CEESA –project

WP 4: Market Development and Public Regulation

Working Paper
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A Framework for the Description and Evaluation of Renewable Energy Policy Measures

by

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1. Introduction

The objective of the Ceesa-project is to develop scenarios for a future energy system with a 100% penetration of renewable energy technologies in a long term time perspective. The research project combines in a unique way scientific knowledge and methods from three areas – 'Energy systems', 'Life-cycle analysis', and 'Market design' – that normally are not integrated in one project.

The special purpose of this paper is to present a framework that explicates all the relevant dimensions of market design that must be addressed analytically and politically in order to make sure that a relevant combination of regulatory instruments can be accommodated.

The premise of the market design is that it must facilitate the penetration of higher shares of RE-based energy in the Danish energy system by 2025. This penetration happens over time in a dynamic process of 'creative destruction' when some energy technologies are phased out and others are phased in order to achieve the new mix of energy technologies.

Since the focus is on the ‘developmental path towards 2025’ a dynamic approach must be taken and this entails a real time based monitoring of the transition – and whether it should be slowed down or speeded up. The context in which this happens cannot be assumed constant. Low penetration rates and unintended effects may occur, also unexpected changes in the rate of change in the climate, in oil prices, oil supply, in our knowledge of the ‘state of the problems and solutions’, and in local and international political concerns and coalitions may lead to shift in the use and value of various instruments.

The reference case for this design is the mix of instruments used from 1977-2005 to facilitate the highly successful penetration of wind power in the Danish energy system. It is assumed that the proposed market design shall facilitate similar – and even larger – effects in terms of transformation and penetration. Thus, the reference case illustrates the penetration of fluctuating energy technologies can be seen as ‘breaking into’ and disturbing the existing energy system.

The forward looking towards 2025 explicitly aims at increasing the penetration of fluctuating energy technologies in the energy system. This demands both R&D programs as well as design of market regulating mechanisms that can facilitate such a transformation: a transformation that can accelerate the relatively high penetration of fluctuating energy technologies in the Danish energy system from 1977-2006.

2. Framework conditions for WP4: Market Development and Public Regulation

2.1. Energy scenarios for 2025

The important task in WP4 is to analyse market design, market organization and public regulation needed to implement the long term renewable energy scenarios. In WP1 of CEESA the following three alternatives are suggested as a starting point for the project:

- ***Biomass scenario***. Based on the IDA 100% RES low demand, mostly biomass.
- ***Wind scenario.*** Based on the IDA 100% RES low demand, mostly wind
- ***High demand.*** Based on the 2004 energy demand, both wind and biomass.

These scenarios are developed on the basis of existing work mainly carried out in Danish Society of Engineers (IDA). The targets of the scenarios made by the Danish Society of Engineers are

- To maintain self sufficiency when oil and natural gas resources in the North Sea are depleted
- To demonstrate the possibility of large scale renewable energy supply.

For more information on the scenario part of CEESA, see the report of WP1.

Similar analyses are carried out in the Danish Technology Council 2006 (Teknologirådet). These scenarios are visions for the long term development of the Danish energy system. The targets of the scenarios made by the Danish Technology Council are

- To reduce CO_2 emissions by 50 % in 2025 as compared to 1990 level
- To reduce oil consumption by 50 % in 2025 as compared to 2003 level.

Both studies, however, lack from suggestions of the policy instruments needed to fulfill these scenarios.

2.2. Aim and disposition

One of the aims of the CEESA project is to identify the most efficient policy measures for regulating the energy market. At the Tune meeting January 10-11 a common need for making assumptions about future policy measures were promoted. In the Market group (working package 4) we decided to develop a catalogue of regulatory instruments to be presented at the common meeting in August 2007.

The regulatory instruments are aiming to implement the renewable energy scenarios for 2025 as was developed by Lund et al 2006. We do not expect that these scenarios can be fulfilled without political action. Most of the technologies included in the scenarios are not able to penetrate existing technologies in the market without the introduction of regulatory instruments by political decisions. It is a big challenge to transform the present energy system based mainly on fossil fuels into the renewable energy scenarios as defined by Lund et al 2006.

