top10.cn

SAARC ENERGY CENTRE
Energy for Peace & Prosperity

Pump System Energy Efficiency and Smart Pump Demonstrator

Hu Bo,
Top10
7 December 2021

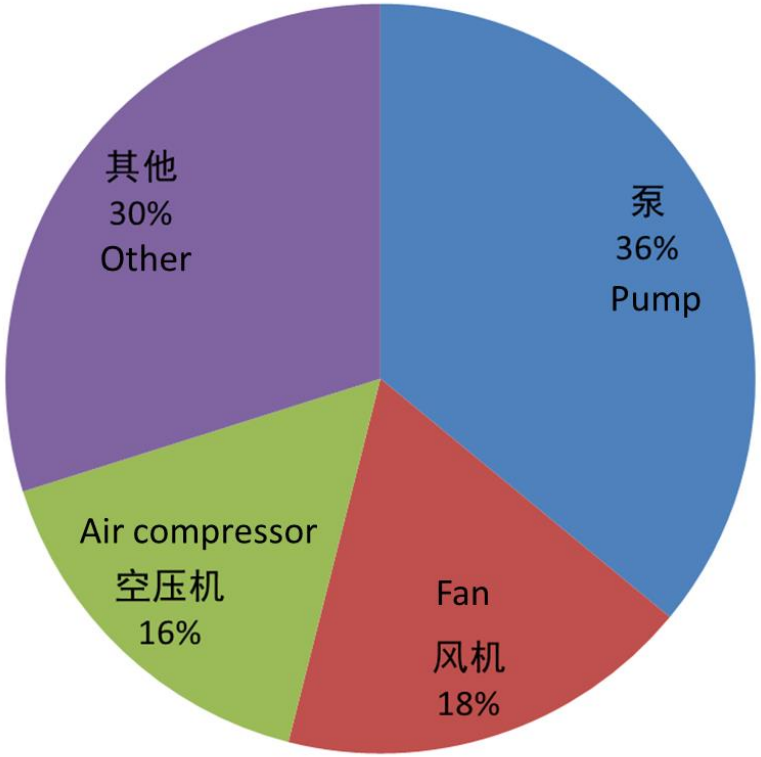
Profile

- Researcher
  - Motor system energy efficiency
  - Appliance energy efficiency standards and labels
  - Cooling efficiency
  - Industrial IoT standardization
- Programmer
  - Embedded device and system
  - IoT cloud OPC UA server
  - Web application
  - Web crawling
- Coordinator
  - International cooperation
  - Technology transfer

Table of content

- Motor system efficiency is the key approach
- Training is the most cost-benefit method
- Smart pump demonstrator – from Switzerland to China
- Smart pump demonstrator platform
- Pump system efficiency cases
- Innovative international cooperation pattern

