



DEVELOPMENT OF AN INTELLIGENT ECO-SOCIAL ENVIRONMENT FOR ASSISTED LIVING

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Abstract

An approach is proposed for development of an intelligent eco-social environment which may be implemented both in a high education institution and in the stationary as well as portable living houses. In case of development of an intelligent mobile tutoring Eco-Social Laboratory for Assisted Recreation, principles are proposed for designing of sustainable power supply and selecting of professional bio-feedback hardware/software for mobile laboratory. Such a mobile Laboratory can be treated as an intelligent object containing areas for varied activities such as sleeping, working, entertaining as well as of planning, monitoring and analyzing of personal biofeedback information during the recreation activities in it. An intelligent environment of the Laboratory may be implemented in the *UltraLite*-type "fifth wheel" trailer which comes with all the necessities for luxury leisure time of the group of up to 6 persons. To assemble of such mobile laboratory by prices of 2009/01/15 might cost of approximate 37,806.00 Euro. This type of laboratory may help to automatically collect of an experience and knowledge in the process of development of preconditions towards of sustainable recreation of the elderly and/or people with movement disabilities based on their assisted activities in the mobile smart flat and an environment around it. Technical and economical investigations of possibilities of generating of a hybrid PV-wind power for supplying of eco-social laboratories of different sizes in Lithuania are performed in section 1 of this paper. In this paper, the possibilities of application of solar radiation energy for heating of water and environment of apartments of eco-social laboratories of different sizes in Lithuania are described in section 2, and investigations of possibilities of application of integrated PV-wind-solar radiation and geothermal energy for heating of water and environment of apartments of eco-social laboratories of different sizes in Lithuania are discussed in section 3. Investigations of possibilities of implementation of intelligent support for assisted living in the eco-social environment of different types are performed in section 4 of this paper.

KEYWORDS: assisted living, intelligent eco-social environment, sustainable power supply, biorobot-based assistance

Introduction

A significant aid to overcome of the worldwide economical recession can be achieved by activating of tutoring steps of society to be actively involved in creating of conditions for sustainable style of living, business, and recreation, management of local energy resources as well as of minimizing of social exclusion of socially isolated and ageing people. The Development of an Intelligent Tutoring Environment for Eco-Social Information Studies may help to training of students as leaders of society to overcome these problems by giving them an opportunity to adapt of their teaching process to every studying person. An intelligent assistance of an inhabitant of such Intelligent Tutoring Eco-Environment is based on non-invasive application of systems of affect sensing in the process of Human Computer Interaction (HCI), Human-Robot Interaction (HRI), and Computer Mediated Communication (CMC). Such systems depend upon the possibility of extracting emotions without interrupting the user during HCI, HRI, or CMC (Healey, 2000, Pentland, 2004, Tapia et al, 2004, and Villon & Lisett, 2006). In the ICT expert group of University of Klaipėda and of Western Lithuania Business College, an active research work runs to developing of ambient intelligence by creating: agent-based adaptive e-learning environment (Bielskis et al, 2008, and 2008), pattern

recognition and artificial intelligent methods and scenarios for gaining of social activities of socially isolated and ageing people, embedded agents and communications between embedded agents in a distributed e-laboratory, models of intelligent bio-robots for e-health and e-social care support (Bielskis et al, 2007, and Drungilas et al, 2008). An active research work runs by constructing of experimental technical elements and software for recognition of physiological state of an individual in order to adapt in real time of his/her activities by using both of biofeedback information as well as of changing level of knowledge of his/her learning (Gricius et al, 2008, Severina et al, 2008, Šriupša et al, 2008, and Vaitonytė et al 2008). An approach of development of an Intelligent Mobile Tutoring Eco-Social Laboratory for Assisted Recreation based on description of principles of designing of sustainable power supply and selecting of professional bio-feedback hardware/software for mobile laboratory is recently proposed in (Andziulis et al, 2009).

The aim of this paper is to propose of preliminary steps of development of an intelligent eco-social environment which may be implemented both in a high education institution and in the stationary as well as portable living house. This aim is planned to be achieved by fulfilment of the following objectives:

1) Investigations of possibilities of generating of a hybrid PV-wind power for supplying of eco-social laboratories of different sizes in Lithuania; 2) Investigations of possibilities of application of solar radiation energy for heating of water and environment of apartments of eco-social laboratories of different sizes in Lithuania; 3) Investigations of possibilities of application of integrated PV-wind-solar radiation and geothermal energy for heating of water and environment of apartments of eco-social laboratories of different sizes in Lithuania; 4) Investigations of possibilities of implementation of intelligent support for assisted living in the eco-social environment.

Selecting PV-wind power for supplying of eco-social laboratories in Lithuania

In the village of Xcalak, Mexico, PV is part of the largest hybrid generation system in the Americas. The system includes 6 wind turbines, 234 PV modules, 36 batteries, and a 40-kilowatt inverter to convert dc power to ac, a diesel generator, and a sophisticated control system, and it can be expanded. Another example is the hybrid PV-wind system with battery storage. It supplies power to a Canon City, Colorado, home. Installed by Solar Solutions Ltd. of Silver Cliff, Colorado, the 2.88-kilowatt system includes 24 120-watt modules, 20 Trojan L-16 6-volt deep-cycle batteries (Exide Deep Charge Battery Trojan L16 Equivalent 6Volt 375Ah), two Southwest Windpower AIR403 wind turbines, two tilt-up wind turbine towers, and a vented battery box. The <http://www.wholesalesolar.com/griddie.html> grid tie solar power systems include the highly efficient Kyocera KD210 solar panels and Solectria inverters (see <http://www.swea.nl/>) by Swea Europe BV Company in the Netherlands who has developed a small Grid Tie Inverter special for small home use wind turbines and solar panels. Type of grid is as follows: 110V-220V 60/50Hz; No batteries are needed; the inverter can be plugged-in to the wall outlet and it can feed back directly the power to the own grid in anyones house from a wind turbine or solar panel. In Fig.1, the hybrid PV-wind power supply system for mobile eco-social laboratory is described. The annual distribution of PV-wind energy in Lithuania is shown in Fig.1a for the system to producing of the 324 Wdc PV and 720W wind power of the following hybrid PV-wind system composed of: 6X54Wdc PV modules; 20A BP Solar GCR 2000M type charger; 720W Rutland 1803 wind turbine http://www.stamford.co.uk/marlec/1803_technical.htm, 8 Trojan T-105 6 V 250 Ah deep charge accumulators; Trace 2624 type 2,6 kVA, 230 V, 50 Hz inverter with 200 W charger. The schematic diagram (see Fig.1b) of mobile eco-social laboratory is proposed, and the typical daily load distribution of such laboratory is given on Fig.1c.

