td>
<td>0.96</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Next morning when Bora was taking a return flight to Dallas, he was still thinking about the trade off between land cost and wind speed. It was not clear to him if the data in Table 1 were sufficient to make any meaningful analysis. He called Aura from the airport to chat about the project and tell her that he would be at the office right around the lunch time. Aura responded in her usual cheerful voice and asked him if they could eat lunch together. This time she had a good reason to be cheerful because she found some wind speed data for White Deer. She obtained an entire year’s actual wind speed data for every hour from West Texas A&M University’s Alternative Energy Institute. These data are in an Excel file called WhiteDeer.
Bora made a mental note to himself that he would first look into this data file once he gets to the office.

After ending his conversation with Aura, Bora started walking in the terminal building. He was thinking that some walking, before sitting for 70-80 minutes in the aircraft, was appropriate. He wished he could walk more but his job did not allow for that. Then he spotted a stuffed armadillo toy at the Amarillo airport store. What makes a better gift for my 3-year old daughter than an armadillo coming from Amarillo he murmured to himself ...

3 Bora’s Revenue and Aura’s Cost

Lunch was fun; the new seafood restaurant in Addison had good menu and outdoor seating space. Aura was enthusiastic with the proposed White Deer project and Bora was happy to be back in Dallas. Aura first briefed Bora on the latest office rumors & politics and why Nilchi wants to focus on the White Deer project. She ordered a cat fish fillet and he ordered a red snapper. After a laughter, she exclaimed “the cat fish and cost are mine; red snapper and revenue are yours.” This was Aura’s way of splitting the work for evaluating the project.

In the afternoon, Bora started to think about computing the revenue from the White Deer Wind Farm. He first checked the wholesale electricity prices per mega Watt-hour in the day-ahead-market and decided that a price of $40 per MWh was a good number to use. What was harder was to find out the average (expected) energy generated by a turbine. He vaguely recalled from his MERIT course there was a formula to compute this energy. But he did not have the course material on his office computer to look up the formula. He postponed this to the night and instead spent the rest of the afternoon on preparing his expense report of his Amarillo business trip.

His daughter was sleeping like an angel. She was handful when awake, yet an angel when asleep. Bora closed the cover of the story book from which he was reading to his daughter and landed a soft kiss on her cheek before leaving her room. Then he went to his home computer and inserted a thumb drive. Lucky he was because he had MERIT material on a thumb drive, so the material was not damaged during the latest home-computer virus episode. In one of the MERIT lecture notes, he found the formula

$$\text{Expected turbine energy generated in Watt-hour in an hour} = \left[ \frac{e \rho \pi}{2} \right] r^2 E(V^3),$$

where $e \approx 0.4$ representing turbine efficiency, $\rho \approx 1.225$ kilogram/cubicmeter for the air density, $\pi \approx 3.14$. The radius $r$ of turbine blades was not clear at this stage because Nilchi did not decide on the type of the turbine yet. Bora decided to consider the latest turbines that came with radius of 42 meters at a cost of $2.8$ million per turbine. He was thinking of using the White Deer wind speed data file to compute the third moment $E(V^3)$ of the random wind speed $V$. He opened the data file and saw months $\times$ days as rows and hours as columns. For each hour of the year, he had the average wind speed in that hour and standard deviation of the speed during the hour. He quickly looked at the standard deviation numbers to find out that most of them were below 1. So he felt confident to assume that the wind speed remained constant throughout each hour at the average wind speed of that hour.

Unlike Bora, Aura was more intuitive. The same night at the same time, she was at a concert centered around pieces written for wind instruments like clarinet, oboe, saxophone and French horn. She was watching attentively how the clarinet player was cleaning the shiny instrument before the concert. Equipment maintenance is definitely key for a smooth performance, she thought. For the maintenance of a single wind turbine, she was thinking of accommodating $10,000 per year. According to her experience
and O&M costs of existing Nilchi wind farms, this was a reasonable estimate. Bora already found about
the land leasing costs in White Deer and it would be relatively easy to compute the land cost per year per
turbine. As the recent turbines had 40 meter or so radius, she thought of accommodating each turbine in
approximately a $300 \times 300$ squaremetre area.

