Quantitative Model of Optimization on Non-Oil Based Fuel Alternative Energy

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Abstract. Research of “Quantitative Model of Optimization On Non-Oil Based Fuel Alternative Energy” is using goal programing method approach which will generate comprehensive mathematic models to determine policy on alternative energy field beside oil based fuel. The result of the research is sensitivity analytic model and optimization model of nonoil based fuel alternative energy. Developed model is goal programing to optimise alternative energy beside oil based fuel. Model implementation conducted on alternative energy are coal, nature gas and hydro. And the calculation result using Expert Choice Version 9.0 is obtained that coal as alternative energy has relative priority value of 36,8% at overall consistency index 0,04 or 4%. Optimization implemented model conducted at alternative oil based energy plan using calculation of Quantitative System 3.0 program conclude that coal = 9.809274, gas = 0.8409028, hydro = 0. Minimal objective = 18.69225

1. Introduction
Increasing growth at several industrial sector is causing tendency growth on energy consumed, but on the other side decreasing PDB on mine and excavation industry sector, which is also resulting on decreasing mine production value at averageof 50% and decreasing of Indonesia crude oil production (DESDM,2005). Moreover, lately depency on oil fuel energy resources get higher. As known, the biggest non OPEC supply is coming from Russia (including ex UniSovyet countries), USA, Norway, UK and Mexico. Limited supply of non OPEC will reach 51,0 bph or 1,0 million bph comparing with supply at 2004 that was reached at 50,0 million bph, despite additional world oil suppy at 2005 will reach 2,0 million bph (Kompas, 26 February 2005).

At policy making process, policy maker always base the decision taken on qualitative and quantitative. Quantitative consideration based on several empirical analysis, while qualitative analysis based on policy maker judgement consideration. Several quantitative approach methods by empirical analysis is linear programing, integer programing, goal programing, while quantitative approach is hierarchy analytical process methods, delphi method, etc.

Research of “Selection and Optimization Model of Non-Oil Based Fuel Alternative Energy Resources (BBM)” using goal programing approach methods and AHP (Analytical Hierarchy Process) have not been found in any literature, which will used differently than previous research, because this research is using four parameter which are coal, gas and hydro. While the optimization model is using goal programing method and the selection is using AHP method. Therefor the result expected is an optimized model and selection of alternative energy, or this research is a breakthrough in handling energy issue in Indonesia nowadays.

The issue of this research can be formulated as below; How to handle energy crisis and high price of oil fuel. How to analyze sensitivity actor role on several alternative energy sources beside oil fuel. How to modelling optimization of alternative energy resources by goal programing.
Beside main goal, this research also has more specific purposes which are; Analyze sensitivity actor role upon several alternative energy resources. Make optimization model of alternative fuel energy using goal programing.

2. Model
Model is an abstract and simplification of the world or reality and pronounce many direct and indirect functional relation, interaction and interdependency between one and another substances (Krisnamurti, 1993). According to Wilson (1984) is a system representation qualitatively and quantitatively which represent a process or an event which can describe clearly an interactive relation between many observed factors.

Despite decreasing oil fuel subsidy have impacts on several industrial sectors, there is compensation on diverting the subsidy. The relocation of oil fuel subsidy needs in 2005 reaches 10,784 trillion rupiahs. With 2005 APBN budgets it reaches 7,340 trillion rupiahs, then related funds with this oil fuel subsidy reaches 18,125 trillion rupiahs.

2.1 Indonesia reserved alternative energy
According to Mineral Energy Resources Minister (ESDM) Poernomo Yusgiantoro four matters causing oil fuel price increases which are oil fuel subsidy incriminating APBN, the subsidy is less reflecting justice for all people, subsidy causing smuggling and illegal oil mixed and not encouraging the use of alternative energy because people tend to be using oil fuel lavishly.

Beside the limited and decreasing of reserved energy of oil fuel, it can be fulfilled by energy comes from geothermal. The potential of geothermal reserved has not been fully utilized to reach commercial level. Indonesia is a country with quite potential reserved geothermal energy, which is 40% of world reserved (Riki F.Ibrahim, Indonesia Geothermal Association), or have total about 219 million BOE with proven reserved 19.66 GW. From the reserved that have been used is around 6851 GWh, with capacity about 787 MW. While on hydro energy also have potential on alternative energy used in Indonesia which is total reserved at 845 million BOE, with proven reserved at 75.67 GW with capacity at 3845 MW.

2.2 Multi Objective Goal Programming (MOGP)
Multiple objective decision making is used to show decision maker situation where the decision making should consider more than one objectives which can not be ignored. These objectives may not always be aligned and often contradictory on one another.

