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Sustainable Energy Generation From Pumped Hydropower

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Presentation Layout

- Introduction
- Need for Small Hydro-Power Plant (SHP)
- Pumped storage HP design
- Automated PSH plant Control
- Conclusions

Introduction

- Power, backbone of every economy.
- Consistent, reliable, adequate supply
- RES, zero or little threat to human lives
- South Africa
  - 90 % of energy from coal
  - 12th biggest CO_2 emitter in the world

Need for SHP

1. **Material**:
   - Depletion of coal stocks and quality
   - high maintenance levels
   - plant failure and inadequate reserves
2. **Pollution**: green house carbon emission
3. **Environmental**: Climate change
4. **Cost**: High cost of other power plants e.g. coal
   - It is available, renewable and sustainable
   - Low or zero maintenance cost

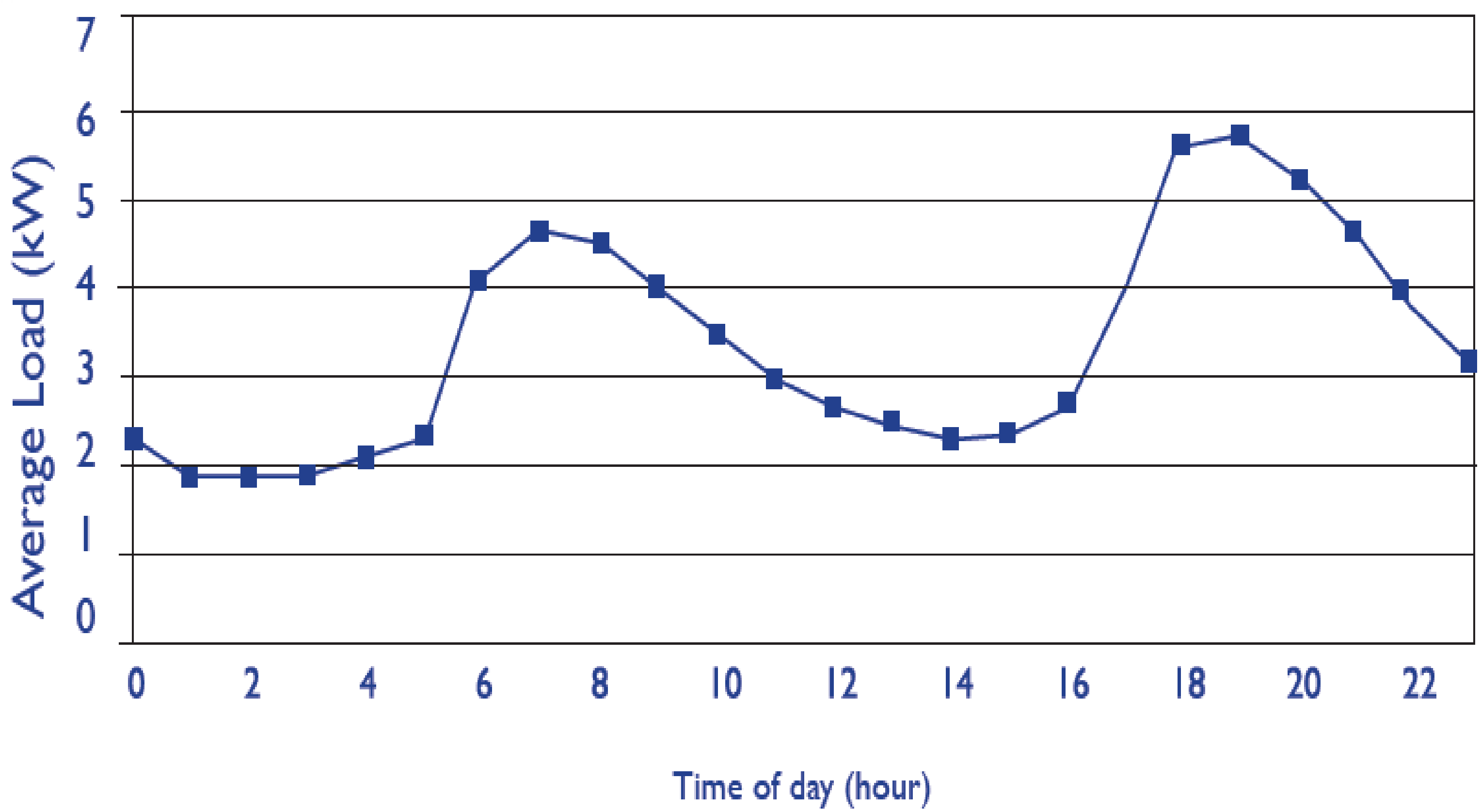
Need for SHP

- Stand-alone System or Grid-Connected
- Simple technology, no need for technician
- Global energy demand increases
- SHP is considered
  - the most cost effective
  - environmentally friendly energy generation
- No Huge storage facility
  - -> Energy should be generated when needed