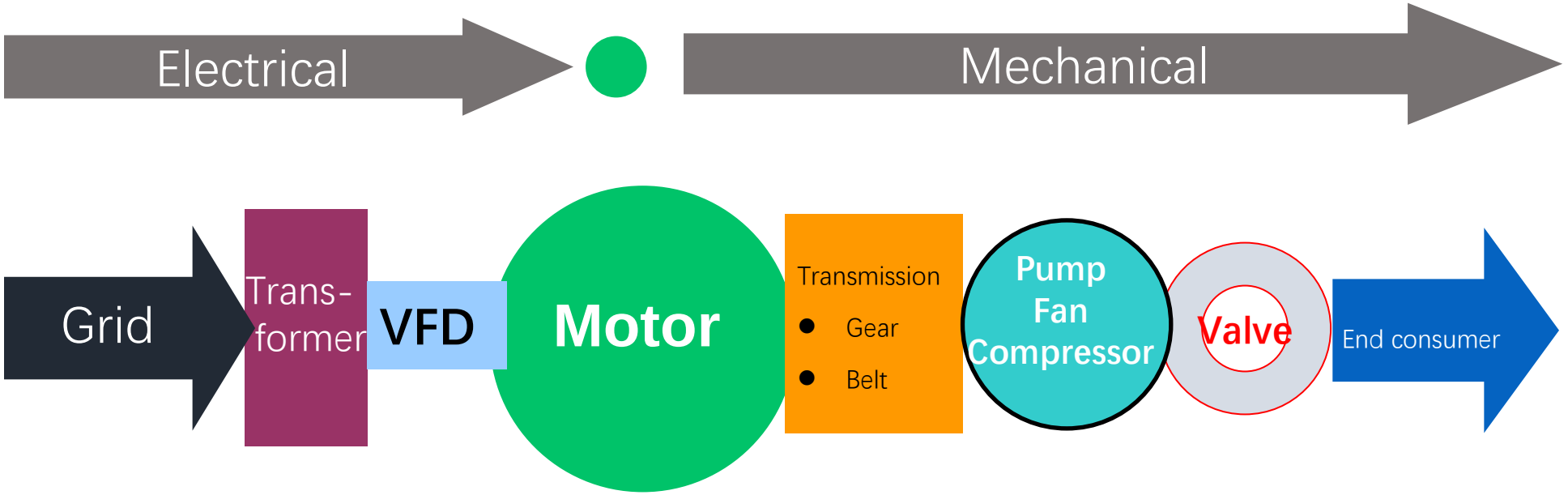
Fluid systems consume major industrial electricity



- Key motor systems in industries
  - Pump systems
  - Fan systems
