



# An AHP decision making model for optimal allocation of energy subsidy among socio-economic subsectors in Iran

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## ABSTRACT

This paper presents an analytical hierarchy process (AHP) decision model for sectoral allocation of energy subsidy based on several criteria. With determination of priorities for these criteria through questionnaire and AHP method, the overall rank of these criteria that have the most influence on distribution of energy subsidy among socio-economic sub-sectors, are as the following: inflation, economic growth, labor intensity, distribution of energy subsidy among socio-economic levels, energy intensity and social cost of air pollution. According to the model, the first priority for allocation of energy subsidy is commercial sector and the last priority is related to transportation sector. Investigating the impact of changing priority of the criteria on overall results indicates that the socio-economic sub sectors' ranking in receiving subsidy have little sensitivity for changing priority of the subsidy criteria.

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## 1. Introduction

Recent OECD studies defined a subsidy in general terms as any measure that keeps prices for consumers below market levels, or for producers above market levels, or that reduce costs for consumers and producers, (OECD, 1998).

In Iranian economy energy subsidies for socio-economic sub-sectors were more than US \$ 41 billion in 2006. In this year the biggest part belongs to gas oil with 24.4 percent of total energy subsidy and electricity is in the second stage with 19.7 percent of total energy subsidy. In that year, transportation sector had the most energy subsidy among socio-economic sub-sectors; 42.7 percent of total energy subsidy had been allocated to this sub-sector. Household sector had the second priority with 25.7 percent. Commercial sector had the lowest energy subsidy with 3 percent of total energy subsidy, (Ministry of Energy, 2006).

Optimal Allocation of Energy Subsidy among socio economic subsectors is a multi-attitudes decision making problem that plays a key role in solution process. To assess the decision maker's preference explicitly with a preference model, many efforts have been made to develop the theory and methodology for preference assessment. In the current literature, the most preferred approach is analytic hierarchy process (AHP; Saaty, 1990).

An AHP allocating energy subsidy model is developed in this research. The decisions are addressed from the perspective of

determination of optimal allocation of energy subsidy among socio-economic subsectors or a reallocation of energy subsidy and improvement of the current allocation. Both qualitative and quantitative ratings are considered in this model. The model is illustrated through an application model.

This paper consists of six sections. After introduction, Section 2 presents the literature review. There, then follows modeling procedure. Optimal allocation of energy subsidy within decision making model based on AHP is presented in Section 4. Applying model is developed in Section 5. An illustration of the solution procedure and the results are in the final part.

## 2. Literature review

### 2.1. Previous studies on energy subsidy

Lewis (1993) analyzed the economic impacts of tax system and energy subsidies on Indonesian economy in 1980s. Using simulation model, this study reveals the small impacts of tax or subsidies abolition on energy consumption. The taxes or subsidies abolition affects consumption through income effect. Within the types of fuel taxes and subsidies, the gasoline tax abolition gives the biggest impact to the increasing of fuel consumption. Meanwhile, the kerosene subsidy abolition gives the biggest impact to the decreasing of fuel consumption. According to the results of simulation, we can conclude that tax system and energy subsidies cause a significant distortion on Indonesian economy and the level of welfare.

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Garbaccio et al. (1999), analyzed the usefulness of tax in order to reduce carbon emission in China. It presents dynamic CGE model of China economy. This model used market institution and planning component to measure the effect of tax on population growth, capital accumulation, technology improvement and changes in demand. In the simulation, they assumed that there were 5, 10 and 15 percent reduction in carbon emission. The results showed that those carbon emission reductions, reduce GDP and consumption in the first year. However, the impact would be positive in the next 30 years, for example 5% carbon emission reduction would increase GDP approximately 34% in the next 30 years.

Naqvi (1998) developed Energy CGE model in Pakistan, which is known as GE-PAK. This model is based on a neo-classic assumption and can capture the relationship between economy, energy and social equity. GE-PAK is constructed using Social Accounting Matrix (SAM) data, which has complete Input–Output (I–O) table.

factors that prevent the poor from using the services. They then conduct simulation to quantify how much targeting performance could be enhanced by changing tariff structures as well as subsidizing connections instead of consumption.

## 2.2. Economic and environmental arguments in energy subsidy

There are many subject matter issues that were discussed in energy subsidy literature; they are divided into two major categories; first, economic argument, and second, environmental argument.

In first category, impact of subsidy reduction policy on economic factors is discussed. In second category, impact of price adjustment policy on environmental variable is discussed. In the following puzzle, economic and environmental variables are presented.

Environmental variables	Author year	N	Economic variables	Author year	N
Air quality on energy and household income	Resosudarmo, 1996	1	National economic, energy consumption, level of welfare	Lewis, 1993	1
Tax increasing in order to reduce carbon emission	Garbaccio et al. (1999)	2	Economy, household income	Resosudarmo, 1996	2
Carbon tax on quality of environment and people welfare	Felder and Schleiniger, 2002	3	Activity of energy intensive industries	Bohringer, 1998	3
Green tax policy affects on environment variables, nation economic and household income	O’Ryan et al., 2002	4	Population growth, capital accumulation, technology improvement and change in demand	Garbaccio et al. (1999)	4
Clean air program on national economic and household income	Resosudarmo, 2002	5	Economy, energy and social equity	Naqvi, 1998	5
			GDP, unemployment rate, saving rate, income distribution, efficiency in energy consumption	Negara, 2000	6
			People welfare	Felder and Schleiniger, 2002	9
			National economic, household income from different socio economic level	Resosudarmo, 2002	10

This I–O table consists of 131 commodities from 128 industries and income–expenditure data from 4 institutions, i.e. households, companies, government and external institution.

Bohringer et al. (2003) analyzed the impacts of emission reduction policy using two approaches, i.e. environment tax escalation and Joint Implementation (JI). JI is the cooperation activities between Germany and other countries (e.g. India). Germany gives funding to India for emission reduction program implementation, which will improve air quality in the world. This paper reveals that the JI approach is much more cost-efficient compared to environment tax escalation policy.

Angel-Urdinola and Woden (2007) provided a simple framework to analyze the determinations of targeting performance of utility tariffs using simulation model and applied it to data on electricity in Capeverde, Rwanda and Sao tome and Principe. They developed a simple decomposition that allows analyzing both “access” and “subsidy design “factors that influence the targeting performance of subsidy. The findings suggest that consumption subsidies for electricity are regressive in large part due to access

## 2.3. Modeling procedure

We use an analytical hierarchy process (AHP) decision model for sectoral allocation of energy subsidy, determining criteria that energy subsidy influences them. These criteria that have been widely used in energy subsidy researches are as the following: economic growth, energy intensity, labor intensity, inflation, social cost of air pollutions and distribution of energy subsidy among socio-economic levels. The process of modeling is as the following:

## 2.4. Quantifying of the criteria

### 1) Energy intensity:

When we decrease volume of energy subsidy, price of energy goes up and consumption of it declines, Therefore energy intensity goes down and this criterion will be better than before. For computing quantity of criterion, we define macro-economic formula among socio-economic subsectors for

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