The capital cost for a turbine actually was much higher than its O&M cost and land leasing cost com-
combined. It occasionally can be as large as 10 times the sum of the O&M and leasing costs. Thanks to sub-
sidized government loans and special deals she stroke with Texas banks, she was able to keep the interest
rate on loans at about 8% per year for 20-year lifetime of wind farm projects. She was expecting to use the
same interest rate for the forthcoming White Deer project. Then the clarinet violently took Aura away from
her thoughts and brought her back to the concert hall.

4 To Invest or Not To Invest?

Bora went to Aura's office next day. Immediately prior to this, he run into one of the Nilchi partners, Nils
Njörd, in the elevator while coming up to his office in the morning. Mr. Njörd, the wealthiest partner and
the largest equity investor in Nilchi, asked about Bora's Amarillo trip and his opinion on the proposed
White Deer project. For the entire elevator ride, Bora talked about his trip, the plane ride, airport, hotel,
Neewd, the land at great lengths to purposefully avoid saying anything about the project. When they were
leaving the elevator, Mr. Njörd looked confused but did not press for Bora's opinion on the project. He
merely said that they should talk about the project in a few days. So Bora knew that he had only a few days
to complete his analysis and combine it with Aura's to form an opinion on the project.

Aura was talking to her plants in her office when Bora showed up. Then she turned to him and asked
whether he liked a particular piece that she heard in the wind instrument concert. Bora could not even
register what the name of the piece was, let alone providing an opinion on it. The opinion he needed was
for the White Deer project, not for a wind instrument piece whose name he forgot in a second. Aura read
the stress on her colleague's face and his body language, and asked him to sit, so they could comfortably
discuss how they should proceed.

Mr. Njörd was scheduled to leave Dallas on next Wednesday afternoon for Frankfurt then to his final
destination Denmark. Aura and Bora decided to go over their numbers over the weekend and to meet
Mr. Njörd on Monday or Tuesday, depending on his availability. Bora asked if Mr. Njörd was going for
business or pleasure. Aura quickly replied back by saying he was a master of combining both. Neverthe-
less, what was known for a fact was that he would visit an offshore wind farm in Denmark. As Nilchi grew
over the years, Mr. Njörd was talking more about offshore projects and international projects. An interna-
tional offshore wind farm investment was not made by Nilchi until this time; but there was no reason not
to consider one.

Bora and Aura agreed that they would proceed as they decided yesterday over the lunch. Bora would
compute the revenue made by a single turbine and Aura would compute the cost of each turbine. Based on
these numbers, they would make their investment suggestion about the White Deer project to Mr. Njörd.
So the question was simple: To Invest or Not To Invest.
Key Steps in the Case Analysis

Required data for the analysis are in WhiteDeer excel file, so first download the data file.

1. First consider a wind farm in the North region in Figure and Table.
   - Annual Revenue: The revenue estimate depends very much on the third moment of the wind speed. Compute this moment by using the data in WhiteDeer excel file. Assuming 8760 hour per year, find the annual energy generated by a single turbine in terms of MWh. If the date given to you are not sufficient, make reasonable and justifiable assumptions to proceed. Finally, it is straightforward to compute the revenue that can be obtained by selling a particular amount of energy in the day-ahead-markets.
   - Annual Cost: The cost estimate involves the capital cost, leasing cost and O&M cost. Compute these costs with the data given to you. If the date given to you are not sufficient, make reasonable and justifiable assumptions to proceed.

   Based on your revenue/cost numbers, determine if Nilchi should invest or not in the North region.

2. Decide whether the West or South regions can yield more favorable cost/revenue numbers than the North region. Repeat the revenue and cost computations for the regions that can be more favorable.

3. Which region, if any, should Nilchi Energy invest to build a wind farm.

4. In the USA, the federal government gives tax credits to investors based on their investments into renewable energy, in particular into wind farms. Find the approximate percentage of this credit and whether it applies to the cost, revenue or something else. Use this credit to update the numbers computed above. Decide whether the tax credits alter the investment decisions.