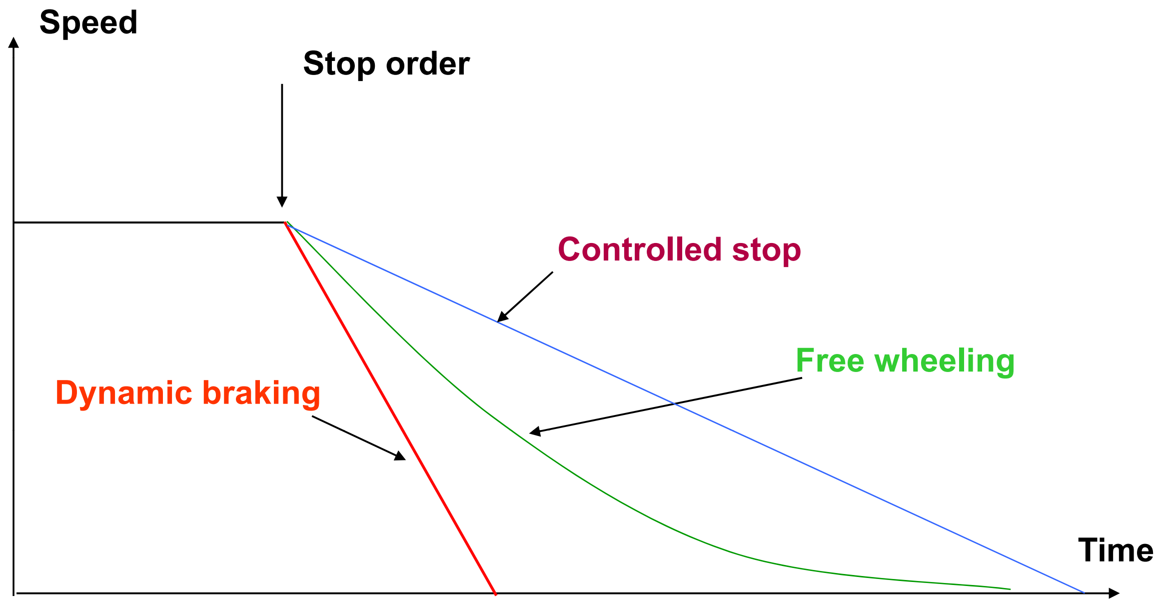
Asynchronous motor braking

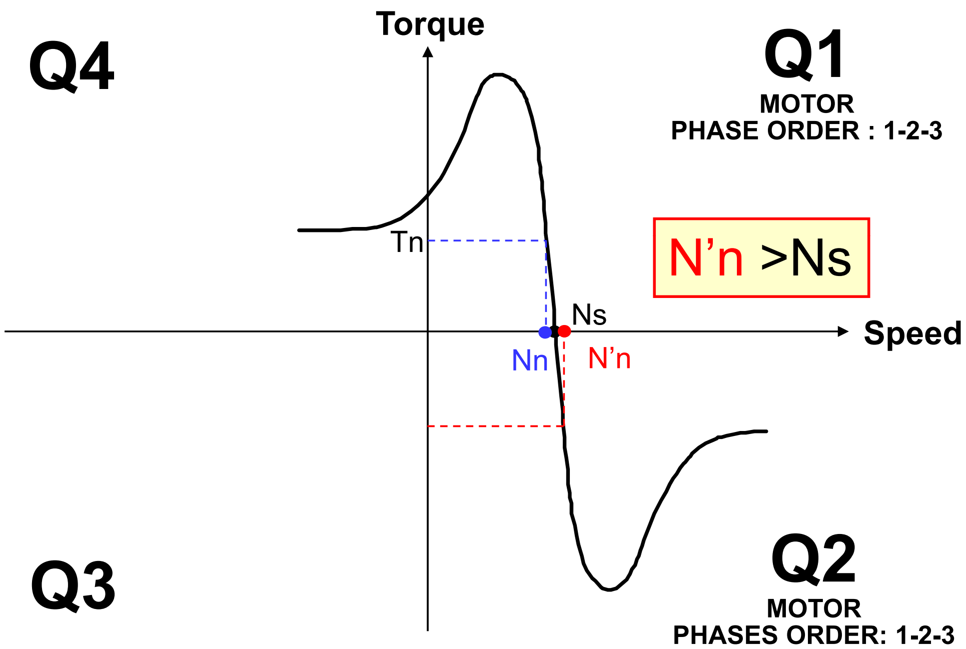
Schneider Electric

Method for stopping the motors

- There are many ways to stop

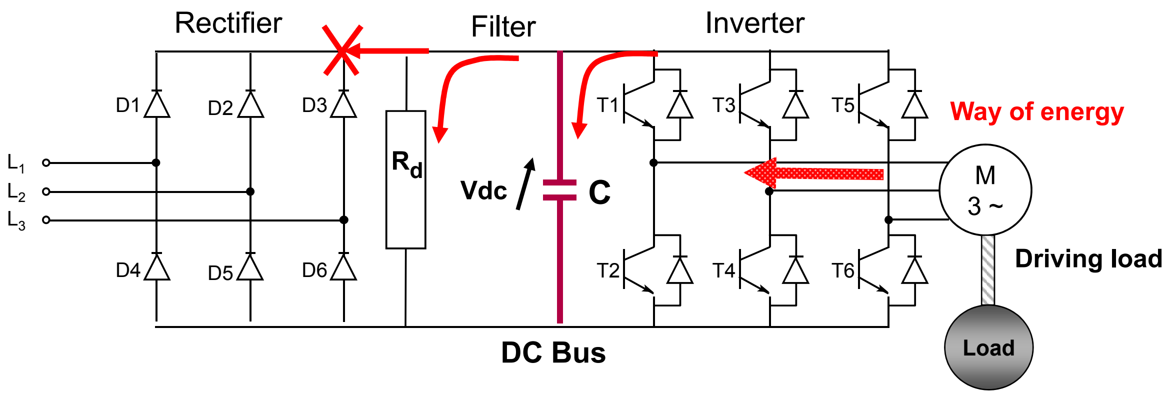


Dynamic braking or hypersynchronous braking



Hypersynchronous braking

- Braking without specific external device

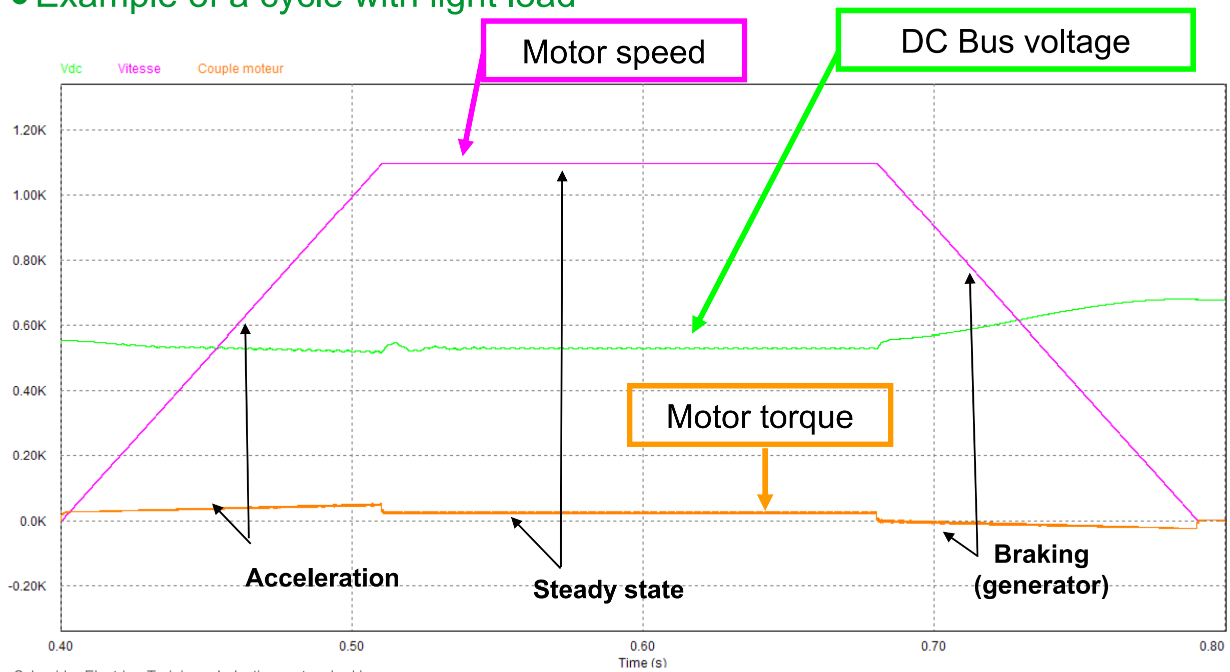


The energy is limited at 1/2 CV² => The capacitor will quickly reach maximum voltage