  - Air compressor system
- It is not only a problem for motor, but also for fluid systems.

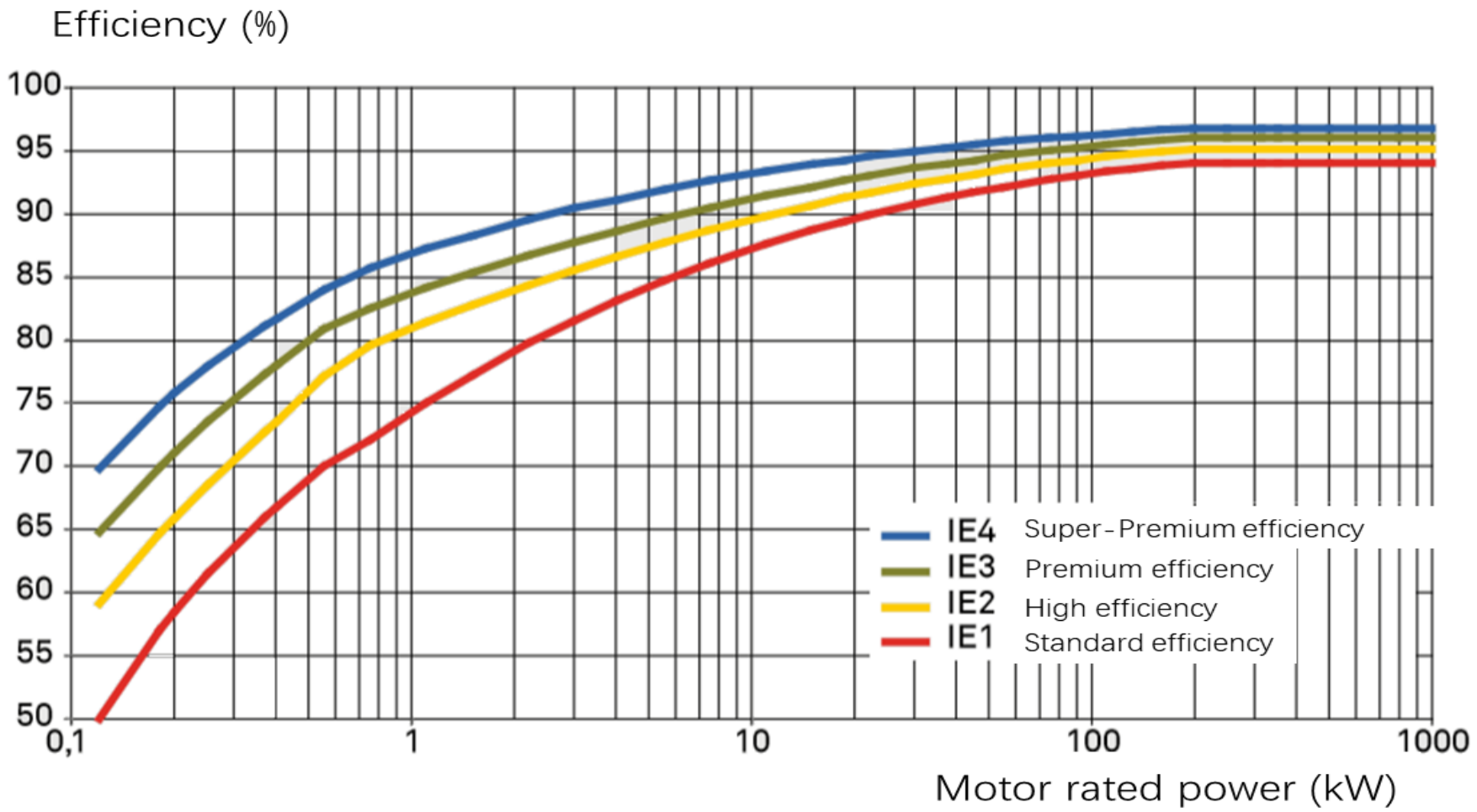
*China industrial motor system energy consumption

