# New parameters for TIMES under TIMES-VDA

Amit Kanudia & Antti Lehtilä

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## 1 Overview

This document describes the TIMES attributes available when using the VDA extension of TIMES. The VDA extension has been implemented originally for streamlining the interface between VEDA-FE and TIMES by introducing new attributes that make it easier for the user to specify some very commonly-needed process attributes, CHP parameters, and commodity relationships. However, the extension can be used equally well in other environments.

## 2 New TIMES attributes in the VDA extension

### 2.1 ACT_EFF

Syntax: ACT_EFF(reg,datayear,prc,cg,ts)

Description:

ACT_EFF can be used for defining process efficiencies of most processes. The parameter value defines the amount of activity that can be produced by one unit of flow of a commodity or commodities on the shadow side of the process. The shadow side of a process is the side opposite to the side of the primary group (PCG). ACT_EFF cannot be used for storage or trade processes.

The commodity groups CG in ACT_EFF attributes can be any of the following:

- commodity groups; these define a common efficiency for all member commodities in the group that are on the shadow side of the process;
- commodity types (NRG/MAT/ENV/DEM/FIN); as above, these define a common efficiency for all member commodities in the group that are on the shadow side of the process;
- the predefined commodity group ACT ; this defines a common efficiency for all members of the standard shadow group of the process, as determined by the model generator;
- single commodities on the shadow side without an associated group efficiency; these define commodity-specific efficiencies, and the shadow group will consist of all commodities of the same type; if no commodity efficiency is defined for some member in the group, the default efficiency 1 is assumed;
- single commodities on the shadow side with an associated group efficiency; these define commodity-specific efficiencies as above, but are multiplied by the efficiency specified for the group; if no efficiency is

defined for some member in the group, the group efficiency is applied directly to that member;
- single commodities C that are members of the PCG of the process; these define commodity-specific multipliers for the process efficiency when producing the commodity C; if no efficiencies are additionally defined on the shadow side of the process, the whole standard shadow group of the process is assumed to be involved in the transformation (as when using ACT ), with the default efficiency of 1 on the shadow side.

The ACT_EFF parameter can also be shaped by using a FLO_FUNCX parameter of the following form:

FLO_FUNCX(reg,datayear,p,CG, ACT ) = shape index;

The CG should correspond to the group of commodities on the shadow side involved in the process transformation equation (the group, commodity type, or ACT 'that was either explicitly or implicitly used in the ACT_EFF parameters that should be shaped).

## 2.2 VDA_FLOP

Syntax: VDA_FLOP(reg,datayear,prc,com,ts)

Description:

The VEDA Flow Parameter (VDA_FLOP) can be used to define relations between the process activity and the flow of any commodity COM in the process topology. The parameter value defines the amount of flow in commodity COM per one unit of activity. VDA_FLOP can be defined for any individual commodity C of a normal process, except for commodities in the primary group. It cannot be used for storage or trade processes.

Remarks:

1. In earlier versions of VEDA, VDA_FLOP was also used for defining process efficiencies. For that purpose, commodity groups (CG) could also be used in the VDA_FLOP attribute instead of single commodities, and also commodities in the primary group could be used. These capabilities are still supported in the code for backwards compatibility, but its use is discouraged, and the use of ACT_EFF is recommended.
2. In VEDA-FE, VDA_FLOP is normally not directly available to the user, but the shortcut attributes INPUT and OUTPUT are used instead.

## 2.3 VDA_CEH

Syntax: VDA_CEH(reg,datayear,prc)

Description:

VDA_CEH defines the slope of the tradeoff curve between electricity and heat for CHP technologies with a pass-out turbine. When VDA_CEH has a value ≤ 1, it represents the amount of electricity loss per unit of heat gained, when moving from condensing mode towards full CHP mode. When VDA_CEH has a value ≥ 1, it represents the amount of heat loss per unit of electricity gained, when moving from CHP mode towards condensing mode. Consequently, the slope of the pass-out turbine can be described in two alternative ways. Using a value ≤ 1 signifies to the preprocessor that the basis of activity is the electricity production in condensing mode, and using a value ≥ 1 signifies that the basis of activity is the total energy output in full CHP mode.

The choice of the basis of activity should be reflected in the efficiency and cost parameters. If the basis of activity is the electricity production in condensing mode, the fuel efficiencies specified should also be those for the condensing mode, and the investment, fixed and operating costs should be described in terms of electrical capacity/production in condensing mode. If the basis of activity is the total energy output in back-pressure mode, the fuel efficiencies should be those for the back-pressure mode, and the investment, fixed and operating costs should be described in terms of total power and heat capacity in back-pressure mode. In both cases, the TIMES code will automatically generate additional parameters that ensure proper description of the plant in the whole operating range.

*VDA_CEH is required* only for CHP technologies with pass-out turbines. However, it can be used also for back-pressure turbines to define the basis of activity. By setting VDA_CEH to 1, a back-pressure mode CHP plant can be described on the basis of total power and heat capacity and total energy production. By setting VDA_CEH to zero (or omitting it) a back-pressure mode CHP plant can be described on the basis of electrical capacity and electricity production. In the former case, the efficiencies should thus correspond to the total energy efficiency, and in the latter case to the electrical efficiency in the back-pressure mode. The only relevant difference is in the meaning of the input parameters, which the user can thus choose for her own convenience.