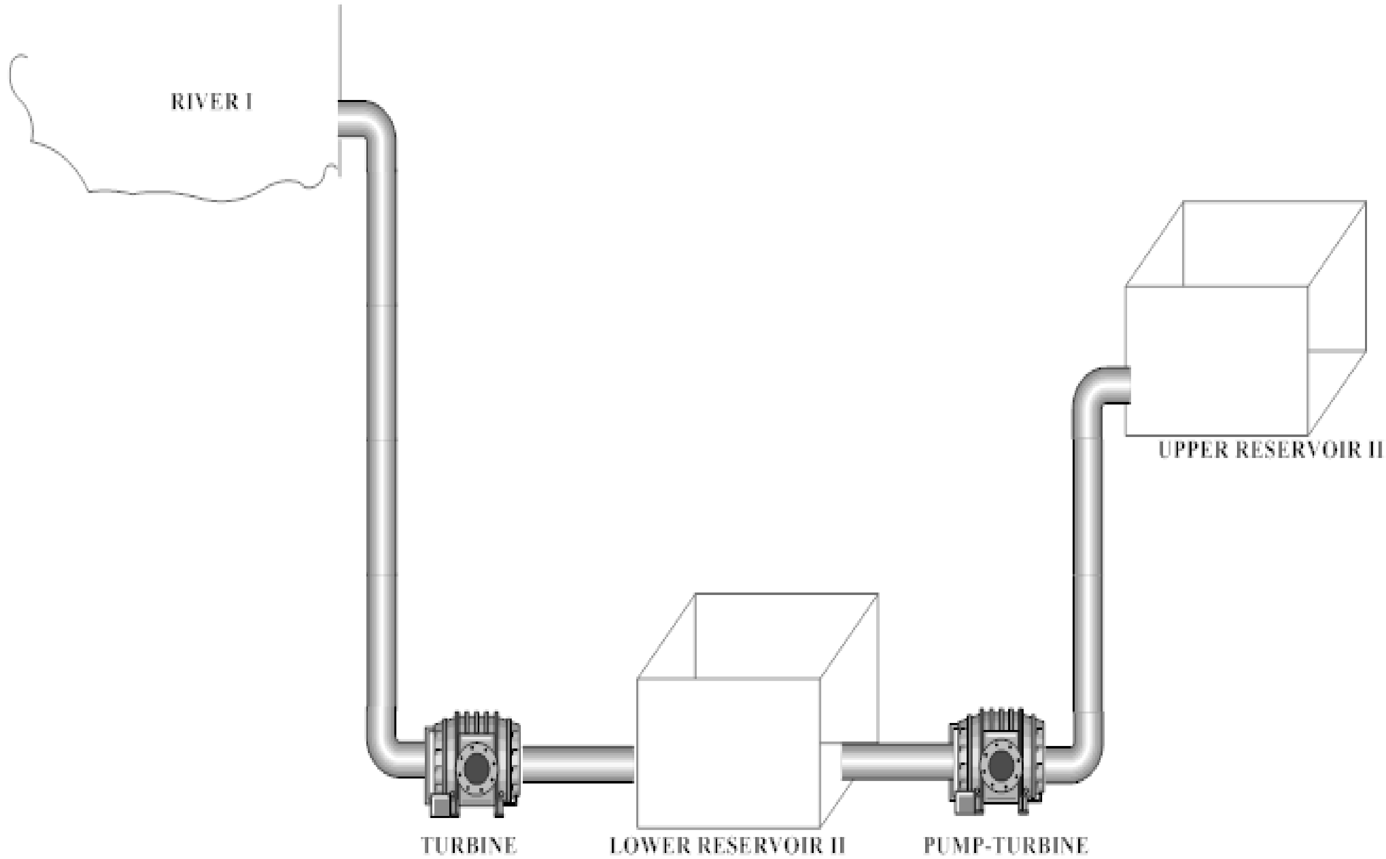
Prospects of SHP in South Africa

- 8 000 suitable potentials in KZN and EC provinces,
  - capable of generating 100 MW
- SHP highly-distributed in South Africa
- Timely utilization of this potential
  - saves the overburdened power generation sector

Average South African household daily electricity consumption pattern



Proposed SHP Hybrid plant.The idea is to meet peak electricity demand.