Principles are proposed in [Andziulis et al., (2009)] for designing of sustainable power supply and selecting of professional bio-feedback hardware/software of an Intelligent Mobile Tutoring Eco-Social Laboratory for Assisted Recreation. Such a mobile Laboratory can be treated as an intelligent object containing areas for varied activities such as sleeping, working, entertaining as well as of planning, monitoring and analyzing of personal

biofeedback information during the recreation activities in it. An intelligent environment of the Laboratory may be implemented in the UltraLite-type “fifth wheel” trailer which comes with all the necessities for luxury leisure time of the group of up to 6 persons. This type of laboratory may help to automatically collect of an experience and knowledge in the process of development of preconditions towards of sustainable recreation of the elderly and/or people with movement disabilities based on their assisted activities in the mobile smart flat and an environment around it. Analysis of those examples allows selecting:

1.1. Elements for the mobile laboratory of Fig.1b:

1) 4 units of 12 V Polycrystalline BP 350J 50W type PV modules (LxWxD=839x537x50 mm – 0, 45 m², 6.0 kg each) to providing of 200 W power;

2) The AIR X 403 wind turbine: Rated Output - 400w at 28mph, Rotor Diameter-116.8 cm, Number of blades-3, Blade Material-carbon reinforced thermoplastic, Lateral Thrust-68kg, Unit Weight-5,9kg, Voltages available-12; 24; and 48 VDC; capable to be mounted on a rooftop, no tower required;

3) 2 or 4 of 12V/105Ah 27TM deep charge batteries (LxWxH=324x171x248 mm, 29kg) connected in series;

4) The PV and Wind Hybrid Charging Controller WS482K (180x137x77.5 mm) is used for charging of 4x12V/105Ah 27TM batteries from both of AIR and the block of 4x12V/50W BP 350U;

5) The 48VDC Morningstar PS-15M-48V Prostar 15 Charge Controller (153x105x55 mm, 0,34 kg) or Morningstar Sunsaver MPPT Charge Controller; 15 A to charging of 48 VDC batteries;

6) Single-phase Output Off-grid SN241KS 24VDC/220VAC Inverter (395x205x365 mm) to produce of 220V 50Hz up to 800W power to main installation for the Laboratory of 19.2 kwh/day.

Total price for equipments for feeding of the mobile Laboratory of 48V/220V 50 Hz up to 800 W is approximately of 9285 Lt. Having 0.33 Lt/kwh and $432 \cdot 0.33 = 142.56$ Lt/month income, the pay-off would be $9285/142.56 = 65.13$ month or 5.43 years.

DC/DC converters are used to supply of iLab as well as sub feeding of hybrid car driving batteries in case if there would be a hybrid car used for pulling the fifth wheel trailer via smart DC/DC converter capable of feeding of car batteries by the range of 240 to 280 VDC. The WG1K5TL inverter (288x417x126 mm, 11.5kg) or Mastervolt Windmaster 500 G83 Approved Inverter of Fig.1b can also be used for feeding the mobile Laboratory as well as to the public power grid if desired. In this case, one could earn money in selling power to other consumers: when there is a surplus of PV power generated during the day and wind power, the excess power is feed into the grid and serves other customers: the power Meter runs backwards, reducing your electricity bill.

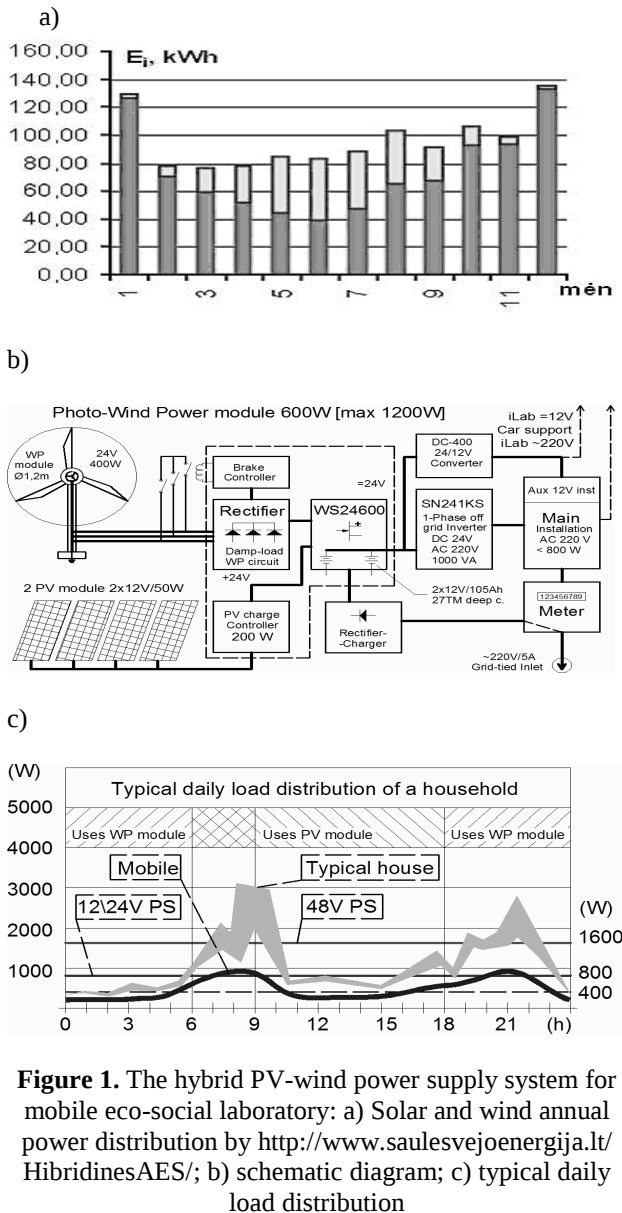


Figure 1. The hybrid PV-wind power supply system for mobile eco-social laboratory: a) Solar and wind annual power distribution by <http://www.saulėsvejoenergija.lt/HibridinesAES/>; b) schematic diagram; c) typical daily load distribution