The intentions of this working paper is to outline the analyses related to market development and public regulation that will be carried out in WP4 of the CEESA-project. This outline has to be seen as the starting point for the reporting from WP4 and will gradually be expanded to include all the relevant issues to be covered in relation to markets and policy instruments. From our viewpoint it is important that this outline reflects the multidisciplinary nature of the CEESA-project, bringing new and visionary thoughts also into the arena of policy measures.

The disposition of the final reporting from WP4 will include the following sections:

Section 3: Institutional framework
Section 4: Organisations and markets
Section 5: Market regulation and policy instruments
Section 6: Political and administrative arena
Section 7: Conclusion and recommendations

In the following contributions to some of these sections are drafted for discussions at the august-seminar.

3. Institutional framework

3.1. Markets as institutions

Markets are not ‘natural’ entities, and yet economic actions are often understood as the result of market laws that look as hard as ‘natural laws’. This may seem paradoxical if the market economy is conceptualized from a purely neoclassical ‘text-book’ perspective, for which institutional intervention is an ‘artificial’ operation that may hinder the natural efficiency of free and competitive market mechanisms. where institutions are seen as hindering economic exchange in the context of such terms like ‘free’ and ‘pure’ markets. But if markets are theorized from the broader perspective of institutional economics, the paradox dissolves because, as hard as their laws may be, markets are always ‘instituted’ processes. The market economy is not naturally existing in all cultures, but represent a specific cultural construction: think for instance of the variance in institutional transformation of old Soviet, Eastern Europe and Chinese ‘planning economies’.

Moreover, any empirical contact with the price structures and forms of competition in the Danish and European energy sector lead directly to political regulations and controversies about the different possible institutional arrangements. Look at the so-called de-regulation of the energy sector where new market actors are legally created, new rules for competition and limits to competition are negotiated, rules for use of grids are negotiated, and where taxes and price models are made and re-made. It is even clearer that the market is constructed and accomplished through the details of the regulations, and not existing outside or without regulations.

Based upon an institutional economic understanding of markets (Coase 1988, Ménard 1995, Fligstein 2001), the market is here defined (similar to Callon 2007), as a specific institutional arrangement (consisting of rules and conventions, technical devices, metrological systems, texts, technical, scientific, legal and economic knowledge), that facilitates economic exchange (the voluntary transfer of property rights) of an economic good by some pricing mechanism. The economic good must be legitimate in relation to explicated and accepted externalities (Callon 1998). The type and model of competition (substitution) can vary with institutional regulations and market dominance of certain economic actors.

3.2. From the rhetoric of ‘pure and efficient markets’ to different configurations of value and performance

From the institutional understanding of markets there are no natural, pure and free markets as any economic actor and commoditized good reflect an implicated institutional arrangement that shapes cost, prices, properties of the good, and competition. Further, neither the actors involved in the historical formation nor the competitive process assures that that the ‘best’ alternative survives in the evolutionary process (March 1992). Due to the co-evolutionary development of techno-economic structures and the implicated institutional arrangements ‘technological variation’ and ‘market selection’ are not mutually independent. Indeed, multiple actors shape (politically, commercially, scientifically, etc.) both variation and selection conditions, and the developmental path is ongoing subject to contingent random events that may reinforce or weaken a fragile technological path until some irreversibility is achieved (e.g. the situation of the Danish Energy system when Riisager made history by connecting wind power to the grid) (March 1992, David 1985, Callon 1991, Karnøe and Buchhorn 2007).[1]

Following this understanding neither historical development nor competition are efficient in terms of the 'best' winning out, but still some technologies stand out as the result of a complex historical process – as the Edison-type centralized base-load system in Denmark. The winning technologies stand out as winners because some-body shaped the conditions for their existence, i.e. their R&D was sponsored, their products were allowed to exist with certain properties and become subject to market transactions. Think about nuclear power the last 50 years: success or failure despite enormous public R&D-funding and market creation; and its near death by late 1990's, and its attempts at revival in the context of global warming, Karnøe and Garud (2007). It may thus be relevant to use the term 'regime of value' for a certain dominant commoditized energy technology such as 'fossil based energy production', 'nuclear power energy production', 'combustion engine private transportation with high CO2 emissions', since the profits that winners can make cannot be separated from the institutional arrangement. A regime of value emerges out of a complex developmental process, and may become a stabilized, not contested solution, which therefore resembles an economic equilibrium where supply side producers and demand side buyers repetitively act accordingly and re-produce the regime.
The regime of value is not 'pure' nor 'best' but reflects in a complex way the particular price/cost factors that are implicated in the institutional arrangements by which the regime was formatted and politically sanctioned (from G8 to local trades – this is an ongoing negotiation).

