KOKKUVÕTE

Anette Piirsalu koostatud töö „Ruhnu saare 100%-line taastuvelektrilahendus" raames koostati mikrovõrkude ja hajatootmislahenduste modelleerimise tarkvaraga HOMER pro kaks mudelit, mis võimaldavad Ruhnu saarel 100%-lise taastuvenergiaosakaaluga elektrienergiat toota. Töö üheks tingimuseks oli see, et elektrienergiat toodetakse taastuvatest energiaressurssidest, mis on saarel kohapeal olemas. Mõlema mudeli seast valiti majanduslikult kõige optimaalsem variant. Nende variantide erinevusi analüüsiti ning selle tulemusel valiti üks majanduslikult kõige optimaalsem variant. Töö valmis koostöös Enefit Green AS-iga. Töö eesmärk oli leida optimaalseim tehnilis-majanduslik lahendus, et Ruhnu saare elektrivajadus oleks kaetud 100% taastuvate energiaallikatega.

Lõputöö kirjeldab hajatootmislahenduste vajalikkust ning programmi HOMER pro, millega on võimalik modelleerida tuhandeid võimalikke mikrovõrkude ja hajatootmislahenduste variante. Töös on ülevaade Ruhnu saarest ning seal hetkel töötavast elektrivarustuse lahendusest. Hetkel on saarel töös päikesepark võimsusega 150 kW, tuulik võimsusega 50 kW, 222 kWh akupank ja 2 160 kW võimsusega diiselgeneraatorit. See lahendus tagab vähemalt 50%-lise taastuvenergia osakaalu. Töö tulemusel selgus, et tegu on hästi töötava lahendusega, mis arvestab saare tarbimiskoormust ning mille tootmisüksuste asukoha valik on optimaalne. Töö ülesanne oli leida lahendus, kus diiselgeneraator peaks töötama vaid siis, kui mõnes taastuvenergia seadmes esineb ettenägematu rike. Sel juhul saab diiselgeneraator tagada elektrienergia olemasolu Ruhnu saarel.

Ruhnu saarele lahenduse modelleerimiseks tehti kaks mudelit. Komponendid jäeti samaks, mis olemasoleval lahendusel, muudeti vaid komponentide võimsusi. Seega koosnesid mudelid päikesepargist, tuulikutest, diiselgeneraatorist, akupangast ja akupanga inverterist. Programmi sisestati ka andmed Ruhnu saare energiatarbimise ning ilmastiku kohta. Kaks mudelit tehti sellepärast, et muuta mudelites tuulikute arvu. Üks mudel koosnes kahest tuulikust, teine mudel optimaalsest tuulikute arvust. Mõlema mudeli puhul genereeris mudel võimalikud lahendused ning autor filtreeris nende seast odavaimat elektrihinda pakkuvad lahendused. Mõlema mudeli puhul kujunesid välja oma võimsuste vahemikud iga komponendi jaoks.

Mudelid erinesid komponentide võimsuste poolest oluliselt. Mõlemast mudelist valiti majanduslikult üks kõige optimaalsem variant. Esimeses mudelis kasutati kaht tuulikut, teises mudelis kasutati optimaalset tuulikute arvu. Esimese mudeli keskmine

elektrihind tuli ~ 1,5 korda kallim teise variandi keskmisest elektrihinnast. Samuti oli esimene variandi investeering ~ 1,7 korda suurem teise mudeli investeeringust. Esimese variandi elutsükli maksumus tuli ~ 1,5 korda suurem teise variandi elutsükli maksumusest. Päikesepark oli esimesel variandil ~ 6,6 korda, akupank ~ 1,4 korda ning inverter ~ 6,3 korda suurem kui teisel variandil. Ainult tuulikute arv oli esimesel variandil väiksem. Seega vastas töö eesmärgile teine variant, kus kasutati optimaalset tuulikute arvu.

100%-lise taastuvenergiaosakaaluga lahenduse rajamine on võrreldes 50%-lise taastuvenergiaosakaaluga lahenduse rajamisega väga kallis. Saarel olemasolev lahendus on hetkel majanduslikult optimaalsem kui 100%-lise taastuvenergialahenduse rajamine. Investeeringu suuruste vahe on lausa kuuekordne.. See tuleb sellest, et mudelites on arvestatud ka seda, et lahendus tagaks lühiajaliste tipukoormuste katmise taastuvenergiast ning seetõttu on komponendid üledimensioneeritud. See tõstis projekti maksumust oluliselt. Seega, kui tagada nt 90%-ne taastuvenergiaosakaal ning pikkadel tuule- ja päikesevaesetel perioodidel katta tarbimine diiselgeneraatorite abil, tuleks projekti maksumus tunduvalt väiksem võrreldes 100%-lise taastuvenergialahenduse investeeringuga.