Elements for the 3-4 people of stationary house-laboratory of Figure.2a:

1) 8 units of 12 V Polycrystalline BP 350J 50W type PV modules (LxWxD=839x537x50 mm – 0, 45 m², 6.0 kg each) to providing of 400 W powers; 2) 2 units of AIR X wind turbine to be mounted on a rooftop, no tower required; 3) 8 units of 12V/105Ah 27TM deep cycle batteries (LxWxH=324x171x248 mm, 29kg) connected in series; 4) 2 units of PV and Wind Hybrid Charging Controller WS482K (180x137x77.5 mm) for charging of 2 blocks of 4x12V/105Ah 27TM batteries from both of AIR and the block of 4x12V/50W BP 350U; 5) 2 units of Morningstar Sunsaver MPPT Charge Controller; 15 A to charging of 48 VDC batteries; 6) 2 units of Mastervolt Soladin 600W grid-tie inverter to deliver 1200W 220VAC power to main installation of the Laboratory to producing of 28.8 kwh/day or 864 Kwh/month.

Total price of PV-wind equipment for the 3-4 people of stationary house-laboratory is 22595 Lt. Having 0.33 Lt/kwh and 864*0.33= 285.12Lt/month income, the pay-off would be 22595/285.12=79.25 month or 6.6 years.

Elements for the up to 100 people of stationary 50-flat type house-laboratory of Figure.2b:

1) 32 units of 12 V Polycrystalline BP 350J 50W type PV modules to providing of 1600 W; 2) 8 units of AIR X 403 wind turbine; 3) 32 units of 12V/105Ah 27TM deep cycle batteries; 4) 8 units of PV and Wind Hybrid Charging Controller WS482K; 5) 8 units of Morningstar Sunsaver MPPT Charge Controller; 6) 8 units of Mastervolt Soladin 600W grid-tie inverter to deliver 4800W 220VAC power to main installation of the house to producing of 115.2 kwh/day or 3456 Kwh/month.

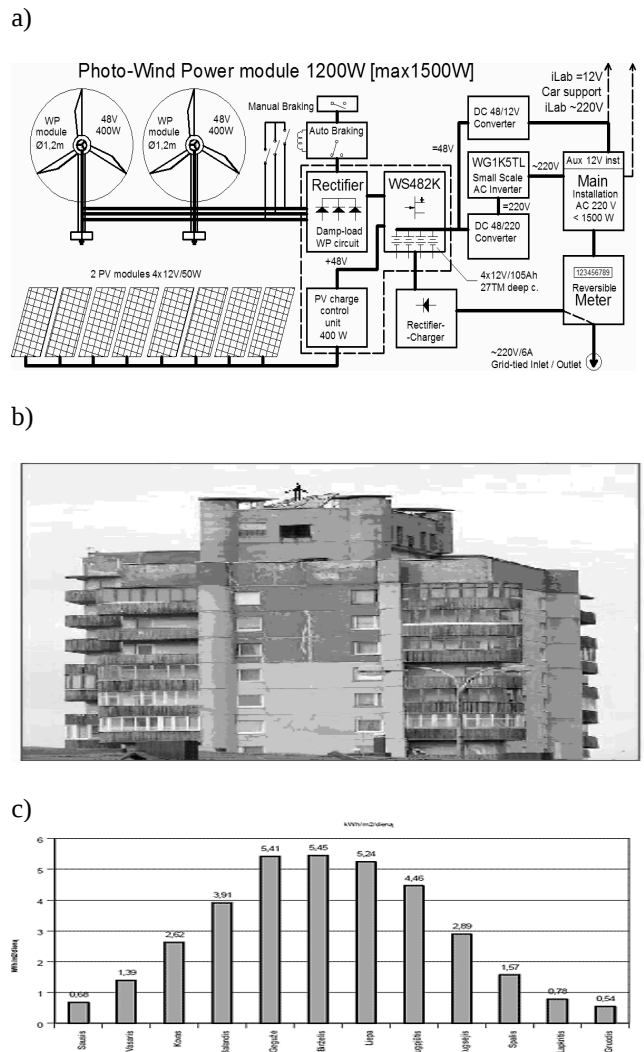


Figure 2. The hybrid PV-wind power supply system for stationary house-type eco-social laboratory: a) Schematic diagram; b) Dislocation of small PV-wind system on the top of condominium type house; c) Average amount of solar radiation in Lithuania by <http://www.kolektoriai.lt/saulės-kolektoriai>

Total price of PV-wind equipment for the 100 people of stationary of 50 apartment type house-laboratory is 90380 Lt. Having 0.33 Lt/kwh and 3648*0.33= 1140.48Lt /month income, the pay-off would be 90380/1140.48=79.25 month or 6.6 years.