Multiple objective linier model transforms multi objective problems into a group of linier functions. This assumes all variable relations or activities that can be represented in linier function. There are many approaches that can be used or proposed to fulfill multi objectives model, generally can be classify into three basic approach (Ignizio,1976):

- Utility/Value Method
- Ranking/Priority Method
- Efficiency Solution Method

2.3 Double Objectives Solution Progamation Method
Double Linier Objectives Solution Progamation Model is the simplest model than other double objectives programation models. Main differences of common model above is stated at linier function equation. Therefor double objectives solution programation is as below:

\[
\hat{x} = \left( x_1, x_2, \ldots, x_j \right)
\]

To minimize achievement function \( \hat{a} \)
In such a way until fulfill objectives:

\[ C_{i,j}X_j + n_i - p_i = b_i \]

\[ i = 1, 2, 3, \ldots, n \quad \text{and} \quad x, n, p \geq 0 \]

3. Research method

In achieving expected purpose, method that will be applied on optimization non-oil fuel alternative energy plan is consists of four main phases, which are:

- Phase One, problem formulation includes: problem identification, literature study and field survey
- Phase Two, developing model includes: form and define model, model analysis and model validation
- Phase Three, implementing model includes: model implementation by using Quantitative System Version 3.0 and model verification
- Phase Four, determining solution includes: data output analysis and determine the best alternative decision

3.1 Optimization alternative energy model rationale

Several items underlying model definition can be explained below:

- Investment cost
- State income
- Production capacity
- Human Resources

3.2 Modelling Optimization Alternative Energy

In making model decision on Programing Double Objectives to optimizing investment of alternative energy planning,

Minimizing:

By regarding:

\[ a = \{ P_1(p_1) + P_2(p_2) + P_3(p_3) + P_4(n_4 + p_4) \} \]

\[ \sum_{i=1}^{N} X_i CI_i + n_2 - p_2 = BI \]

\[ \sum_{i=1}^{N} X_i M_i + n_9 - p_9 = SDM \]

\[ \sum_{i=1}^{N} X_i P_i + n_5 - p_5 = PR \]

\[ \sum_{i=1}^{N} X_i STP_i + n_6 - p_6 = KAP \]

\[ X_i, P_1, P_2, P_3, P_4, n_1, n_2, n_3, n_4, p_1, p_2, p_3, p_4, \geq 0 \]
4. Data Presentation

4.1 Investment cost data
Investment cost resources must be optimised to gain ship dock investment plan result. Regarding number of investment cost become given limit by investor known as given policy, than the must do effort is to use the cost as optimal as possible.

| Variables | Project Illustration | Operational Cost (Billion Rp/year) |
|-----------|----------------------|----------------------------------|
| Fuel      | Coal                 | 91,815                           |
| Gas       | Natural Gas          | 6,948                            |
| Hydro     | Hydro                | 1,935                            |

Considerate Objectives: Minimize by 100,698

4.2 Human Resources Data/Labour

| Variables | Project Illustration | Number (person) |
|-----------|----------------------|-----------------|
| Fuel      | Coal                 | 121.508         |
| Gas       | Natural Gas          | 1.529           |
| Hydro     | Hydro                | 48.403          |

Considerate Objectives: Maximize by 171.44

4.3 Production Capacity Data

| Variables | Project Illustration | Volume (million/m³) |
|-----------|----------------------|---------------------|
| Fuel      | Coal                 | 94.9                |
| Gas       | Natural Alam         | 0.0866              |
| Hydro     | Hydro                | 82.15               |

Considerate Objectives: Maximise by 177.1366

4.4 State Income Data

| Variables | Project Illustration | Amount (Rp Trillion) |
|-----------|----------------------|----------------------|
| BB        | Coal                 | 64,61045             |
| Gas       | Natural Gas          | 17,24785             |
| Hidro     | Hidro                | 39,689               |

Goal: Maximize 121.5473
4.5 Optimization Model of Alternative Oil Fuel Energy

Formulating Optimization Model of Alternative Energy Investment Plan can be seen as below:

Minimizing:

\[ a = [P_1(p_1) + P_2(p_2) + P_3(p_3) + P_4(p_4)] \]

By regarding:

- Investment cost:
  \[ BB + G + H + n1 - p1 = 100,698 \text{ (billion rupiahs)} \]
  \[ 91,815 + 6,948 + 1,935 + n1 - p1 = 100,698 \]

- Human labour:
  \[ BB + G + H + n2 - p2 = 171.44 \text{ (person)} \]
  \[ 121.508 + 1.529 + 48.403 + n2 - p2 = 171.44 \]

- Production Capacity:
  \[ BB + G + H + n3 - p3 = 177.1366 \text{ (million/m3)} \]
  \[ 94.9 + 0.0866 + 82.15 + n3 - p3 = 177.1366 \]

- State Income:
  \[ BB + G + H + n4 - p4 = 121.5473 \text{ (trillion rupiahs)} \]
  \[ 64.61045 + 17.24785 + 39.689 + n4 - p4 = 121.5473 \]

Which is:

\[ X_i, P_1, P_2, P_3, P_4, n_1, n_2, n_3, n_4, p_1, p_2, p_3, p_4, \geq 0 \]

5. Analysis Result on Running Program Quantitative System 3.0

From the result of running model optimization of alternative non-oil fuel energy plan using Quantitative System 3.0 program, it is known the parameter number of variables (view calculation result at attachment 2).