The Stern-report illustrates this point as it brings attention to externalities back at centre stage for political market design. It concludes that not taking externalities serious was the biggest market failure in last century – and now we pay the price. This externality view on economic processes in the energy sector implicates that existing fossil fuel energy technologies historically have had 'lower costs and prices' than if externalities had been enforced. And consequently these technologies have had much better competitive positions compared to alternative energy technologies (of any kind – not only renewable). From this perspective fossil fuel energy technologies were subsidized as the environmental costs were excluded from their cost structures. It is therefore important to contest the legitimacy of such sentences – 'renewable energy cannot at present make it on pure market terms' (Danish Prime Minister June 9th 2007, interview Politiken Newsaper section 1 p. 6). This understanding does not reflect the 'reality' of wind power, if one believes the many studies on social cost (i.e. ExternE-report 2003, Skou Andersen 2006). The point here is not to advocate an easy defined optimum on externalities, but to avoid the simplistic political rhetoric as well as pointing to the externality issue as one of the

[1] See Granovetter and Maguire's (1998) study of Edison's successful attempt to organize political, managerial as well as technological networks to compete against gas-lightning and Westinghouse system of alternate current.

biggest areas of contestation as well as one of the most important ones for coercive regulation and economic incentives for future energy technologies.

Therefore the objective of the Ceesa-project to increase the RE-penetration must be seen from a perspective where the 'efficiencies' of existing energy markets reflect institutional arrangements and politically sanctioned ways of regulating the working and effects of a particular market configuration.

In times like the present where the global warming problem is translated into the bedrock of the Stern Report and gradually increased political will and commitment to deal with the existing energy systems, a massive increase in market-based RE-penetration will entail a disruptive transformation of the entrenched and existing actors. They may have something to loose when the status quo is challenged by innovative creative destructions. This innovative challenge must include more than the 'technical' technology because the existing institutional arrangement is favouring certain technologies for market – and they will have will have a cost-advantage. Therefore creative destruction and the development of new techno-economic structures implicate the co-creation of new institutional arrangements for the future energy market: this is the most important agenda.