The energy can also go in the discharge resistor and also in the drive control supply => Maximum braking at about 20% Tn

Hypersynchronous braking

- Example of a cycle with light load

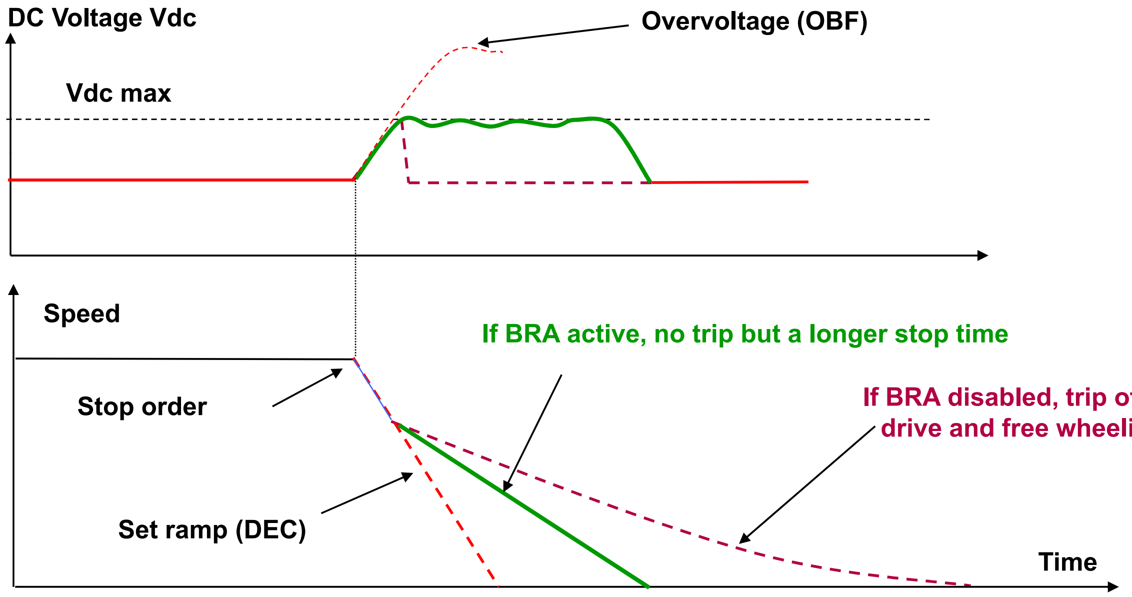


Hypersynchronous braking

- The braking without accessories can be performed in 2 ways:
  - BRA = YES : Braking Ramp Auto-adaptation :
    - The ramp is automatically change in order not to go over the maximum DC bus voltage for BRA (a little below the overvoltage DC Bus trip level).
  - BRA = DYN_A , Dyn B ou Dyn C (Specific to ATV61 or 71):
    - Same thing than with BRA but with special algorithm that enhance losses inside the motor and cables Idem to increase the braking torque.
    - This king of braking must remain ”exceptional” in the way that the energy is dissipated in heat inside the motor or cables and repetitive use can lead to overheat for both motor and cables.
    - Example : A 400kw fan stops in free wheeling in 500s and with BRA enabled stops in 200s. With Dyn C braking, stop is achieved in 50s. (1 stop per day).