In summary, depending on the way the CHP process has been modeled, the capacity of CHP processes can represent any of the following in TIMES:

- Electrical capacity in back-pressure mode (VDA_CEH=0 or omitted);
- Electrical capacity in condensing mode (0 < VDA_CEH ≤ 1);
- The sum of electrical and heat capacity in back-pressure mode (VDA_CEH ≥ 1);

## 2.4 NCAP_CHPR

Syntax: NCAP_CHPR(reg,datayear,prc,bd)

Description:

NCAP_CHPR defines the heat-to-power ratio of a CHP technology in the full CHP mode. NCAP_CHPR is actually an *original TIMES attribute*, but it was for some reason omitted from the basic TIMES documentation.

For CHP technologies without pass-out turbine capability, a *fixed bound* NCAP_CHPR parameter should normally be specified. However, if one can assume that the technology can be also operated in such a way that the turbine is by-passed, a sole lower bound could also be specified.

For CHP technologies with a pass-out turbine, an *upper bound* NCAP_CHPR parameter should always be specified. In addition, a lower bound can also be specified to describe the minimum heat production due to limited turbine capacity.

Remark: Although NCAP_CHPR can be viewed as a bound attribute, it is by default fully interpolated and extrapolated to milestone years.

## 2.5 NCAP_AFC / NCAP_AFAC

Syntax: NCAP_AFC(reg,datayear,prc,com,tslvl)
NCAP_AFAC(reg,datayear,prc,com)

Description:

NCAP_AFC can be used to describe commodity-specific availability factors. It is thus meaningful for only processes with several commodities in the primary group. NCAP_AFC is automatically combined with any normal annual availability factors defined for the process. If no normal availability factors have been defined on the timeslice level *tslvl*, an upper limit of 1 is always used as the default. If NCAP_AFC is specified for only some but not all commodities in the primary group, a default value of 1 will be used for any missing commodities.

NCAP_AFC can be used for any processes, including storage and trade processes. In the case of storage processes, only the output flow of commodity COM is considered in the availability constraint.

Good examples of uses of NCAP_AFC are dual mode cars (short distance/long distance) with different availabilities in each mode, and CHP plants with pass-out turbines, where the annual utilization factor of heat production is typically rather low, but for electricity production it can still be high, thanks to the pass-out turbine.

An additional good example is *pumped-hydro* power plants modeled as seasonal or daynite storage technologies. In such technologies NCAP_AFC can be used for changing the basis of the process availability constraint from the storage level to the produced electricity. This enables the modeling of investment costs and availability parameters in a similar way as for normal power plants.

NCAP_AFAC is a shorthand alias for NCAP_AFC(…,ANNUAL).

## 2.6 COM_AGG

Syntax: COM_AGG(reg,allyear,c,com)

Description:

By using the COM_AGG parameter either the NET or the total production of several commodities C can be aggregated into the production side of the commodity balance of another commodity COM. The commodities C and COM cannot be identical. The user should also avoid creating any other circular relationships between commodities by using COM_AGG.

When using the COM_AGG(reg,allyear,C,COM) parameter for any non-demand commodities C that are either explicitly or by default defined to be of LIM type 'LO', the *NET production* of commodities C (multiplied by the parameter value) will be aggregated into the production side of the commodity balance of commodity COM. For example, all emission commodities are by default of LIM type 'LO'. However, when using the COM_AGG parameter for any demand commodity, or for a commodity of LIM type 'FX', the *total production* of commodities C (multiplied by the parameter value) will be aggregated into the production side of the commodity balance of COM.

## 2.7 FLO_EMIS

Syntax: FLO_EMIS(reg,datayear,prc,cg,com,ts)

Description:

FLO_EMIS can be used to specify an emission factor of an emission commodity COM for the commodity flows belonging to group CG of process PRC.

The group CG can be any individual commodity of process PRC or any commodity group. However, CG should not contain commodities of type 'ENV' (any such attribute instance will be ignored).

As a special case, the predefined commodity 'ACT' can be used in place of the CG. This will result in an emission factor for the process activity. If the PRC_ACTFLO parameters of the process are not 1, the resulting emissions will thus be different from those when using the process primary group as the CG. All emission factors of emission commodity COM of a process P that have been specified by using either VDA_EMCB or FLO_EMIS can be shaped by using a simple FLO_FUNCX parameter of the following form:

FLO_FUNCX(reg,datayear,p,com,com) = shape index

## 2.8 VDA_EMCB

Syntax: VDA_EMCB(reg,datayear, c ,com)

Description:

VDA_EMCB can be used to define a default emission factor of an emission commodity COM for all processes consuming commodity C. The source commodity C cannot be of type 'ENV' (such will be ignored). If FLO_EMIS is additionally defined for the same input commodity and the same emission commodity, the FLO_EMIS parameter will override the default value specified by VDA_EMCB.

## 2.9 PRC_RESID

Syntax: PRC_RESID(reg,datayear,prc)

Description:

PRC_RESID can be used to describe the residual capacity still available in each period. Normally existing capacities are in TIMES specified by using NCAP_PASTI. However, for some types of processes the residual capacity approach can be more convenient.

PRC_RESID is implemented as a single process vintage at the year BOH–1. PRC_RESID can be specified for any DATAYEARs (there is no need to include any value for the internal vintage year BOH–1). PRC_RESID is automatically interpolated between DATAYEARs. However, if only a single value for one year is specified, the preprocessor interpolates between the value specified and a zero value at NCAP_TLIFE years later than the single DATAYEAR specified.