3.3. A framework for experimental market design: in vitro and in vivo

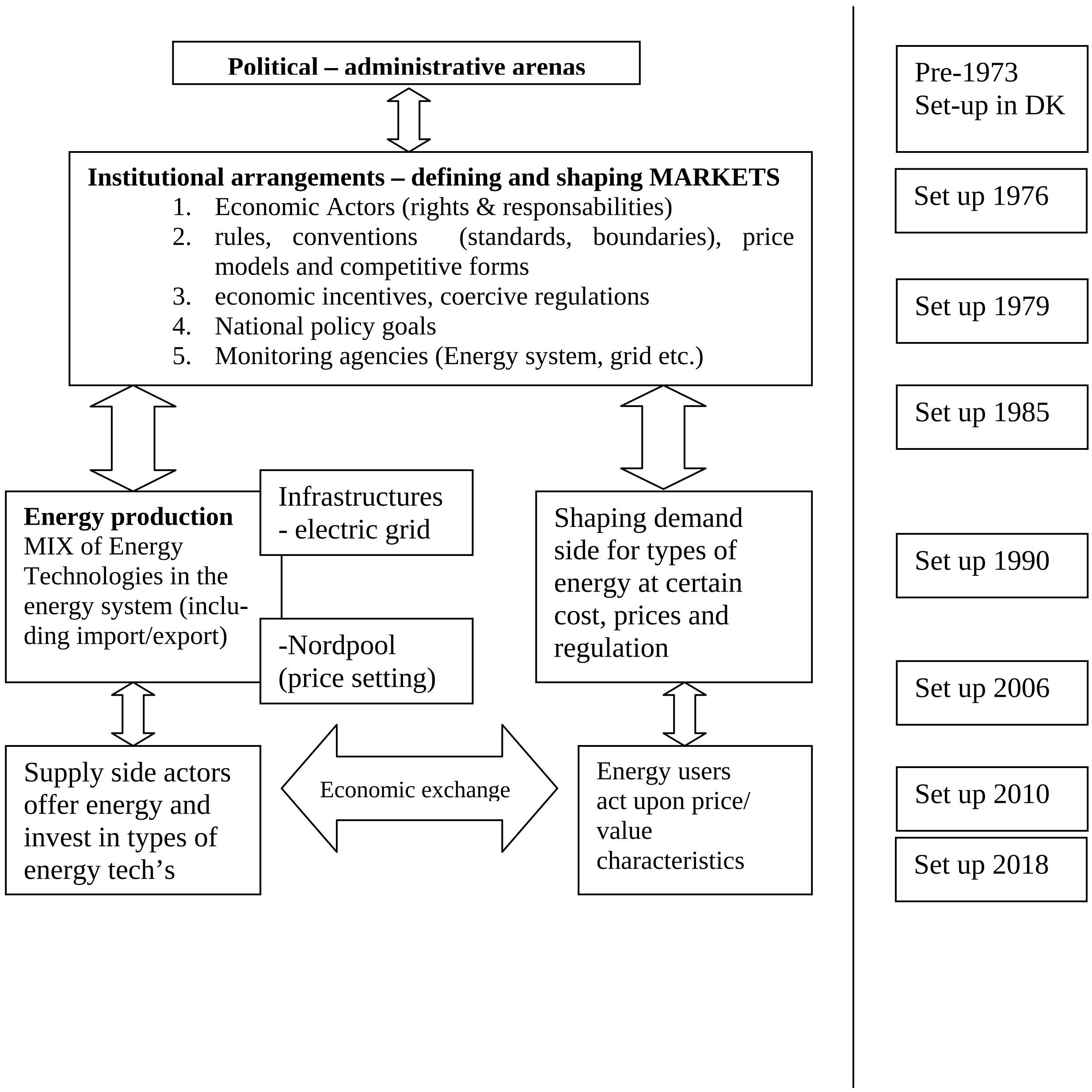
The relation between the work of the Ceesa-market design and the real life effects of this in shaping real markets can be illustrated by the well-known terms from the experiments in pharmaceutical industry: in vitro and in vivo effects. The Ceesa market design group experiments with alternative models for market designs in their 'laboratory' (in vitro), but in order for the selected model to become relevant for real market transactions it must be translated into specific institutional arrangements (in vivo). And yet since 'all things are not equal', as they are with the controlled situations in the laboratory model, it is not known exactly how the reactions will be to the proposal and how the economic effects will be. For example the Danish certificate market for that was designed in vitro in 1999 did never facilitate any economic transaction in 'vivo' (Hvelplund 2006).

3.4. The task for market regulation in the Ceesa-project

The key criteria for the market design is not the lowest possible prices of energy, but price structures and regulations that can facilitate a transformation of the Danish energy system towards a higher penetration of fluctuating energy sources at reasonable prices when (relevant or all?) externalities are taking into account. (How to build in long run 'efficiency' when it contrasts short term optimum?)

The following chapters in this report are structured in order to highlight the most salient dimensions of market design according to the framework shown in figure 1.

Figure 1: Market design: Simplified model of the co-existence of techno-economic structures and the implicated institutional arrangements (set up). Set-up in years illustrates changes in DK 1976-2018



4. Organisations and markets

Issues to be addressed in this section will include:

- Organisation and ownership
  - The process towards 2025
  - Which structural changes are needed in infrastructure and regulation of the energy system?
- Power markets and CO2 trading systems
  - Market designs, including gate closure time etc.
  - Interactions of markets and measures

5. Market regulation and policy instruments

The design of renewable energy scenarios for Denmark in 2025 needs knowledge about the technical possibilities in the years to come. What are presently the best available technologies and how will they develop over the next two decades? Will new technologies be available in the years to come? And how will different technologies interact in the whole energy system? The challenge of the designer will often be to target a physical object (e.g. a specific level of reduction in green house gas emissions or a use of renewable energy sources) with the lowest costs to society compared to a business-as-usual scenario. Scenarios are often based on bottom up analysis founded on very specific technologies and system analysis models including learning effects, synergy effects between technologies and energy resource restrictions. The renewable scenarios for 2025 to be analysed within the CEESA project are the results of such a design process.

