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A method for assessing support schemes promoting flexibility at district energy plants

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HIGHLIGHTS

- District energy plants may become major actors in integrating wind and solar power.
- Often electricity prices do not create sufficient feasibility for needed investments.
- Support should be minimized while ensuring adequate installed capacity at plants.
- Method for determine the production and store capacities support schemes will promote.
- The method used shows a premium scheme promotes more flexibility than a FIT scheme.

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ABSTRACT

Flexible District Energy plants providing heating and cooling to cities have an important role in the transition to a renewable energy system. They may become major actors in integrating wind and solar power, when equipped with a combination of combined heat and power units, heat consuming absorption chillers, heat pumps producing both heating and cooling and large thermal energy stores.

However, often electricity prices do not create sufficient feasibility for these to be installed thus calling for support schemes. The societal resources dedicated to support should be minimised while ensuring the establishment of an adequate amount and right ratio between these units. This paper presents a method for determining the capacities different support schemes will promote as a function of dedicated resources. The method is used in a comparison of two support schemes promoting combined heat and power; a premium on top of hourly wholesale electricity prices and a fixed Feed in Tariff. The comparison shows that the premium scheme requires a little less total support than the Feed In Tariff scheme for promoting a given amount of electrical capacity, but promotes a five-times larger thermal energy store capacity, thereby promoting substantially increased flexibility for integrating intermittent power production.

1. Introduction

Climate change has been on the global political and environmental agenda since the 2015 Paris agreement [1] established a common target to limit global warming to well below 2 °C. Most countries are therefore seeking ways to reduce greenhouse gas emissions [2].

The European Union (EU) has set a target of 40% reduction in CO_2-emissions by 2030, compared with 1990 [3]. In order to achieve this target, certain actions are planned, amongst others a revision of the EU Emissions Trading System after 2020 [4] and binding emission targets for all the EU member states for the sectors outside the ETS until 2030 [5]. Regardless of the ways for the reduction, enhanced deployment of renewable energy sources (RES) is one of the main elements; sources that to a high degree are of an intermittent nature.

Concurrently with the transition of the energy system, the United Nations (UN) World Urbanization Prospect [6] has described an ongoing urbanization worldwide. Today more people live in urban areas than in rural areas, and the Prospect projects that by 2050, 66% of the world's population will be urban. This impact both which RES to use and how to use these for covering demands. Appropriate technologies for covering heating and cooling demands depend for instance on the demand density in the cities, where the high densities favour the District Energy (DE) systems.

The UN Environment Programme [7] states that half of the energy

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Nomenclature

Flexible units units that may advance or defer production or consumption through access to thermal storage. Includes Combined Heat and Power (CHP) units, Heat Pumps (HP) and electric chillers
Premium scheme support scheme, with a fixed price supplement on top of hourly wholesale electricity prices
FIT scheme in this paper, a Feed In Tariff scheme is a support scheme, where the electricity producers get a fixed price in all hours

used in buildings today is heating and cooling and that most of this comes from fossil fuels. It further states that DE is a tried-and-tested answer to a more sustainable coverage of urban heating and cooling demands, however current DE development is limited [8].

The research project Heat Roadmap Europe [9] concluded that a 30–40% reduction of the existing heat demand in Europe is socio-economic feasible, and approximately 50% of the remainder should be covered by DE. As an indicative figure, the project finds that when the heat density is above 120 TJ/km^2, DE is socio-economic the cheapest way of covering the heat demand. A thermal atlas [10] made in the Heat Roadmap Europe shows e.g. that parts of all major cities in Germany and the United Kingdom have higher heat densities than this threshold. DE plants providing heating and cooling to cities should thus have a significant role in the emission reduction and transition to a renewable energy system.

Providing heating and cooling to multiple buildings, DE systems can use far larger sources of heating and cooling than can be connected to just one building [7]. The sources include waste heat from industry or power stations [11]; large solar thermal [12]; heat from groundwater and sewage systems [13], free cooling from lakes, rivers or seas [14] and geothermal energy [15].