Solar radiation energy for heating of water and apartments in Lithuania

Solar radiation system for individual house-type eco-social laboratories: By <http://www.schueco.com/web/lt/klientai>, Schüco International KG offers attractive and technically advanced solutions for generating energy in the form of heat or electricity. Schüco has solar energy systems, photovoltaic systems and heat pumps and is one of the most successful providers of complete solar technology systems in Europe. The www.sunmaxxsolar.com proposes that with a simple investment of only a few thousand dollars, the average household can supply 50 – 75% of their hot water and home heating needs with the clean, efficient renewable energy of the sun. We design, manufacture, and distribute a number of the industry's leading solar heat and hot water heating technologies and products, including evacuated tube solar collectors, flat plate solar collectors, solar hot water storage tanks with integrated internal heat exchangers, external solar hot water heat exchangers, system controllers and circulators, solar heat dumps, and pre-packaged solar heat & hot water heating systems. The <http://www.kolektoriai.lt> recommends the system 220-2/30 for 3 people house: 30 tubes collector; Biawar MEGA Solar 220 Ltr solar heater; SP24l controller; Taifu TRS 25/6 heat pump; Expansion tank for 20 Ltr.; d15 25 m copper tubes. The Solar North <http://www.activesolar.co.uk/> proposes a flat type solar collector System: 5.4m² Drainback solar kit Flat plate solar collector kit with drainback, suitable for houses with 2 or more bathrooms and 4/6 people; recommended cylinder size of 216 ltr. The Kit Includes: 2 x 2.7m² solar collector with center connections; 1 x Drainback unit for 2 x 2.7m² collectors; 15 x Mtrs of high temperature insulation; 1 x 216L twin coil hot water cylinder; 1 x Deltasol BS, 3 sensor drainback controller; 1 x 21Volt mains adaptor for controller; 1 x 1 ltr Glycol antifreeze. Kit Excludes: Copper pipe and delivery.

Solar system for water heating of 100 residents of stationary 50-flat type house-laboratory: The Junkers (<http://www.bosch.lt/junkers/index.html>) flat plate collector system is used in Šilutė Elderly House for water heating. It uses 40 X 1,2 m² flat collector field for heating of amount of 5 m³ water for half a year without charge. It is able to reduce the heating expenses during the winter seasons by 30-40 %.

For water preheating, the SunMaxx specialists are recommending (see www.sunmaxxsolar.com) for Lithuania type climate to build the systems with SunMaxx Evacuated Tube Solar Collector kits. Each of these kits is designed to producing of certain amount of hot potable water each day for the residents in the customer's household: 1-3 People (full time) will use between 20 and 60 gallons of hot water per day, and this customer should purchase the "Evacuated Tube Heat Exchanger System - 65 Gallon" that includes: 1 SunMaxx-20 Evacuated Tube Solar Collector; 1 20 Plate External Heat Exchanger; 2 TACO Circulator Pumps; 1 Goldline GL-30 Differential Temperature Controller; 4-6 People (full time) household will use between 80 and 120 gallons of hot water per day, and this customer should purchase the "Evacuated Tube Heat Exchanger System - 120 Gallon" which includes: 2

SunMaxx-20 Evacuated Tube Solar Collectors; 1 20 Plate External Heat Exchanger; 2 TACO Circulator Pumps; 1 Goldline GL-30 Differential Temperature Controller. If the customers require a larger system because they have more than 6 people in their household, a single SunMaxx-20 Evacuated Tube Solar Collector will heat between 40-50 gallons of hot water per day, and therefore for 8 Household Residents, the 160 Gallons SunMaxx-20 is needed by using a 120 Gallon Pre-Packaged System with 1-2 additio 1 SunMaxx-20 Evacuated Tube Solar Collectors. 80 Gallon 2 Heat Exchanger Storage Tank (Pressure) can be used for energy conserving insulation. This tank can run in series with a second tank which uses electric as a backup heating source for hot water of this 50-flat type house. On sunny days, however, when a typical solar system can raise water to 55°C, the backup heater remains off. On-demand hot water heaters (which heat needed water instantly "on-demand") can also be used as a back-up system for solar hot water. The electric element of the SunMaxx-80SS1HX 80 Gallon 1 Heat Exchanger Storage Tank assists the system only when the solar energy cannot maintain the desired temperature or during periods of peak demand. Automatic temperature control thermostat keeps stored water at desired temperature. Tanks can be horizontally mounted. This 80 gallon unit has an internal heat exchanger for systems that use heat transfer fluids. It is sufficiently sized to provide potable hot water for 4-6 people on the average day, as typical family of four in the U.S. uses about 80 gallons of hot water each day. To heat that water with electricity takes about 16 pounds of coal. The water preheating system composed from 2 pairs of those tanks can be used for hot water storage in the 50 flat type houses for 100 residents. For water heating of 100 people of stationary 50-flat type house, the following equipment should be used: 5 X 200 Gallons SunMaxx 20 system assembled by using 5 systems of "Evacuated Tube Heat Exchanger System - 120 Gallon" that include: 10*2 „SunMaxx-20 Evacuated Tube Solar Collectors“; 10*1 „20 Plate External Heat Exchanger“; 10*2 „TACO Circulator Pumps“; 10*1 „Goldline GL-30 Differential Temperature Controller“. This system may be used for 60 residents of this house. The additional 12 „SunMaxx-20 Evacuated Tube Solar Collectors“ should be used to providing hot water for the rest of 40 residents for the cost of \$660*12= 7920*2.63=20830 Lt. The total price of the system with the water preheating facilities is 101670 Lt. Such system is able to becoming as a backup heating source for heating of towel drying coils and circulating hot water of this 50-flat type house. As an example, let us look at the bill for heating of hot water of 168.8 kwh equal to 44.72 Lt and the bill for heating of towel drying coil of 100 kwh equal to 26.48 Lt given by „Klaipėdos Energija“ to one flat for two residents of this house for February 2009. According to Fig.2c, solar energy may be successfully used for water heating during 9 months of the year in Lithuania. Having an average income of residents of this flat from solar water heating system equal to (44.72 + 26.48)*9/12=53.4 Lt/month and a total bill for equipment to be played by residents of this flat equal to 101670/50=2033Lt, the pay-off of the system for residents of this flat would be 2033/53.4=38.1 month or 3.17 years.

Integration of Solar water preheating subsystem into typical heating system of stationary 50-flat type house-laboratory: A method of integration of solar water preheating system into typical heating system of stationary 50-flat type house-laboratory is shown in Fig.3. During the winter period when sun energy amount is not sufficient, such subsystem may be supplied by using TASSA Gmb 5 kW Wind Power System for water heating as it is shown in Fig.4.