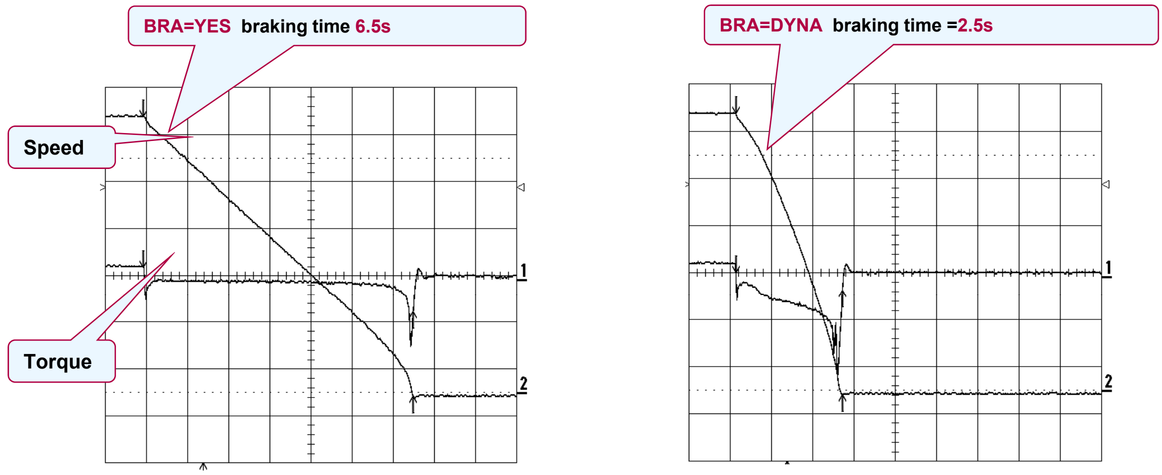
Hypersynchronous braking

- Braking with BRA enabled:



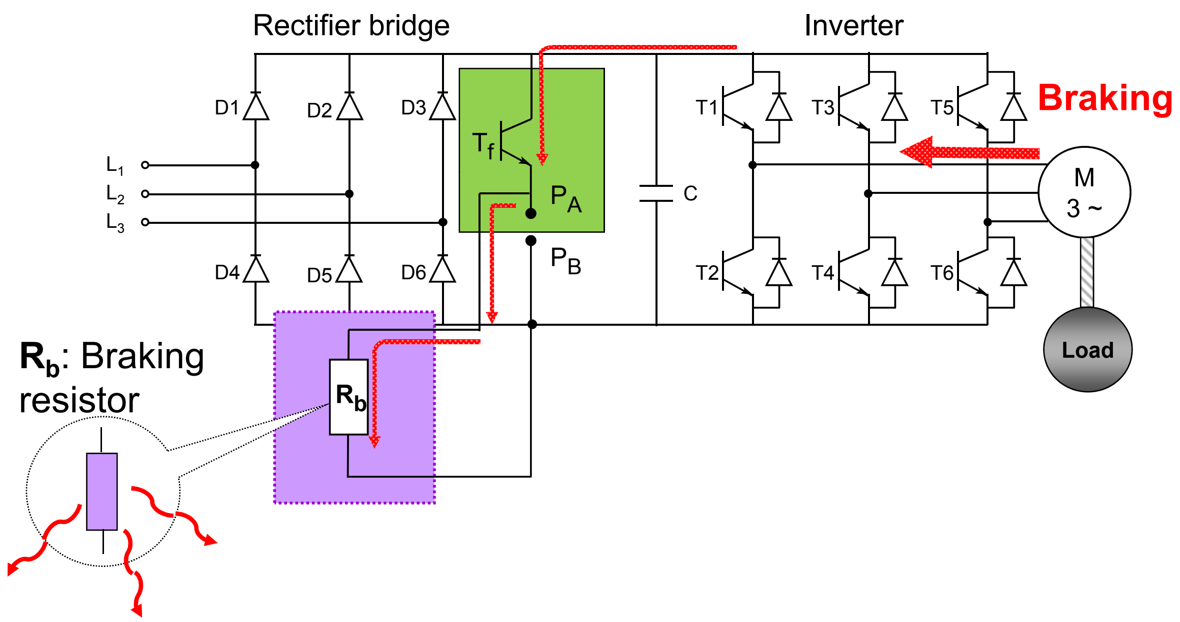
Hypersynchronous braking

- DynA, B or C braking with ATV61 et 71
  - ex: motor/drive 7.5 kW, SVCU law
  - inertia of 8 time motor inertia
  - Ramp of 0.1s, deceleration from 60hz to 0Hz