Töö eesmärk oli leida majandus-tehniliselt optimaalseim variant Ruhnu saarel elektrienergia tootmiseks 100%-se taastuvenergiaosakaaluga. Eesmärk täideti, kuid töös ei arvestatud detailselt seda, kui keeruline ja pikaajaline võib olla väikesaarele tuule- ja päikesepargi rajamine. Olenevalt projekteerimise käigus selguvatest detailidest võib see eeldada planeeringuprotsesse ning täiendavat elektrivõrgu rajamist. Töö keskendus eelkõige sellele, milline tootmisüksuste osakaal oleks majanduslikult kõige optimaalsem. Samuti vajab tuulikute planeerimine saarele täiendavat modelleerimist, mis arvestab võimaliku turbulentsi tekkega. Need aspektid on aluseks edaspidistel uuringutel.

Töö tulemusena saadi teada, et 100%-lise taastuvenergialahenduse loomine Ruhnu saarele on võimalik, kuid nõuab suurt investeeringut ning seetõttu on ka kujunev elektrienergia omahind väga kallis.

SUMMARY

This thesis – "Renewable Electricity Solution for Ruhnu Island" – was written by Anette Piirsalu. In the thesis, two models were generated for producing electrical energy from 100% percent renewable resources on Ruhnu island. The models were generated with microgrid and distributed electrical power systems modeling software HOMER pro. One of the prerequisites for the modeling was that the renewable resources utilised would be available on the island itself. From the generated models, the most economically optimal configuration was chosen. The initial project was proposed by Enefit Green AS, who also provided the input data and were consulted with in the process of writing this thesis. The goal of this thesis was to find a solution to cover the electricity needs of Ruhnu island with 100% renewable production in the most optimal way in the economic and technical sense.

In the thesis, the need for a distributed electricity production solution is described, along with the HOMER pro software that enables modeling large amounts of possible microgrid and distributed electrical power production solutions. A general overview of the Ruhnu island and its current electricity supply solution is given. Currently, the demand of electricity on the island is covered with 150kW solar power plant, a 50 kW wind turbine, a 222kWh battery and two 160 kW diesel generators. The current solution guarantees at least a 50% share of renewable electricity. The current solution has been designed according to the demand of the island, and the production facilities are located optimally. In this thesis, the goal was to find a solution where the diesel generator would act as a backup for outages in the renewable production facilities. In these circumstances the generators would guarantee the availability of electricity on the island.

Two models were generated to model the new solution for the island. The production methods were chosen in accordance with the existing solution on the island, while changing the capacities of the components. Hence, the models utilised a solar power plant, wind turbines, backup diesel generators, a battery and an inverter. The electricity consumption and weather data was entered into the software. The distinction between the models was the amount of wind turbines used. The first model utilised two, and the second more than two wind turbines. For both of the models the possible configurations were generated by the software, and the author selected the configurations offering the lowest cost of electricity.

The two selected models exhibited a large difference in terms of the capacities of the subcomponents, mainly because of the requirements set on counts of the wind turbines. This also resulted in a notable difference in the electricity cost – the first model reported the average electricity cost ~1.5 times higher that the second model, and also a ~1.7 times greater required initial investment. In addition, the lifecycle cost of the first model was reported ~1.5 times higher than the second model. The first model exhibited a ~6.6 times larger solar power plant, ~1.4 times larger battery and a ~6.3 times more powerful inverter compared to the second model. Only the amount of wind turbines was smaller for the first model. Taking these factors into account, the second model was chosen as the best fitting the requirements.

The cost of establishing a 100% renewable electricity production solution is proportionally significantly higher compared to the 50% renewable solution. The currently existing solution is economically more viable than the proposed solution. The proposed solution requires a six-fold increase in investment. This is due to the fact that the proposed solution has a capacity large enough to cover even the peak consumption rates from renewable resources. This factor contributes to the increase in the project cost. A 90% renewable solution, that would employ the diesel generators during periods of sunlight and wind deficiency, would reduce the cost of the project significantly.

The goal of this thesis – to find the most economically optimal solution for electricity production from 100% renewable sources on Ruhnu island – was met. However, the efforts of constructing the solar power plant and wind farm were not estimated, which can be a challenge on a small remote island. Detailed planning might reveal the need for additional planning processes and the additional development of the electricity grid. The most economically optimal production capacities were the main focus of this thesis. In addition, the detailed planning of the wind farm would require additional modelling of the generated turbulence. These aspects would be the basis of further research in this matter.

As the result of this thesis, it was concluded that a 100% renewable electricity production solution on Ruhnu island is viable, but requires a large investment, which contributes to the high net cost of the generated electricity.