Pumped storage HP design contd

- Allocate pumping power

$$P_{pump} = \frac{\rho_w.g.Q_p.H_p}{\eta_p}$$ ----------------(1)

- Compute flow at each power requirement and estimate average pumping Q_p

  -$Q_{pump} = P_p.\eta_p / \rho_w.g.H_p$-----(2)

Pumped storage HP design

Calculate losses in the pumping mode and compute the value of h_L

- Compute, minor head losses,

$$h_{minor,} = \frac{V^2}{2g} * (K_{entrance} + K_{valve} + 2K_{bend} + K_{exit})$$

- Compute, major head losses

$$h_{major} = f * \frac{l}{D} * \frac{V^2}{2g}(K_{suction} + K_{delivery})$$

Compute PSH generated power using

- $P_g = \rho_w . g . Q_g . H_g . \eta_t$ ----------------(3)

Design Parameters

River-run of Plant

- Power = 3.924kW
- Turbine efficiency = 0.8
- Flow = 0.05m^3/s
- Head = 10m

Pumped Storage Plant

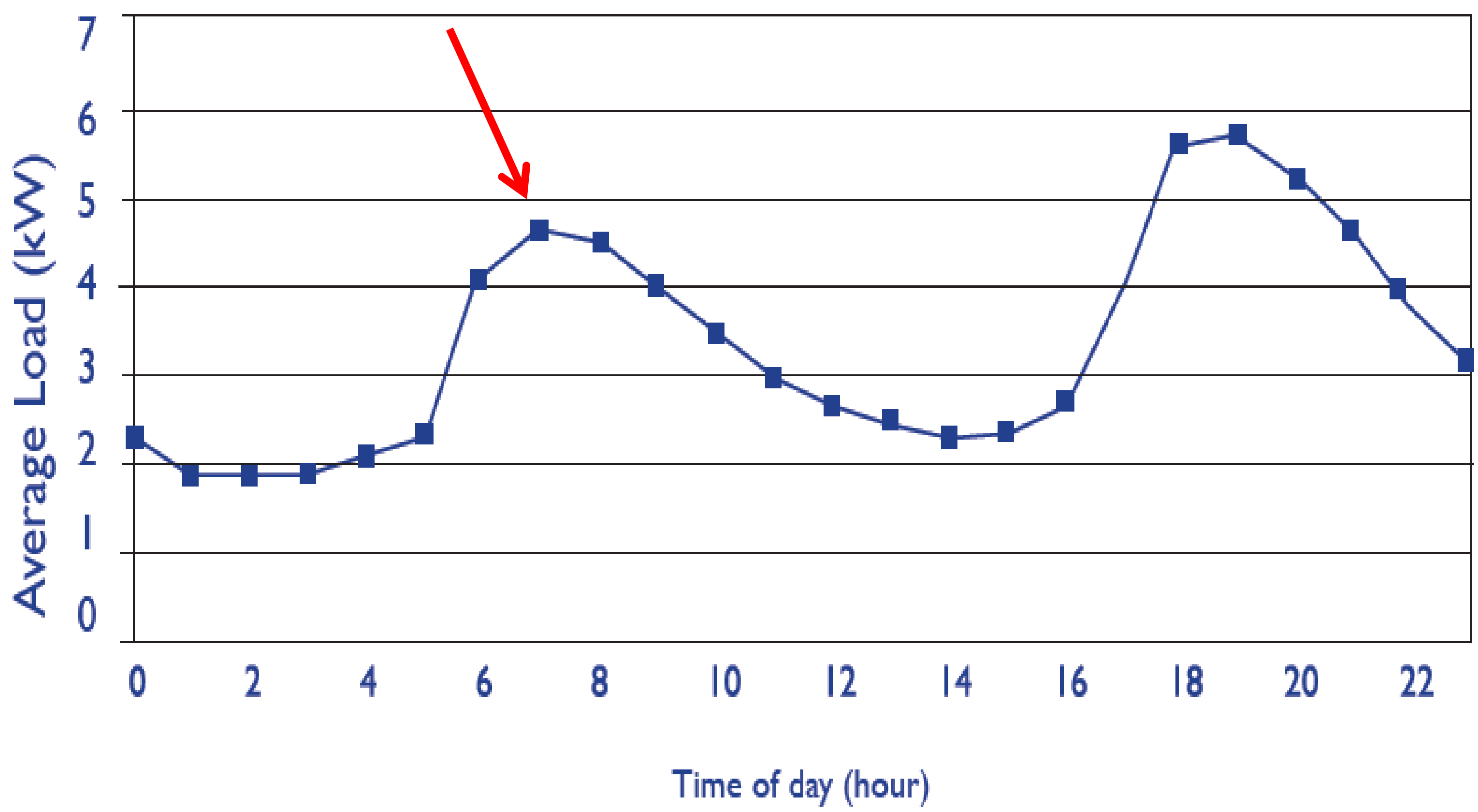
Head = 5m