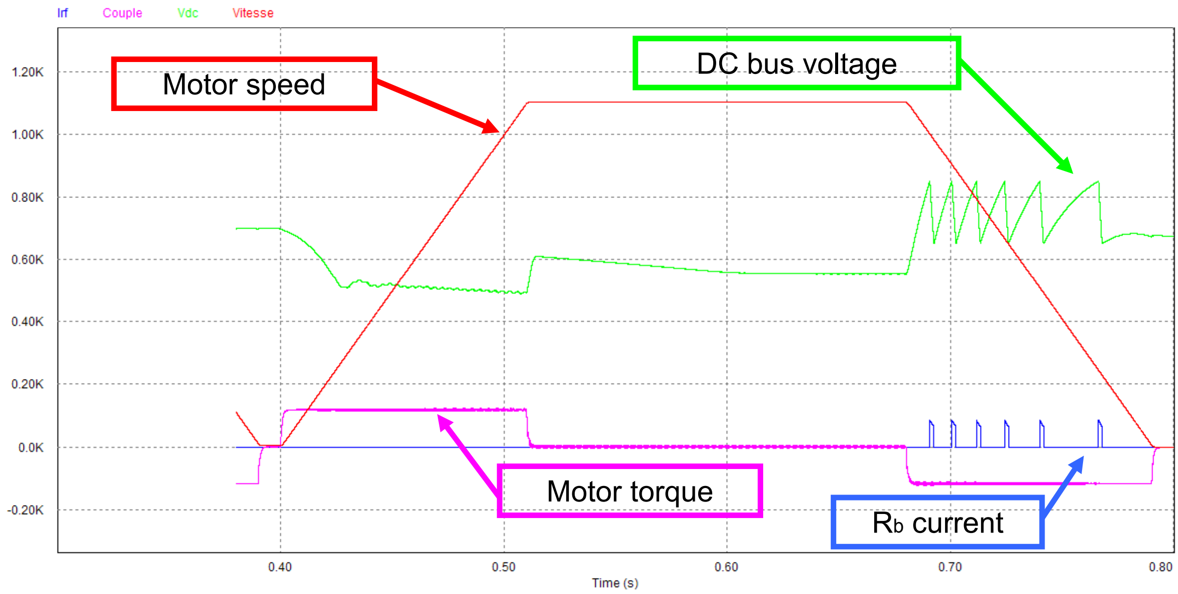
External braking device: resistor

- Braking with a braking resistor



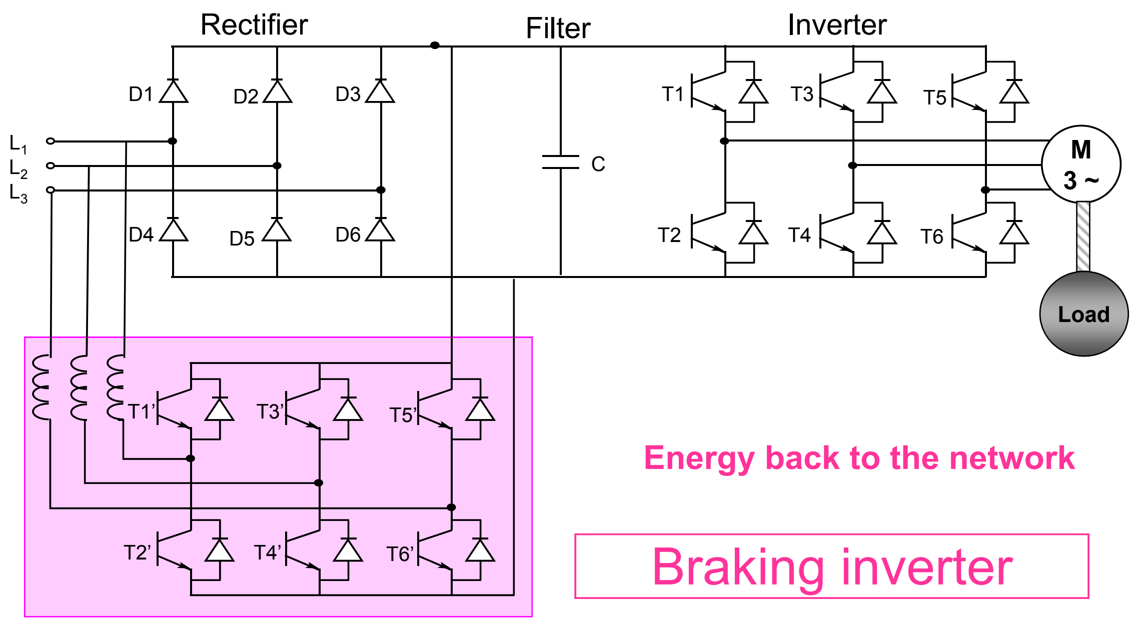
External braking device: resistor

- Example of a cycle with high inertia and braking resistor



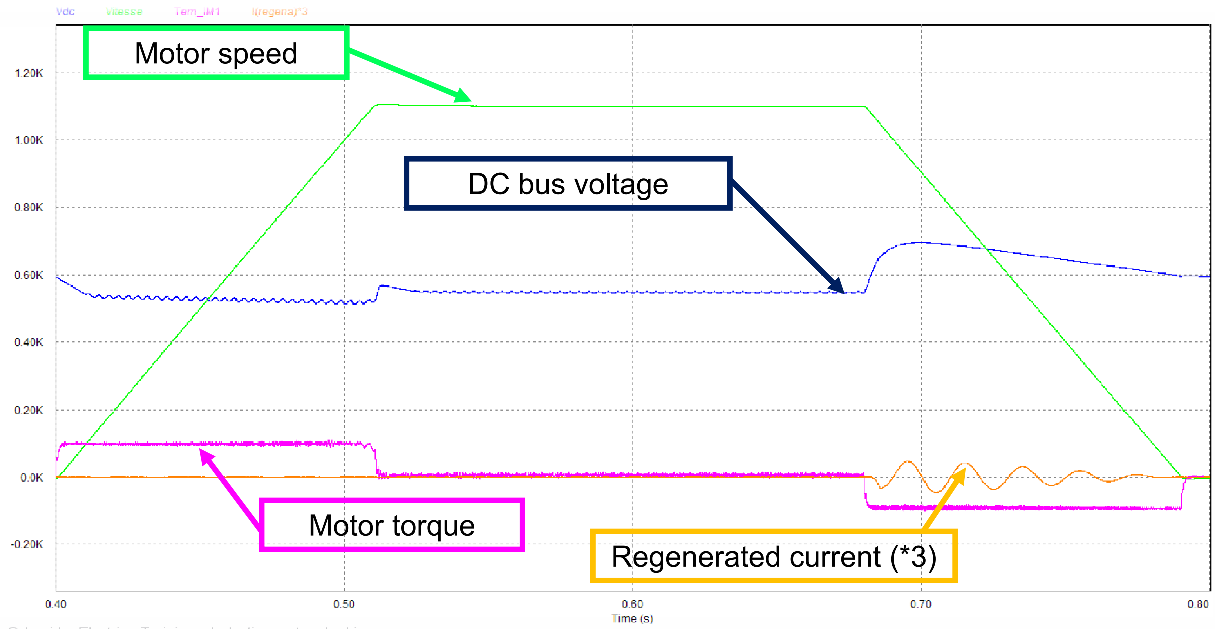
External braking device: REGEN

- Braking with network braking unit (NBU)