- Fuel (Coal) = 9.809274
- Gas (Gas) = 0.8409028
- Hydro (Hydro) = 0
- Minimal Objective = 18.69225

When variable value zero it means the department has been optimised, on the contrary if it valuation more than zero then the resources can still be more optimizing. From the two alternatives, the chosen alternative with different priority can produce smaller minimal objective.

6. Conclusion

Based on selection model and conducted optimization at the research it can be concluded that:

1. The planning of investment on alternative non-oil fuel energy selection, have been suggested on three types of alternative energy which are coal, gas and hydro.
2. Optimization model of non-oil fuel alternative energy are consist of 4 decision variables, 4 objectives functions, 3 priority alternatives and 4 achievement functions.
3. From running optimization model using Quantitative System 3.0 program it is known the variable parameter value.

- Fuel (Coal) = 9.809274
- Gas (Gas) = 0.8409028
- Hydro (Hydro) = 0
- Minimal Objective = 18.69225

7. References

[1] Ahyari, A. [1996], Manajemen Produksi: Perencanaan Sistem Produksi, Balai Penerbit Fakultas Ekonomi Universitas Indonesia, Jakarta, Edisi IV.
[2] Azhar, Ali, [2001], “Analisa dan Pemodelan Perencanaan Investasi Galangan Kapal”, Tesis Magister Teknik Program Studi Teknik Kelautan, Institut Teknologi Sepuluh Nopember, Surabaya (Tidak dipublikasikan).
[3] Ciptomulyo, Udisubakti, [1999], Metode Delphi dan Pendekatan AHP Untuk Penetapan Prioritas Kebijakan Energi Alternatif, Teknik Industri Institut Teknologi Sepuluh Nopember, Surabaya.
[4] Chang, Yih Long, [1993], Quantitatives Systems Version 3.0, Prentice-Hall. Dinas Energi dan Sumber Daya Mineral, [2005], Informasi Umum Sumber Daya Mineral dan Energi Indonesia, Jakarta

[5] Djamarus, et al. [1999], Simulasi Perencanaan Program Pembangunan dengan Menggunakan Program Tujuan Ganda, Proceeding Makalah Aplikasi dan Pengembangan Simulasi Komputer dalam Menyelesaikan Masalah Industri di ITS Surabaya, hal 11-18.

[6] Expert Choice, Inc. [1995], Expert Choice Decision Support Software Tutorial, Version 9.0, Mc Lean, Virginia.

[7] Harian Kompas, 25 Februari, [2005], “Pemerintah Menjamin Atasi Dampak Negatif” Harian Kompas, 26 Februari, [2005], “Presiden Siap Tidak Populer Dengan Kenaikan Harga BBM”

[8] Harian Jawa Pos, 6 Maret, [2005], “BBM Kian Mahal Energi Alternatif Tak Kunjung Diurusi”

[9] Ibrahim, F., R., [2001], Pengembangan energi Panas Bumi Menuju Pemanfaatan Energi Masa Depan Indonesia, Kampus Trisakti, Jakarta

[10] Ignizio, James P. [1976], Goal Programming and Extensions, Lexington Books, London

[11] K. Ramanathan, [1994] dalam Lianto, Benny G. [1999], “Technology Choice-An Integrated Approach for the Choice of Appropriate Technology”, Science and Public Policy, vo.21, no.4, August, pp 221-232.

[12] Nasendi, BD, Anwar, Efendi, [1985], Program Linier dan Variasiinya, PT Gramedia, Jakarta.

[13] Saaty, T. L. [1993], Pengambilan Keputusan Bagi Para Pemimpin, Seri Manajemen, No 134, Pustaka Binaman Pressindo, Jakarta.

[14] Saaty, T. L. [1988], The Analytical Hierarchy Process, University of Pittsburgh, USA.

[15] Simatupang, Togar M. [1995], Pemodelan Sistem, Penerbit Nindita, Klaten.

[16] Suparno, [1999], ”Peranan Pemodelan Simulasi dalam Sistem Manufactur”, Proceeding Makalah Aplikasi dan Pengembangan Simulasi Komputer untuk Mendukung Pengambilan Keputusan dibidang Industri Manufactur dan Jasa di TI-ITS Surabaya.

[17] Tabucanon, Mario .T. [1988], Multi Criteria Decision Making in Industry, Elsevier Science Publishers B.V, New York USA.

[18] Wilson, Brian, [1984], Systems: Concept, Methodologies and Applications, John Wiley and Sons Ltd, Chichester.

[19] Soelistijo W., U., Suseno, Triswan, Suherman, Ijang, [2001], Tinjauan Ekonomi Pengembangan Briket Batubara Sebagai Salah Satu Sumber Energi Alternatif BBM, Pusat Penelitian dan Pengembangan Teknologi Mineral dan Batubara, Bandung.