RESHYVENT
Hybrid Demand Controlled Ventilation System
*Mild/Moderate Climate (IC3)*

M. Jardinier, S. Berthin

*Aereco S.A., 9 allée du Clos des Charmes, Collégien
F - 77615 MARNE LA VALLEE Cedex 3*

**ABSTRACT**

The purpose of this system is to provide one improved ventilation system allowing significant good indoor air quality, heating (and cooling) energy savings and acceptable thermal comfort on summer, by using especially renewable energy.

This concept is based on sensors measuring relative humidity in bathroom and kitchen, occupancy in bedrooms and toilet, and agitation (i.e. the number of people) in the living room.

Driving forces are as much as possible natural ones (thermal stack effect, and wind induction), assisted with a photovoltaic supplied “roof cowl fan” whose speed is adapted to only compensate natural stack effect deficiency in the hotter times.

According to total ventilation forces evaluation, motorised inlets and extract grilles are driven in order to ensure suitable air renewal in each room, in correlation with need measurements.

In case of very hot times, a “night cooling” mode consist in an “over-ventilation” (maximum fan assistance) and in the opening of motorised windows, during summer nights, when outdoor temperature is colder than indoor.

**KEYWORDS**

Hybrid ventilation, presence & humidity control, communication, night cooling, renewals, strategy, motorised inlets/outlets, photovoltaic, experiments

**CONCEPT FROM EU SAVE PHOTOVENT PROJECT**

In 1999, a first collaboration between Aereco (French designer and manufacturer of modulated ventilation systems), Renson (Belgium market leader for natural ventilation) and the Belgium Building Research Institute has already led to the development of one improved controlled ventilation system, in the frame of the PHOTOVENT European project.

This system has been installed and tested in a “real” test house.

As shown next page (Figure 5), it was composed with :

- **Motorised Inlets**: they are placed in the “dry rooms”. A motorised mechanism allows to open these inlets at wanted areas, so that airflows can be controlled in these rooms. They are PV supplied thanks to photovoltaic cells on their façade (plus one battery).

![Figure 1: PhotoVent PV inlet](image1)

- **Motorised extract grilles**: they are placed in the “wet rooms”, where airflows can also be controlled. The energy supplying is ensured by non rechargeable batteries whose life time was close to two years.

![Figure 2: PhotoVent Extract Grille](image2)
Presence sensors: installed in the bedrooms and in the toilet, they tell the system whether these rooms are occupied or not. Non rechargeable batteries also ensure energy supplying.

Figure 3: PhotoVent Presence (or Agitation Sensor)

Agitation sensor: this detector counts the number of movements in the living room, and consequently provides information about the number of people in this room.

Humidity sensors: they measure relative humidity in the kitchen and in the bathroom.

Figure 4: PhotoVent Humidity Sensor

This full mechanical sensor only required non rechargeable batteries for data communication.

Figure 5: Mechanical PhotoVent System
Ventilation force is ensured by **Mechanical Exhaust**. Since inlets are sized for natural air supplying, this system is based on the “C Belgium configuration”.

A “Central Station” (PC / software) has been developed to apply one simple strategy.

![Figure 6: Central Station](image1.jpg)

Sensors measurements are sent to the Station every 5 minutes. According to the needs evaluated in every rooms, individual air renewal are calculated and balanced, so that “entering” airflows should be the same than “extracted” ones. Then, every 15 minutes Inlets and Extracted grilles are driven to reach a suitable opening areas that allow individual expected airflows. Opening areas calculations are very simple: given the mechanical exhaust, an almost constant 100 Pa depression is ensured by the fan; since a 10 Pa depression is wanted inside the dwelling, it is easy to calculate both inlets and extract grille opening, to ensure each individual airflows.

(Low energy) communication between inlets/grilles/sensors and the Station was realised with 433 MHz **Radio Transmitters and Receivers**.

![Figure 7: Transmission/Reception Module](image2.jpg)

For several months, the system has been installed and tested in the BBRI Test House. Airflows have been measured in each room – thanks to gas tracer facilities – and the comparison with the calculated expected airflows (Figure 9) showed very impressive correlation, in spite of the air leakage and the crossing flows – due to wind – from one façade to another.

![Figure 8: BBRI Test House](image3.jpg)

![Figure 9: Airflow measurements results](image4.png)
**RESHYVENT PROJECT: HYBRID VENTILATION CONCEPT**

Based on demand controlled ventilation, the PhotoVent concept allowed both air quality improvements and heating energy savings on winter (by the limitation of “cold entering” airflows at just useful levels).

One step further in rational energy using was to “optimise” natural ventilation – which is known as working correctly in cold times – and then use a mechanical assistance only when necessary.

The challenge was to develop a very low energy assistance, so that the “unavoidable” fan could be supplied with photovoltaic. Consequently, a Full Natural Modulated Ventilation working correctly all the year becomes possible.

Moreover, given the now importance of thermal comfort on summer, the use of a “boosted” assistance fan on night – associated to larger ventilation openings – allows to realise efficient Night Cooling, an alternative to cooling systems which require many energy.