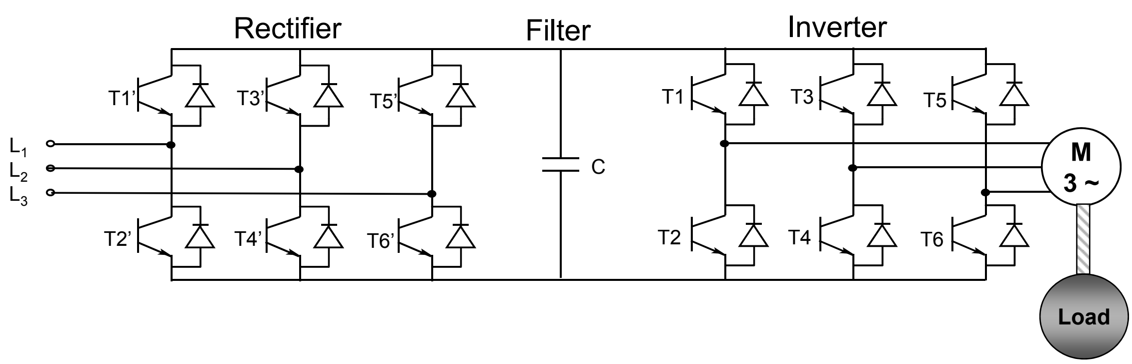
External braking device: REGEN

- Example of a cycle with high inertia and network braking unit



Other topologies

- Active Front End (sine wave rectifier)

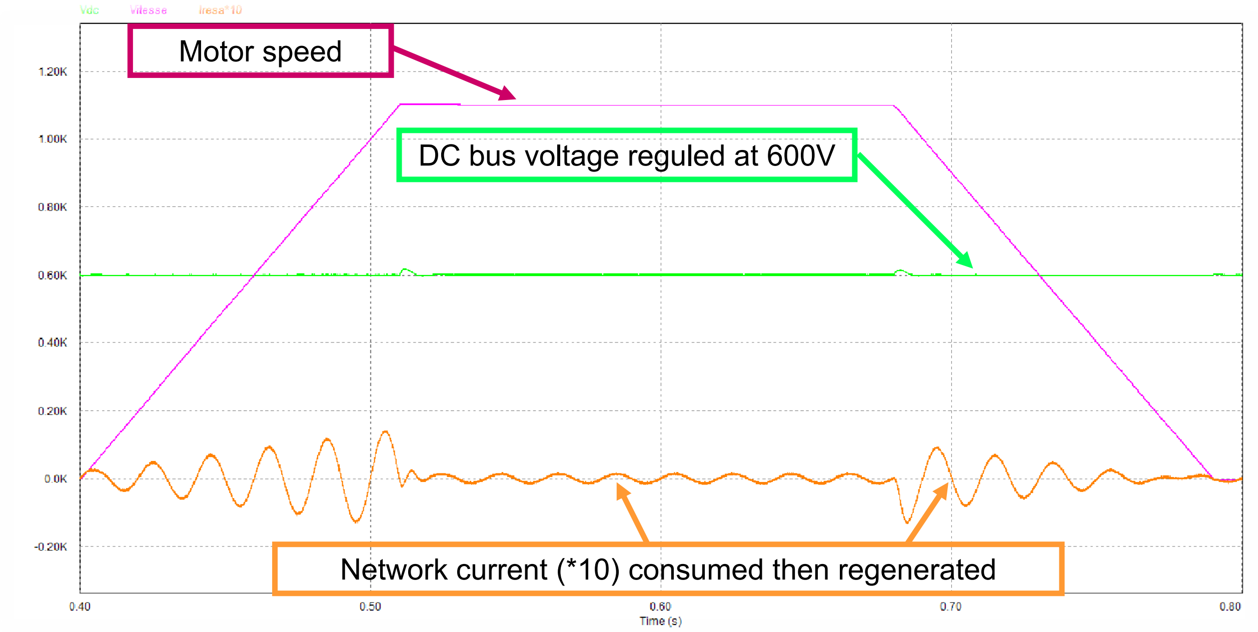


Sine wave current consumed and regenarated on the network

At PF=1 (reactive power compensation available)