The role of DE plants changes with the renewable energy exploitation. Before a country has developed a comprehensive amount of intermittent renewable energy production, DE plants primarily displace fossil fuel-based condensing mode power plants, heat production on individual and communal boilers [16] and cooling from electric chillers. This is accomplished though cogeneration of heat and power (CHP) and trigeneration units that are producing as much electricity as the heat and cooling consumption allows.

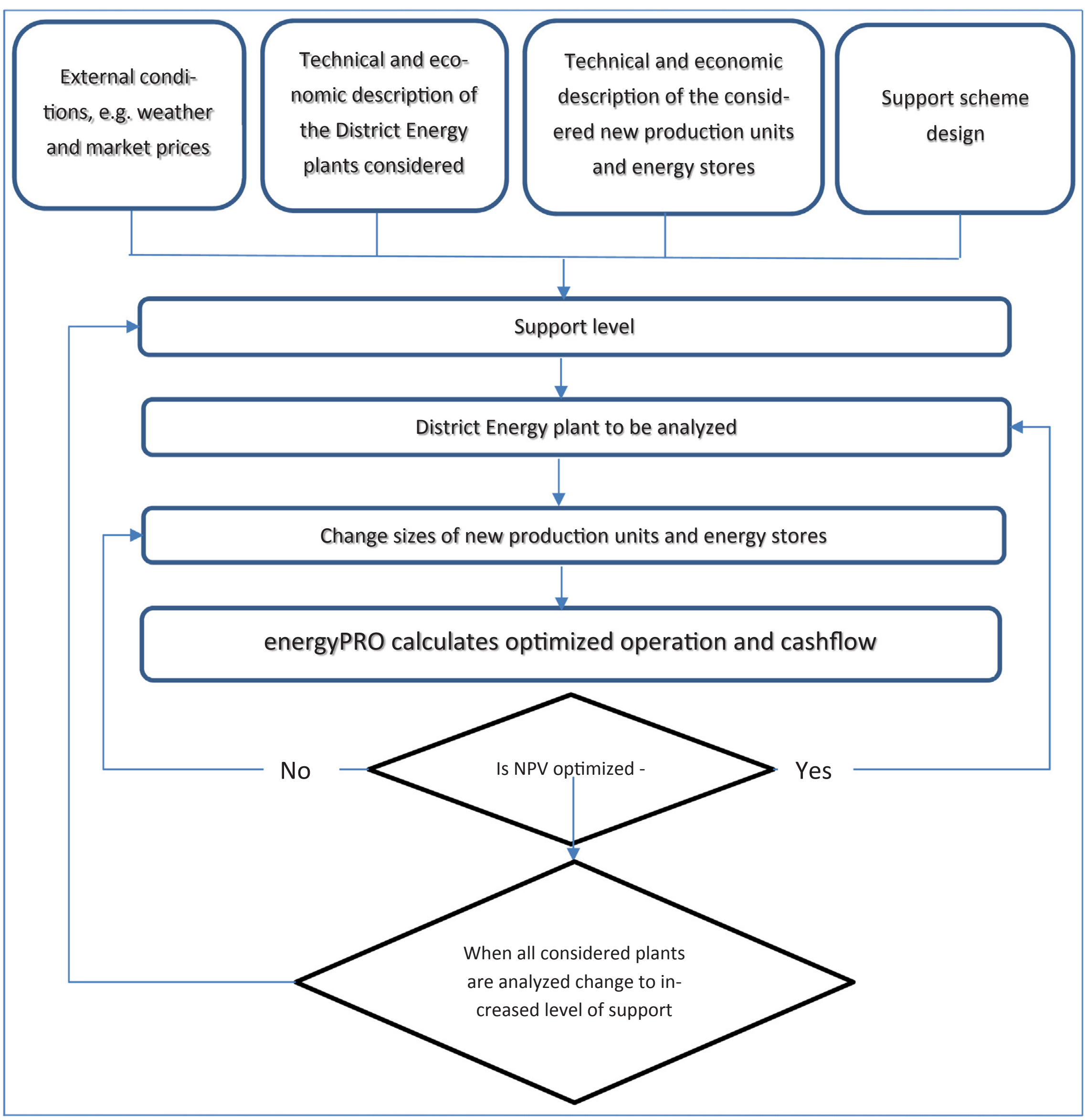

Fig. 1. Flowsheet for quantifying the costs of support schemes.