**DEVELOPMENT OF A HYBRID VENTILATION FAN**

A fan fulfilling the objectives of the ReshyVent concept has been developed and improved during the first year of the project.

The main characteristics of the fan are the following ones:

- Generation of very low depression (5~15 Pa), similar to level met in classical natural ventilation. The depression level can be adjusted in order to reach an “optimised” assistance, and to limit energy over expenditure.

- When natural ventilation alone is sufficient enough, the fan can be switch off. Since it is connected in the extraction part of the ventilation net, it must not brake the exhaust flow. This is why, when off, the fan has a very low pressure drop (coefficient $\xi=0.9$).

- As shown Figure 11, the fan is installed as a traditional roof cowl. Therefore, the effect of the wind on the roof can be exploited to improve ventilation efficiency.
Many wind tunnel tests have been led to ensure good depression, even for significant extracted flows.

Figure 13 : Wind Tunnel Tests

➢ As shown Figure 12, *very low energy power* is required to run the fan (2 watt per dwelling on average), at low voltage (~12 Volt). Hence, *photovoltaic* supplying is quite suitable.

**DEVELOPMENT OF IMPROVED COMPONENTS**

Given the PhotoVent system was a concept prototype, industrialised components (i.e. “low costs” for the market) had to be developed and improved from the PhotoVent experience.

As shown Figure 14, most of ReshyVent components are similar to the PhotoVent ones, except Indoor and Outdoor temperature sensors, necessary for ReshyVent strategy appliance.

Figure 14 : Hybrid ReshyVent System
Motorised Inlets: according to the (Belgium) market evolution, two types of standard natural inlets manufactured by Renson have been motorised, using a low cost stepper motor technology.

Motorised extract grilles: as for inlets, extract grilles are standard Aereco natural grilles, motorised with low cost stepper motor. Eight accurate positions (from 10 cm² to 100 cm²) can also be reached.

Presence / Agitation sensors: they are standard Aereco detectors, very reliable and low cost.

Temperature / Humidity sensors: given the last technological evolutions of especially humidity sensors, “reliable and cheap enough” electronic sensors have been chosen.

COMMUNICATION DEVELOPMENTS
From the PhotoVent experience, radio communication between every system components seemed quite feasible. Radio modules that where expensive five years ago are now cheap enough, and energy consumption has significantly decreased. Except distance or transmission issues, the main problem is the presence of a “constant” interference sources (more powerful).
Focusing on a system more dedicated to new dwellings than to retrofitting – where cable installation is not a real barrier – very reliable wired solution has been developed (Figure 19).

The developed solution is very simple for installation, since only two wires allow both energy supplying (low voltage) and data transmission for every components: the idea is to simply “connect a black wire on the black connector of the component, and a red wire on the red connector”. Inlets, grilles, sensors can consequently be linked in whatever order.

**SYSTEM STRATEGY**

An “improved” strategy had to be developed to make the system compensate natural forces deficiencies:

1. **Determination of each individual airflow**: given the need (“pollution level”) measured in each room by sensors, first suitable airflows (for efficient air renewal) are calculated. In order to balance the total flow (global entering airflow has to be equal to global extracted airflow), some individual flows are increased. Then a total required flow is determined (Ex. Figure 20: 160 m$^3$/h).
2. **Calculation of “optimum” assistance**: according to Indoor and Outdoor temperature measurements, the natural thermal stack effect is evaluated. Then, if necessary, the fan is run to reach a ventilation depression level sufficient to ensure the expected airflows. *(Ex. Figure 20: fan power at 4 watt).*

3. **Calculation of extract grilles openings**: knowing the total extracted flow and the running power of the fan (and the pressure drop level of the exhaust net), depression available at the extract grilles can be determined *(Ex. Figure 20: 6 Pa).* Since a 3 Pa depression is expected in the dwelling, grilles openings calculations (for kitchen, bathroom, toilet) can be done to reach the expected airflows (Figure 21).
4. **Calculation of inlets openings:** given that a 3 Pa depression is expected in the dwelling, inlets openings calculations (for bedrooms, living rooms) can also be done.

![Figure 21: Grilles opening calculation](image)

5. **Night cooling launching:** based on a basic thermal model for dwellings, simplified criteria based on instantaneous indoor and outdoor temperatures, and also on outdoor average temperature on the last 24 hours, have been found to start “Night Cooling” on hotter times: the fan is run at its maximum speed (16 watt), inlets and grilles are fully opened, and motorized windows can also be opened.

**CONCLUSIONS: WAITING FOR FIRST EXPERIMENTS RESULTS**

Rough simulation showed that differences lower than ±15% from the “ideal” airflows had to be expected.

In order to test especially the system strategy reliability, the impact of outdoor conditions, and the solar supplying sizing, one experiment has just been launched in July 2004, in a Aereco building, close to Paris in France.

![Figure 23: Grilles opening calculation](image)

![Figure 24: system installation for experiment](image)