PV-wind-solar radiation and geothermal energy for heating of water and apartments

Solar radiation and geothermal energy system for individual house-type eco-social laboratories: Geothermal probes are the most common geothermal heat source, particularly in commercial applications. They allow the full benefits of geothermal cooling in terms of heat source regeneration to be utilised, as heat is stored very efficiently in rock structure. Hair-pin shaped loops of high quality HDPE plastic tubing are encased in a vertical borehole, around 12cm in diameter. The tubing is hard wearing and a good conductor. The specific removal capacity of the heat exchanger is only slightly influenced by the diameter of the hole, arrangement of pipes and pipe fittings. Far more important is the length of the hole, as capacity increases in proportion to the length. The Avolsheim Northeast France Ground-source heat pump (see http://www.heatpumpcentre.org/Publications/Case_Avolsheim.asp) is one of the first vertical ground-source heat pump installations in France. This water-to-water heat pump provides: installed capacity - 10 kW, Heated floor area -100m², Refrigerant- R-407C, Heat source - Ground, 240 W of ground-source is controlled through heat pump + 100 W for distribution, controlled through ambient thermostat, Type of ground heat exchanger - Vertical, Pipe length (m) - 100, Borehole depth (m) - 20, Heat transfer fluid - Water/glycol, Flow rate (l/h) - In pipe 1.47 m³/h, distribution 1.33 m³/h, Supply and return temperature (°C) for Heating - 35/30, Heat pump design - 115% of the heat loss.

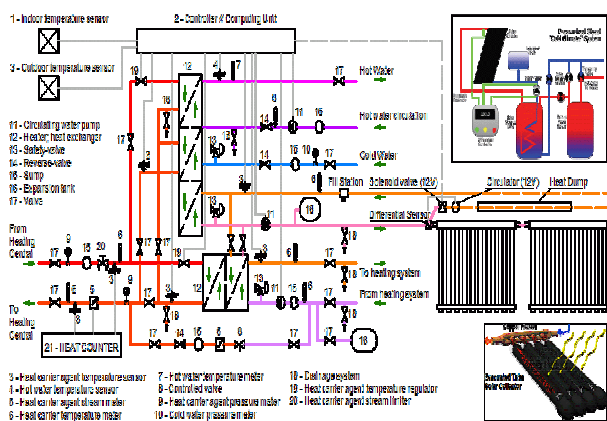


Figure 3. Integration of Solar water preheating subsystem into typical heating system

Supplementary system is complementary electric heater in the bathroom and direct electrical heater for DHW (domestic hot water), heat pump system completion date - 1998, Energy input (kWh/year) for Heat pump 2, 788, for

Aux. heating system 20, for Auxiliaries 583, Energy output kWh/year -8 921, Capital cost (excluding heat pump) (EUR): 14, 270. In the Netherlands near the Rotterdam (see http://www.heatpumpcentre.org/Publications/Case_Near_Rotterdam.asp), heat pumps with vertical ground-source heat exchangers are used for space heating, production of DHW and passive (free) cooling - for direct utilisation of the cold from the ground source. The dwellings are also provided with balanced ventilation systems with heat recovery units (97%). Two of these dwellings are monitored by the Institute of Environmental Sciences, Energy Research and Process Innovation, Department of Refrigeration and Heat Pump Technology. The ground source heat exchangers are filled solely with water. No antifreeze is used. The COP of the utilised heat pump is 5.64 at test conditions. Building type: Two single-family house(s), Number of storeys: 2 and attic, Heated floor area (m²): 120, Design outdoor temperature (°C) -7, Design indoor temperature (°C) 20, Heat pump type(s) - Water-to-water, Capacity kW - 8, Refrigerant - R134a and R407C, Borehole depth (m) - 15-20, Pipe length (m) - 600, Heat transfer fluid - Water, Cooling energy Residence 1/ Residence 2 - Energy input (kWh/year) - 1340 / 830, Energy output (kWh/year) - 5650 / 4570, Heating energy Residence 1/Residence 2 - Energy output (kWh/year) 1825 / 1914, Domestic hot water Residence 1/ Residence 2 Energy input (kWh/year) - 885 / 515, Energy output (kWh/year) 1715 / 1180, Coefficient of performance (COP) 3 - 84 and 5.46 (according to the EN 255-2).

The following Heat pumps may be used for the Smart House/Flat type Eco-Environment with Integrated Property of **Personal Health Assisting**:

a) The GMWW 28 Golf Maxi/Standard/R for heating and active cooling (Price excluding U-Pump - **10,965** Euro); b) The Heizungs-Wärmepumpen GMDW 8 Golf Plus for heating and cooling (Price - **6,755** Euro); c) Multifunktional-Package, the Solar-Warmwasser-Wärmepumpe EUROPA 303 S (Price - **4618** Euro).

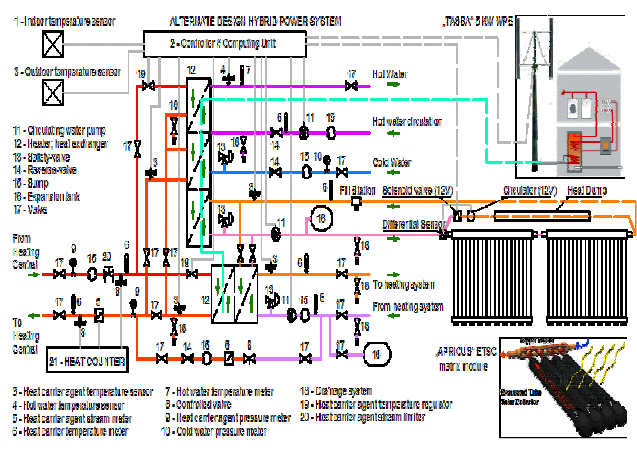


Figure 4. Integration of TASSA Gmb 5 kw Wind Power System for the water preheating

PV-wind-solar radiation and geothermal energy system for heating of water and apartments of 100 residents of stationary 50-flat type house-laboratory: The following elements of the PV-Wind energy

generating subsystem for the up to 100 people of stationary 50-flat type houses should be installed:

- 1) 32 units of 12 V Polycrystalline BP 350J 50W type PV modules to providing of 1600 W;
- 2) 8 units of AIR X 403 wind turbine;
- 3) 32 units of 12V/105Ah 27TM deep cycle batteries –32*247;
- 4) 8 units of PV and Wind Hybrid Charging Controller WS482K;
- 5) 8 units of Morningstar SunSaver MPPT Charge Controller;
- 6) 8 units of Mastervolt Soladin 600W grid-tie inverter to deliver 4800W 220VAC power to main installation of the house to producing of 115.2 kwh/day or 3456 Kwh/month.