Active Front End

- Example of a cycle with high inertia and AFE



Dynamic braking: Conclusion

- Without any accessory
  - Benefits : No extra cost for the customer
  - Limitations: limited to 20% of torque (Value can change according to the drive power but decreasing with the power)
- With a braking resistor
  - Benefit : Little extra cost and possibility to brake at 100% of torque or more
  - Limitations: wasting energy, all is transformed in heat.
- With a REGEN module
  - Benefit : Efficiency, possibility to connect modules in parallel, less thermal losses
  - Limitations: Beware during running on emergency generator or islanded network: Risk of important overvoltage or overspeed of the generators.
  - No network = No braking (Beware of emergency stop regulations)
- With AFE
  - Benefit : No more harmonics problems, the current is quite sinus with a possibility to compensate the network cos φ (avoid a capacitor bank)
  - Limitations: Same as REGEN + beware of EMC due to high frequencies on the network side

Example of a return on invest

- For hoisting
  - Power — Pf = 100kW
    Braking time per cycle — t_b = 10s
    Number of cycles per hour — n = 30/ h
    Operating hours per day — h = 18h / d
    Working days per year — d = 350d / y
    Energy costs — K = 0,1 EUR / kWh
    NBU cost VW3A7210 - 120kW — Rk= 18800 eur
    RB cost VW3A7814 - 112kW — Ck= 7550 eur
    AFE cost VW3A7250-260-265 – 120kW — Ak= 9970 eur
  - Energy savings per year

$$W = 52500\, kWh / year \qquad W = \frac{100kW \cdot 10s \cdot 30/h \cdot 18h/d \cdot 350d/y}{3600}$$

  - Costs savings per year:

$$E = 5250\, \text{eur} / year \qquad E = W \cdot K \qquad E = 52500\, kWh / year \cdot 0{,}1\, \text{eur} / kWh$$

  - R.O.I : could be shorter thanks to environmental policy or price agreement

REGEN $A = 2.14$ years $\Rightarrow 26\, months$ $\quad A = \frac{(R_K - C_K)}{P_B \cdot t_B \cdot n \cdot B_T \cdot K \cdot F} \quad A = \frac{(18800eur - 7550eur) \cdot 3600s}{100kW \cdot 10s \cdot 30/h \cdot 18h/d \cdot 0{,}1eur}$

AFE $A = 0.5$ year $\Rightarrow 6\, months$

Example of a return on invest

- For a conveyor
  - Power — Pf = 10kW
    Braking time per cycle — t_b = 5s
    Number of cycles per hour — n = 30/ h
    Operating hours per day — h = 22h / d
    Working days per year — d = 350d / y
    Energy costs — K = 0,1 EUR / kWh
    NBU cost VW3A7203 – 11 kW — RK = 5435 eur
    RB cost VW3A7710 - 25kW — CK = 2860 eur
  - Energy savings per year

$$W = 3208\, kWh / year \qquad W = \frac{100kW \cdot 5s \cdot 30/h \cdot 18h/d \cdot 350d/y}{3600}$$

  - Costs savings per year :

$$E = 321\, \text{eur} / year \qquad E = W \cdot K \qquad E = 3208\, kWh / year \cdot 0{,}1\, \text{eur} / kWh$$

  - R.O.I : could be shorter thanks to environmental policy or price agreement

$$A = 8.02 \text{ years} \qquad A = \frac{(R_K - C_K)}{P_B \cdot t_B \cdot n \cdot B_T \cdot K \cdot F} \qquad A = \frac{(5435eur - 2860eur) \cdot 3600s}{10kW \cdot 5s \cdot 30/h \cdot 22h/d \cdot 0{,}1eur}$$