The target of a Danish energy system in 2025 based on 100 % renewable energy is very ambitious. In 2005 renewable energy accounted for 15.5 % of total energy use in Denmark. Since 1985 renewable share has increased from 4.6 %, see Table 1. Waste, wind and biomass are the dominant renewable sources in Denmark, see Table 2.

Table 1: Renewable energy in percent of total energy consumption in Denmark – 1985 to 2005

Year	1985	1990	1995	2000	2005
Renewable energy share	4.6	6.4	7.4	10.5	15.5

Source: Danish Energy Authority, www.ens.dk

If the penetration of renewable energy develops linear along the historical trend the 100 % target will be reached in year 2160 if development since 1985 is the basis for extrapolation or in year 2090 if tail end from 2000 to 2005 is making the basis for the forecast. When making these very simple forecasts it is worth to consider that the penetration of renewable energy has been based on massive support schemes. A good example is wind power. Still after the liberalisation of the Danish electricity market support to wind power production is in range billion 1.5-2 DKK per year, Munksgaard and Morthorst 2007.

On this background it is relevant to question: How could 100 % renewable scenarios be reached and what are the path to be chosen between the present 2007 energy system and the 2025 energy scenario?

5.1 Is there a need for market regulation?

The development of renewable energy in the Danish energy system has to face the liberalization of energy markets. Since year 2000 the markets for electricity and gas has been liberalized and the support to renewable energy has been redesigned. The tariffs offered to wind power producers are today less attractive to the producers as producers have to adapt to market prices as compared to the previous more favourable price guarantees (so called feed-in-tariffs applied in the 1990'ies).

The relatively strong position of wind power and straw, see Table 2, is not due to the market forces but to the use of strong support from policy measures. Through heat planning biomass was supported when Danish district heating in the 1980'ies and 1990'ies were transformed from boiler technologies into combined heat and power plants. Also the development of wind power was heavily supported in the pre-market regime where the Danish electricity sector was a de facto monopoly acting on a cost of service basis, i.e. prices were set to balance actual costs.

The liberalization of energy markets implies that monopoly privileges are replaced by competition thereby making a potential for efficiency gains. Efficiency gains imply that high cost production technologies are substituted by low cost technologies having a better opportunity to make a profit in the market. As renewable technologies are high cost technologies compared to most fossil fuel technologies they will most likely suffer from liberalization unless they could benefit from energy market regulation.

However, is there a need for market regulation after markets have been liberalized?

Yes, one could pay attention to at least two reasons to regulate the energy markets by policy measures: One is that energy markets are imperfect in the sense that energy markets do not cope with external environmental costs from energy use; two is that political environmental targets have become more ambitious than the market forces are expected to fulfill.

Market imperfections also call for policy measures in order to improve the efficiency of the market. A good example is environmental externalities not considered by the market. Environmental externalities mean that the producer leaves over the environmental costs to be paid by the society.

Policy measures are aiming to fulfill targets set by the politicians if market by itself is not able to fulfill the targets. Given the targets, aim of the measures are to fulfill the targets in an efficient way. From an economic point of view efficiency implies that welfare is optimized and/costs of regulation is minimized.

5.2 Theoretical considerations

[Not much literature found with specific focus on the need for policy regulation with regard to renewable energy. In the area of environmental economics I have found:

- Van den Bergh, J. 1999: Handbook of Environmental and Resource Economics. Part 3: Economics of Environmental Policy, Edward Elgar
- Hanley N; J.F. Shogren and B White 1997: Environmental Economics – in Theory and Practice].

5.3 Catalogue framework considerations

In order to make a catalogue of policy measures to support renewable energy technologies some questions can be raised: How should the framework of the catalogue be? And what is the purpose?