Total price of PV-wind equipment for the 100 people of stationary of 50 apartment type house-laboratory is 90380 Lt. Having 0.33 Lt/kwh and $3648 \cdot 0.33 = 1140.48$ Lt /month income, the pay-off would be $90380/1140.48 = 79.25$ month or 6.6 years.

Solar subsystem for water heating of 100 residents of stationary 50-flat type house should be composed by using of the water preheating facilities composed from 2 pairs of SunMaxx-80SS2HX and SunMaxx-80SS1HX tanks of 320 gallons (1211 ltr) for hot water storage in the 50 flat type houses for 100 residents. For water heating of 100 people of stationary 50-flat type house, the following equipment should be used: 5 X 200 Gallons SunMaxx 20 system assembled by using 5 systems of "Evacuated Tube Heat Exchanger System - 120 Gallon" that include: 10*2 „SunMaxx-20 Evacuated Tube Solar Collectors“; 10*1 „20 Plate External Heat Exchanger“; 10*2 „TACO Circulator Pumps“; 10*1 „Goldline GL-30 Differential Temperature Controller“. The additional 12 „SunMaxx-20 Evacuated Tube Solar Collectors“ should be used to providing hot water for the rest of 40 residents. The total price of the system with the water preheating facilities is 101670 Lt. Such system is able to becoming as a backup heating source for heating of towel drying coils and circulating hot water of this 50-flat type house. As an example, let us look at the bill for heating of hot water of 168.8 kwh equal to 44.72 Lt and the bill for heating of towel drying coil of 100 kwh equal to 26.48 Lt given by „Klaipedos Energija“ to one flat for two residents of this house for February 2009. According to Fig.2c, solar energy may be successfully used for water heating during 9 months of the year in Lithuania. Having an average income of residents of this flat from solar water heating system equal to $(44.72 + 26.48) \cdot 9/12 = 53.4$ Lt/month and a total bill for equipment to be played by residents of this flat equal to $101670/50 = 2033$ Lt, the pay-off of the system for residents of this flat would be $2033/53.4 = 38.1$ month or 3.17 years.

Having of total 1.211 m^3 storage for heated water, one can save by 0.1 – 0.15 times of heating expences by using radiant solar energy at least of 3 months of winter. Taking into account of bill given by „Klaipedos Energija“ for heating the flat of 72 m^2 of this house during the February of 2008 equal to 191 Lt for 721 kwh or 2.652 Lt/m^2 , and for 5300 m^2 house $5300 \cdot 2.652 \cdot (0, 1 - 0, 15)/2 = 702, 78 - 1054 \text{ Lt}$ / 50 house, the pay-off would be for one flat equal to 14, 05 - 21, 08 Lt/month. This would give the total pay-off for solar system equal to

$158166/(2670 + (702,78 - 1054)) = 46,89 - 42,47$ months or 3.9 - 3,54 years.

The geothermal subsystem may be composed by using of OCHSNER Wärmepumpen GmbH Golf Midi GMDW 11 Plus 2.2 kW heat pump system that may be installed for 50 flat. If the power of 2.2 kW necessary for feeding of this heat pump would be taken from the hybride PV-wind subsystem, it will be able to generate $2.2 \cdot (4-5) = 8.8 - 11 \text{ kw}$ power or $(8.8 - 11) \cdot 24 \cdot 30 = 6336 - 7920 \text{ kwh/month}$ for heating of this 5300 m^2 house and save $(6336 - 7920) \cdot 2.652 = 16803 - 21004 \text{ Lt/month}$. If this house had to pay of $5300 \cdot 2.652 = 14059.7 \text{ Lt/month}$ for heating for the February 2008, that will cover all expences for heating of this house per February of 2008. The pay off of such integrated PV-wind-geothermal system for this 50 flat house would be $(90380 + 101670 + 75252) / ((16803 - 21004) + (702, 78 - 1054) + 1140.48) = 267302 / (18646 - 23198) = 14.33 - 11.52$ months or 1.19 – 0, 96 year.

Intelligent support for assisted living in the eco-social environment

Analysis of professional equipment to be used for support of humanbeing in the portable eco-social laboratory: 4 Laptop computers have to be used for online wireless communication with remote server and the following biofeedback devices:

a) The **ProComp5 Infiniti™**. The ProComp5 Infiniti system, with 5 simultaneous feedback channels, includes the BioGraph Infiniti software, the EEG or Physiology Suite with the following modules: **EMG** module, **EKG** module, The **GSR** module, the **Temperature** module, **Respiration** module, and the **Heart Rate/BVP** module;

b) The **GSR 2 (M-10-2120-CalmLink+GSR/Temp2X)**, the GSR2 home biofeedback device precisely monitors one's stress levels by translating tiny tension-related changes in skin pores into a rising or falling tone. By resting two fingers on the sensing plates, one can learn to lower the pitch and one's stress level. Cordless finger-rest sensor with built-in-tonal feedback automatically measures galvanic skin resistance (GSR);

c) The **CalmLink Software** for GSR2 which is the GSR2 PC Interface software for relaxation and stress control;

d) The **Biofeedback Starter Kit**, the BSK utilizes several different physiological systems in order to provide an easy and inexpensive way to show simple relaxation techniques. The CalmLink Software for GSR2 the CalmLink is the GSR2 PC Interface software for relaxation and stress control;

e) The **Heart Wizard HRV System**, the HRVW is an interactive Internet tool capable to obtain and process of Heart Rate Variability (HRV) from a simple non-invasive sensor that clips on the earlobe or finger tip. The interpretation of this data provides valuable, and more importantly, useful insight into the psycho-physiological health status of both healthy people and those who are unhealthy. Computer requirements: A desktop or a laptop with OS Windows ME or newer and NET Framework 1.1. Additional User Module for Heart Wizard allows recording of more than one individual. Each user has

one's own slot (module) to allow for individual tracking of personal wellness;