Flow = 0.04m^3/s

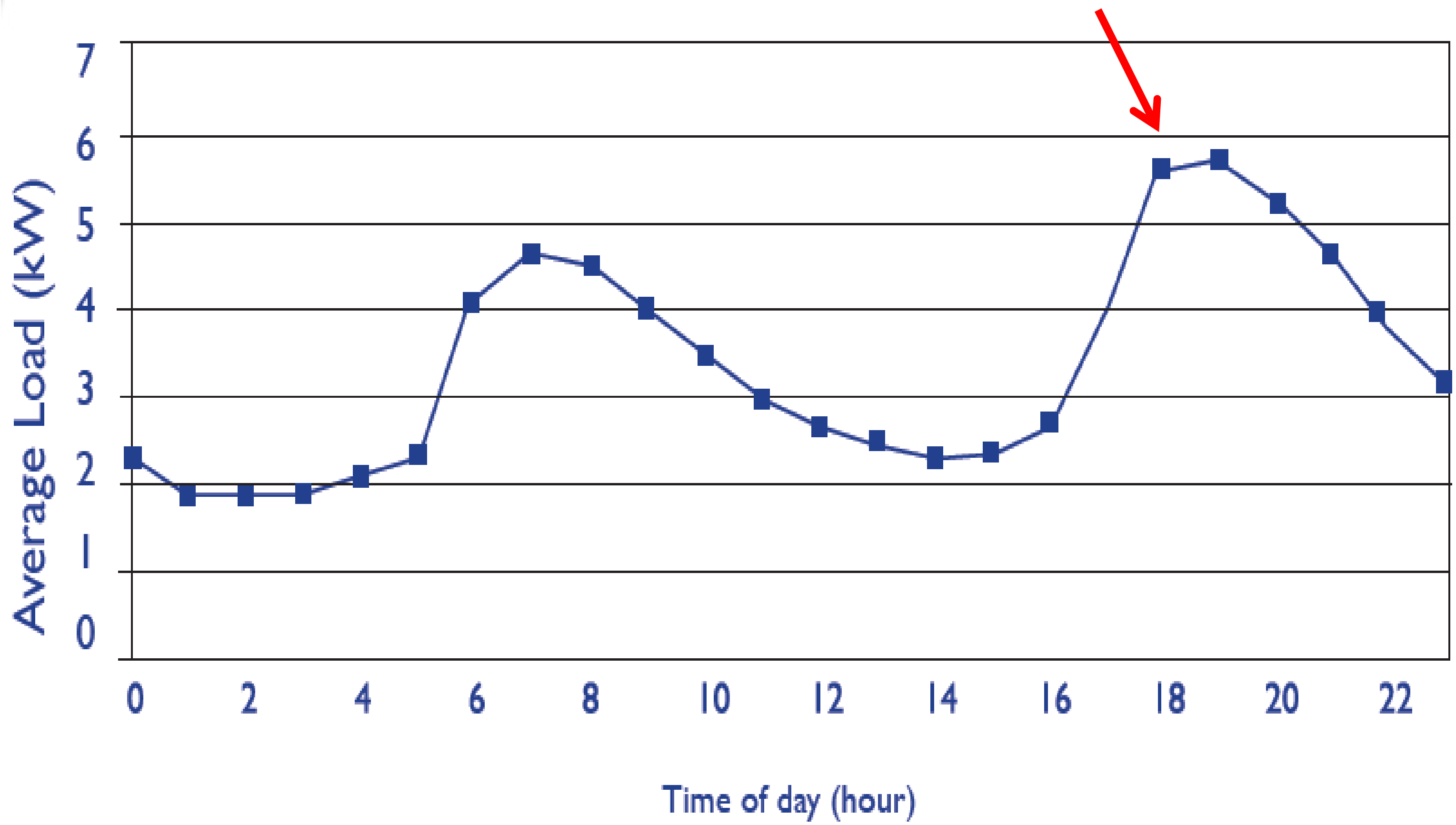
Reversible-turbine efficiency = 0.75

Generated power at full capacity = 2.616kW (this is additional power to meet peak demand)

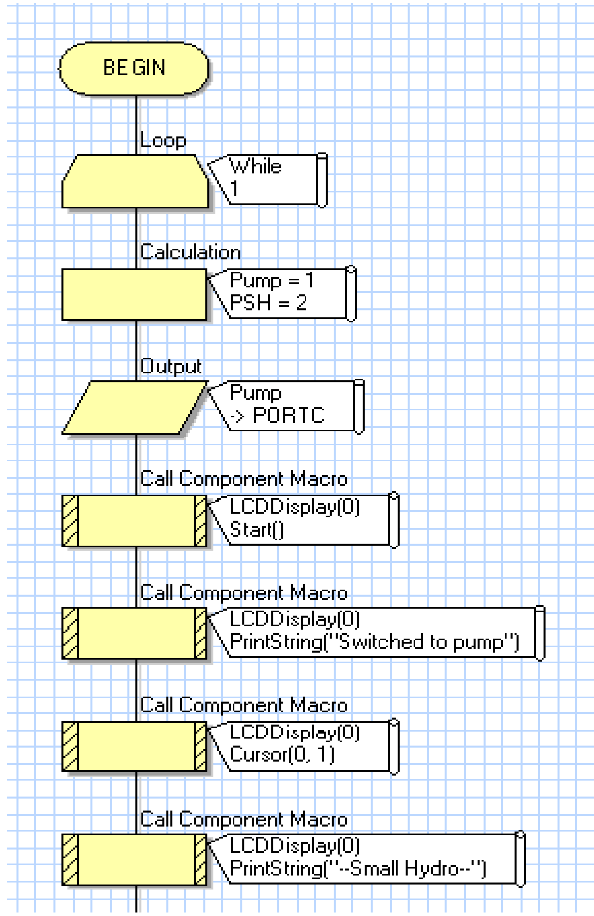
Between the hours of 5am to 10am PSH helps to meet power demand



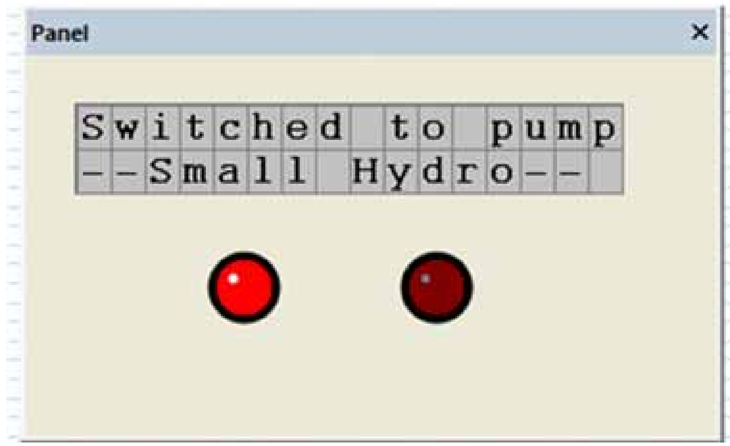
Between the hours of 5pm to 9pm PSH helps to meet power demand from the extra 2.616kW