The catalogue should include general measures targeting all kind of renewable energy technologies as well as measures of relevance to specific energy technologies, e.g. wind power and transport energy.

Besides a list of potential measures, there is a need to develop criteria in order to rank the proposed measures or to select the most efficient measures. Selection criteria could be:

- Effectiveness
- Efficiency
- Experiences from other countries
- Distributional considerations
- Fiscal aspects (effect on public revenue)
- Monitoring and control.

One could consider the use of a matrix structure for the assessment of the policy measures. One dimension is the kind of policy measure proposed. The other dimension is the criteria for evaluating the measures. Summing up the scores on the different criteria could make a total ranking of the measures.

In Russell and Larsen 2007 such a matrix structure is applied for the description of alternative measures to regulate point source pollutions. The paper includes criteria for evaluation of the policy measures. Reiche and Bechberger 2004 include a matrix of the distribution of the policy measures on European countries.

The catalogue could also include an overview of renewable energy measures used in Denmark and in other countries. International Energy Agency (IEA) supply a database including information on the use of renewable energy technologies in EU countries:

Global renewable energy policies and measures database
http://www.iea.org/textbase/pamsdb/grindex.aspx

We have discussed the possibility of making description from different theoretical approaches, e.g. politics, context and economy.

5.4 Catalogue of policy instruments

This section is a description of alternative policy measures which could be used to promote renewable energy scenarios. The list is a first draft and therefore, off course, calls for further development.

- **Taxes**
  - *Green tax (producer tax on energy or emission, e.g. CO2)*
    A green tax is a standard text book policy measure which aims to compensate for the external economies of energy markets. Green taxes should be equal to the external damage costs paid by third parties. Due to uncertainty it is difficult to estimate the damage costs though several attempts have been done, e.g. EU External E (more references). Renewable energy benefit from green taxes in the way that their competitiveness in the market is increased as the production costs of fossil fuel technologies are increased. Green taxes are considered to be a first best policy measure as it repairs the market imperfection that producers face too low production costs by not taking into account external damage costs. Further, green taxes are considered to have a low impact on allocations from other markets. Contrary to what has been the practice in Denmark green taxes should be levied on the fuels used for production or consumption and not on produced energy like electricity and district heating. Thereby, the tax will directly influence the producer decision about the fuels to be used.
  - *Production tax credits (REPC)*
    Subsidy given to specific technologies as a tax credit. In US a tax credit of 1.5 cents/kWh is given to electricity produced from wind, biomass, solar and geothermal, Palmer and Burtraw 2005
  - Exemption from energy taxes
  - Energy taxes finance renewable energy supply
    Surcharge on electricity consumption. Tax revenue used for auctions allowing renewable energy producers to bid for per-kWh subsidies
- Certificates and qoutas
  - Tradable certificates
    - Markets for SO2 and NOx
    - Revenue from free CO2 certificates has to finance investments in renewable technologies
  - Non-tradable CO2 certificates (quotas)
  - Tradable green certificates (used in UK, Sweden, Belgium and Italy, Palmer and Burtraw 2005

    - Renewable portfolio standard (RPS)
        i. Renewable energy sources have to account for a minimum share of electricity production or sales by a particular date. Flexible is included, i.e. trading of renewable energy credits to meet the requirement. Used in some states in the US, Australia and Japan, Palmer and Burtraw 2005
- Funding to research, development and demonstration of renewable technologies (RT)
- Cheap investment loans for renewable technologies (e.g. DUF)
- Feed-in or premium tariffs (price guarantee): electricity and others?
- Investment subsidies
- National subsidies to industries, e.g. nuclear and coal
- Tendering or bidding system
    - Bid to supply renewable energy of a particular type for many years for a minimum price of electricity
- Norms for energy consuming appliances and apparatus
    - Limits for environment effects, e.g. emissions
    - Norms for energy efficiency
- Information campaigns
- Marketing.

[Each measure will be described (defined) and could include pros and cons of each measure – three of each. Interactions between policy instruments will be discussed. We will also stress the importance of the context for using the policy measures. The point is that the context in which the measure is applied has a big influence on the outcome of the proposed measure. Within the field of sociology that approach has been promoted by Pawson and Tilley, see Pawson and Tilley 1997.

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