f) The **Polar RS800 Heart Rate Running Computer**, the *PolarComp* is a complete system for planning, monitoring and analyzing of one's training and allows you to create and name your own favorite time and/or heart rate. It provides an easy way to select and monitor the intensity of your training and to follow Poplar's sport zones based training programs;

g) The **Personal Efficiency Trainer ® PET ECG** module for PET ECG 2 channels Package can be used for Heart Rate/Heart Rate Variability Monitoring and Feedback. The *BioExplorer* software is required for the PET WIRELESS ECG or PET WIRELESS ECG/EMG;

h) The **PET EMG** module for PET EMG 2 channels Package measures muscle tension in various muscle groups in the body. It can be used for research or as a tool to reduce tension and induce a more relaxed state. It can also be used to monitor or promote subtle changes in the muscle activity for peak performance training in sports;

i) The **PET GSR** Wireless Package can measure aspects of stress, orienting response, and vigilance, includes Wireless GSR module, GSR Sensor, *BioExplorer* Software v1.5. The *BioExplorer* is a Windows program for real-time biophysical data acquisition, processing, and display. For post-session review of recording the time, date, electrode locations, and subject name with each session, the *BioReview* can be used.

Selecting of Smart Control System for the Laboratory: The 2.4GHz T-bus EIB smart home control system (see <http://www.walltongroup.cn/support/070824090256.html>), the European Installation Bus (EIB) system can be used for "intelligent" electrical installation networking in the Laboratory. The bus cable installed in addition to the supply cable combines devices and systems (e.g. heating, lighting or ventilation), which previously functioned separately from one another, into an economical system optimally adapted to individual requirements. Both now and in the future, this domotic network provides new functions which previously were either very difficult to implement or could not be implemented at all. For example, a turn of your house key can switch off forgotten basement light or the power supply to the iron. The result: EIB improves customized home living, security and efficiency - day for day - an entire life. Here's how the "intelligent" home works: The EIB system serves as the automatic controller of devices and systems in homes and apartment houses, and functional and commercial buildings. Sensors, such as motion detectors and thermostats, send impulses over a transmission medium to so-called actuators, for example. Sensors and actuators communicate with each other via four alternate transmission media. Sensors and actuators can be programmed and linked by the technician as desired. It is easy for home occupants to manipulate the functions of the EIB system using familiar switches, the telephone or the touch screen. You can change links as required and add new functions to the system any time you want. The flexible EIB adjusts your home to the needs of the person - no matter what time of the day, season or phase of life. That also goes for the future. EIB is a standardised, OSI-based network communications

protocol. The EIB protocol is the digital language by which any number of devices in the building may communicate with each other. In this way, the devices (sensors, actuators, and smart controllers) can cooperate to perform distributed control application functionality, such as: automatized doors and gates; access, alarms and security control; air conditioning and another temperature and climate control; energy and load management; lighting and scenery control; white and brown home appliance control; windows, blinds and shutter control. EIB has opted for a small, economical set of standard datatypes for shared variable datapoints. Each device publishes a set of *Group Communication Objects*, each of which exhibits one of the standard datatype. The designer of the project establishes shared variable communication by connecting (binding) two *Group Communication Objects* of matching type with a group address, e.g. the value output of a temperature sensor to the corresponding input object of a room temperature controller, or the switching output object of a pushbutton sensor to the input object of a binary output device. The specification defines physical communication media, over which devices may send protocol messages to their partners on the system: Twisted pair communication; Powerline communication (PLC); Wireless communication. EIB imposes no direct requirements on microprocessor architecture; this means any suitable chip may be used as a platform for implementation. Alternatively, a manufacturer may prefer to focus on his application domain know-how, and just construct application-specific hardware and firmware - using certified EIB building blocks (transceivers, protocol stack implementations, protocol stack source code etc.), offered by a number of specialised system providers. PC solutions are as follows: ANubis is the IPnet (Internet, intranet and extranet) connectivity road for EIB; ETS - EIBA's suite of tools focused around powerful design, configuration and commissioning of EIB network installations, iETS is a ANubis component; eteC - EIBA's state-of-the-art component API's, based on the DCOM component technology; Falcon - the eteC-based 32bit access library for Windows; The EIB OPC (OLE for Process Control) server adds an OPC Server layer to the eteC Falcon component for network access, focussing on runtime (group addressing) functionality. OPC is the de facto standard for process control and visualisation on Windows system platforms; the only way, until now, to connect a PC to an EIB installation is via RS-232 and USB serial interface.

The 1-Wire Bus Masters (see <http://embeddeddatasystems.com/page/EDS/CTGY/HA>) known as host adapters may also be used in the Laboratory. The 1-Wire Bus Masters are available in a wide variety of form factors and interface types. They are divided into two basic categories: The Intelligent Bus Masters and the 1-Wire Level Converters. The Intelligent Bus Masters, the Intelligent Adapters relieve the host from the burden of generating the time-critical 1-Wire communication waveforms while supporting all Dallas 1-Wire and iButton devices with simple ASCII commands that can be easily generated. This enables 1-Wire networks to be used by nearly any device that can read/write ASCII data via any of the following interfaces:

RS232 / RS485 / TTL. The 1-Wire Level Converters require the host to generate the 1-Wire timing, and are compatible with both the Dallas TMEX API's and OneSix DDE / OPC server software for Microsoft Windows. **The HA7Net Ethernet to 1-Wire interface** to remotely monitor and control 1-Wire networks, sensors, and controls can be used in the Laboratory.

Conclusions

An approach is proposed for development of an intelligent eco-social environment which may be implemented both in a high education institution and in the stationary as well as portable living houses based on: 1) Investigations of possibilities of generating of a hybrid PV-wind power for supplying of eco-social laboratories of different sizes in Lithuania; 2) Investigations of possibilities of application of solar radiation energy for heating of water and environment of apartments of eco-social laboratories of different sizes in Lithuania; 3) Investigations of possibilities of application of integrated PV-wind-solar radiation and geothermal energy for heating of water and environment of apartments of eco-social laboratories of different sizes in Lithuania; and 4) Investigations of possibilities of implementation of intelligent support for assisted living in the eco-social environment.