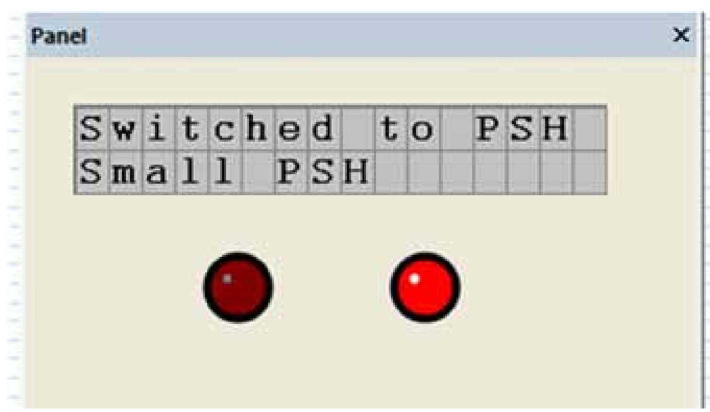


Flowcode control flowchart

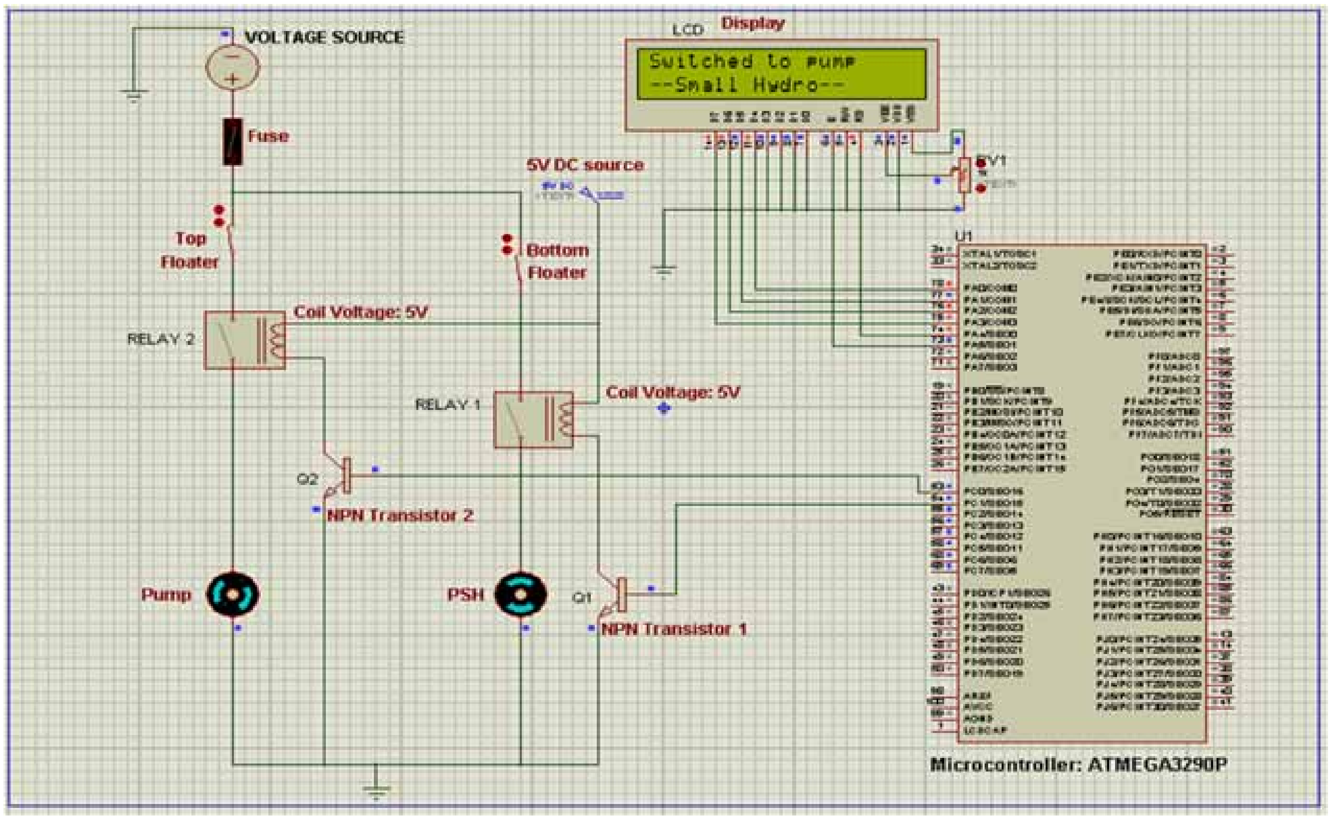


Flowcode panel display

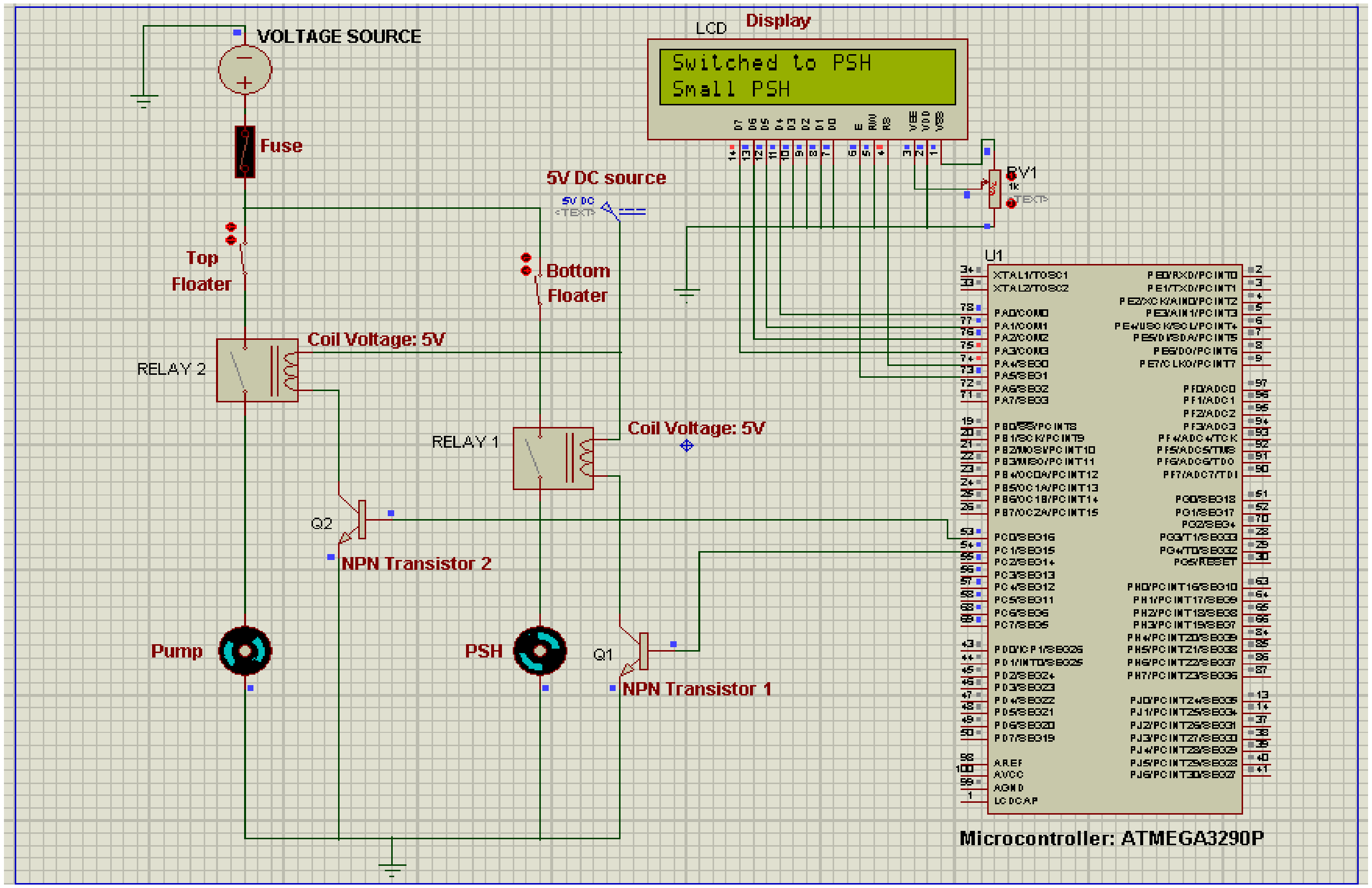




Proteus microchip control arrangement (pumping mode)



Proteus microchip control arrangement (PSH generation mode)



Conclusions

- SHP for small communities in developing countries
- Two hydro generation systems combined
  - to meet peak electricity demand
- Effective control
  - every plant activity shown
  - ensuring maximum use of rejected power

Conclusions

- The design ensures power is stored and made available only when needed
- Unnecessary plant breakdown is avoided
  - Due to over-pumping or over-generation
- Can work as
  - Stand-Alone for Rural Electrification
  - Feed the main grid

Acknowledgement

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Thank You