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INTELEKTUALIOS EKO-SOCIALINĖS APLINKOS ASISTUOJAMAM GYVENIMUI KŪRIMAS

Santrauka

Jau keletą metų Klaipėdos universiteto Informatikos katedroje vykdomi tyrimai žmogaus gyvenimo kokybei gerinti. Pasitelkiant visų pakopų informatikos studijų programos studentus, yra kuriamos kompiuterizuotos žmogaus sąsajos su tam tikrais dirbtinio intelekto požymiais pasižyminčia ekologiškai orientuota mokymosi ir gyvenamąja aplinka. Tai leido sukaupti patirties kartu su kitų GMMF ir JTF katedrų specialistais bei studentais projektuojant automatinio valdymo hibridines saulės-vėjo ir radiacinės energijos kompleksinio panaudojimo sistemas individualiems namams ir butams daugiabučiuose namuose. Tokių sistemų pagrindą sudaro ant privačių namų ir daugiabučių namų su plokščiais stogais montuojamos saulės ir vėjo alternatyvios elektros ir šilumos generavimo jėgainės, į bendrą kompiuterizuotą valdymo sistemą sujungiant keturias komponentes: 1) saulės baterijų elektros jėgainę, 2) mažųjų vėjo turbinų elektros jėgainę, 3) saulės kolektorių saulės radiacinės energijos kaupimo šildomame vandenyje termiškai izoliuotose talpose jėgainę ir 4) geoterminės energijos panaudojimo šilumos siurblių jėgainę. Privačiame name šilumos gaminimo jėgainės pašildomo vandens talpos gali būti montuojamos namo patalpose, kitus elementus išdėstant ant namo stogo. Daugiabučių namų atveju visi hibridinės jėgainės elementai – saulės baterijos, vėjo turbina ir šilumos generavimo kolektoriai bei vandens talpos montuojami ant plokščio stogo, įrengiant į pietus pasvirusią 71 laipsnio kampą saulės baterijų ir saulės kolektorių išdėstymui bei vandens talpų ir elektrą kaupiančių akumuliatorių patalpinimui skirtą patalpą. Tokios jėgainės namo ar buto savininkui galėtų kurti alternatyviąją energiją, taupiai ją naudojant vartotojo elektros poreikiams ir vandens bei patalpų šildymui, sumažinant iki 70 – 80 procentų iš elektros ir šilumos tinklų imamos energijos sąnaudas.

Pasiūlytas metodas intelektualios, mobilios, besimokančios eko-socialinės laboratorijos vystymui, taikytinos asistuojamos rekreacijos tyrimams. Sukurtas projektas atsinaujinančio maitinimo šaltinio ir profesionalios biologinio grįžtamojo ryšio aparatinės/programinės įrangos mobiliai laboratorijai realizuoti. Tokia laboratorija galėtų būti panaudota kaip pramogų priemonė tipiskam Europos namų ūkiui/šeimai. Laboratorija gali veikti kaip intelektualus rekreacinis objektas, turintis savyje vietas darbui ir relaksacijai, o taip pat biologinio grįžtamojo ryšio dėka – kaip asmeninės sveikatos informacijos surinkimo ir analizavimo priemonė. Intelektuali laboratorijos aplinka gali būti įgyvendinama UltraLite tipo turistinėje priekaboje, su visais pirmo būtinumo dalykais komfortiškam iki 6 asmenų grupės laisvalaikiui. Aprašytos mobilios laboratorijos įrangos kaina (2009-01-15) apie 37806 eurų. Aprašytoji laboratorija gali padėti rinkti ir kaupti žinias pagyvenusiujų ir/ar žmonių su judėjimo negalia reabilitacijos procese, padėti atstatyti aktyvumą jiems įprastoje aplinkoje.

Jei darbe pasiūlytoji hibridinė elektros jėgainė butui arba individualiam namui, teikianti vidutiniškai 8 val. 240 W saulės baterijų galią, kuri būtų parduota elektros tinklams po 1.7 Lt/kwh 8 mėnesius per metus, vidutiniškai galėtų duoti 66 Lt/mėn, o vėjo jėgainė, Klaipėdos regione esant metiniam vidutiniam 7 m/s greičiui, sukurdamą apie 50 kwh/mėn. ir sukaupdamą akumuliatoriuose energiją rudens, žiemos ir pavasario mėnesiais bent 6 mėnesius po 5040 VAh akumuliatoriuose, ją panaudojant po 1 kW 4 val. per parą po 0.33 Lt/kwh, galėtų duoti 36.3 Lt/mėn., tai tokios hibridinės jėgainės įrenginių vienam butui arba mažam namui atsipirkimo laikas galėtų būti per 109.7 mėn. arba 9.1 metų.

Jei montuotume 11226 Lt kainuojančią jėgainę, 300-2/40 komplektą ir naudotume ¼ SE62-119R-045S 120 šildytuvo vienam butui, imant 4 butų bendrijos atvejį, galėtume per metus sutaupyti už elektrą 1227.6 Lt, už vandens ir gyvatukų pašildymą –855 Lt ir už šildymą per 6 mėn.:

a) Renovuotam namui, esant 2.652 lt/m² 138 m² ploto dviems butams 3 mėnesiams visiškai atsisakant šilumos tinklų paslaugų turėtume 1098 Lt/3 mėn. ir šalčiausiu metų laiku paliekant iki 0.2 šilumos tinklų paslaugų –768 Lt/ kitiems trims mėnesiams, sistemos atsipirkimas vienam butui galėtų būti per 16750/3152=5.31 metų;

b) Nerenovuotam namui, esant 7.56 lt/m² 138 m² ploto dviems butams 3 mėnesiams visiškai atsisakant šilumos tinklų paslaugų, sutaupyti 3129 Lt/3 mėn. ir šalčiausiu metų laiku, paliekant iki 0.3 šilumos tinklų paslaugų, sutaupyti 2190 Lt/ kitiems trims mėnesiams, tokios sistemos atsipirkimas vienam butui galėtų būti per 16750/5319=3.15 metų.

PAGRINDINIAI ŽODŽIAI: asistuojamas gyvenimas, intelektualioji eko-socialinė aplinka, atsinaujinančios energijos, biorobotų paslaugos.

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