System efficiency and saving are the key factor

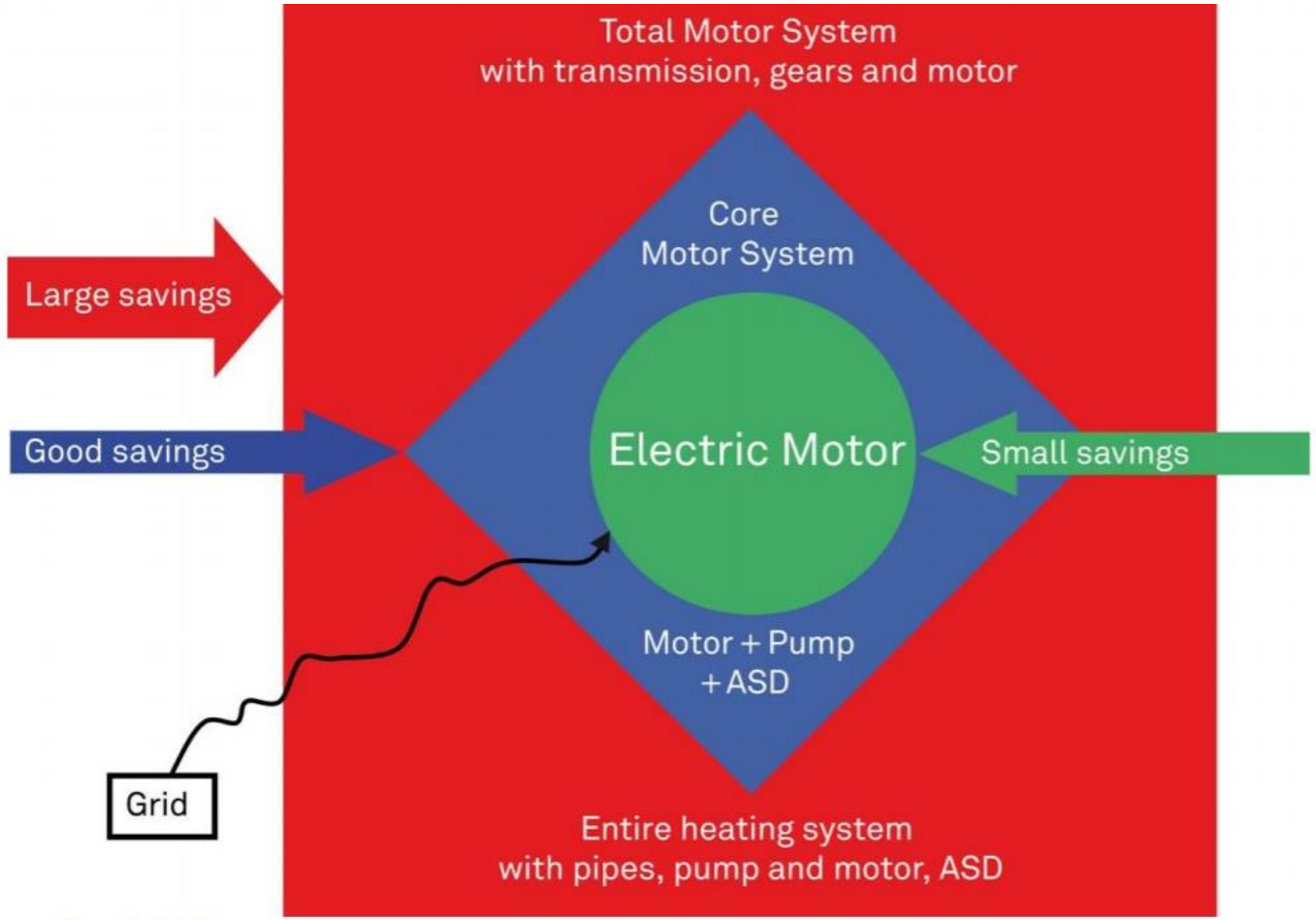


- System efficiency is the multiplicative results of all component efficiency
- The lowest efficiency component decides the whole system efficiency: Barrel effect
- Replacing high efficient motor has limited improvement of system efficiency

IEC motor efficiency classification



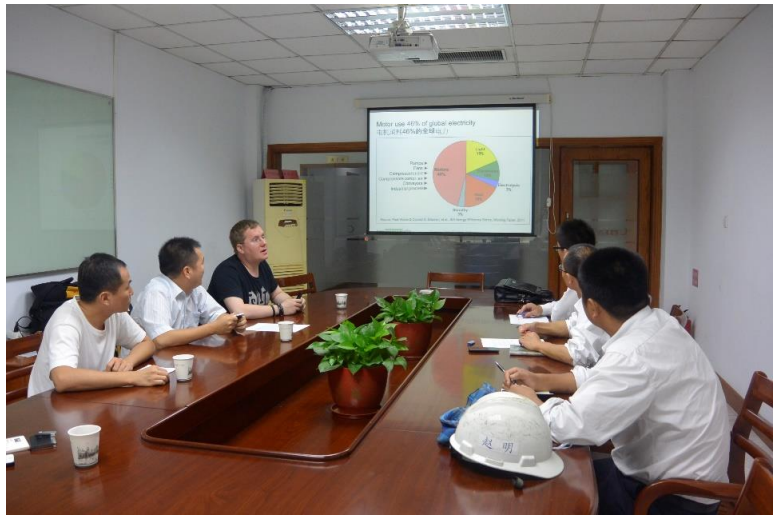
Motor system optimization can gain the biggest saving potential



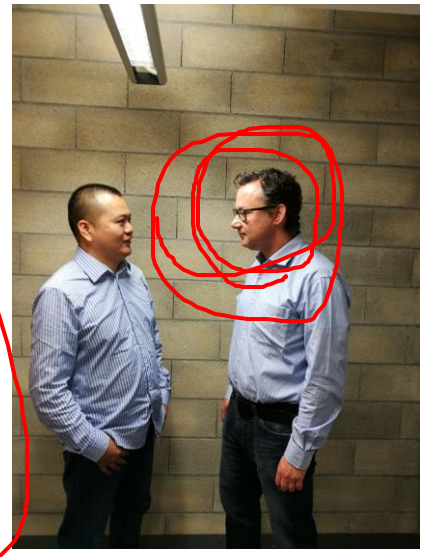
Source: A+B International, 2008.

Considerable energy saving can be achieved by low or even no cost!!!

Effective training is the key factor of success



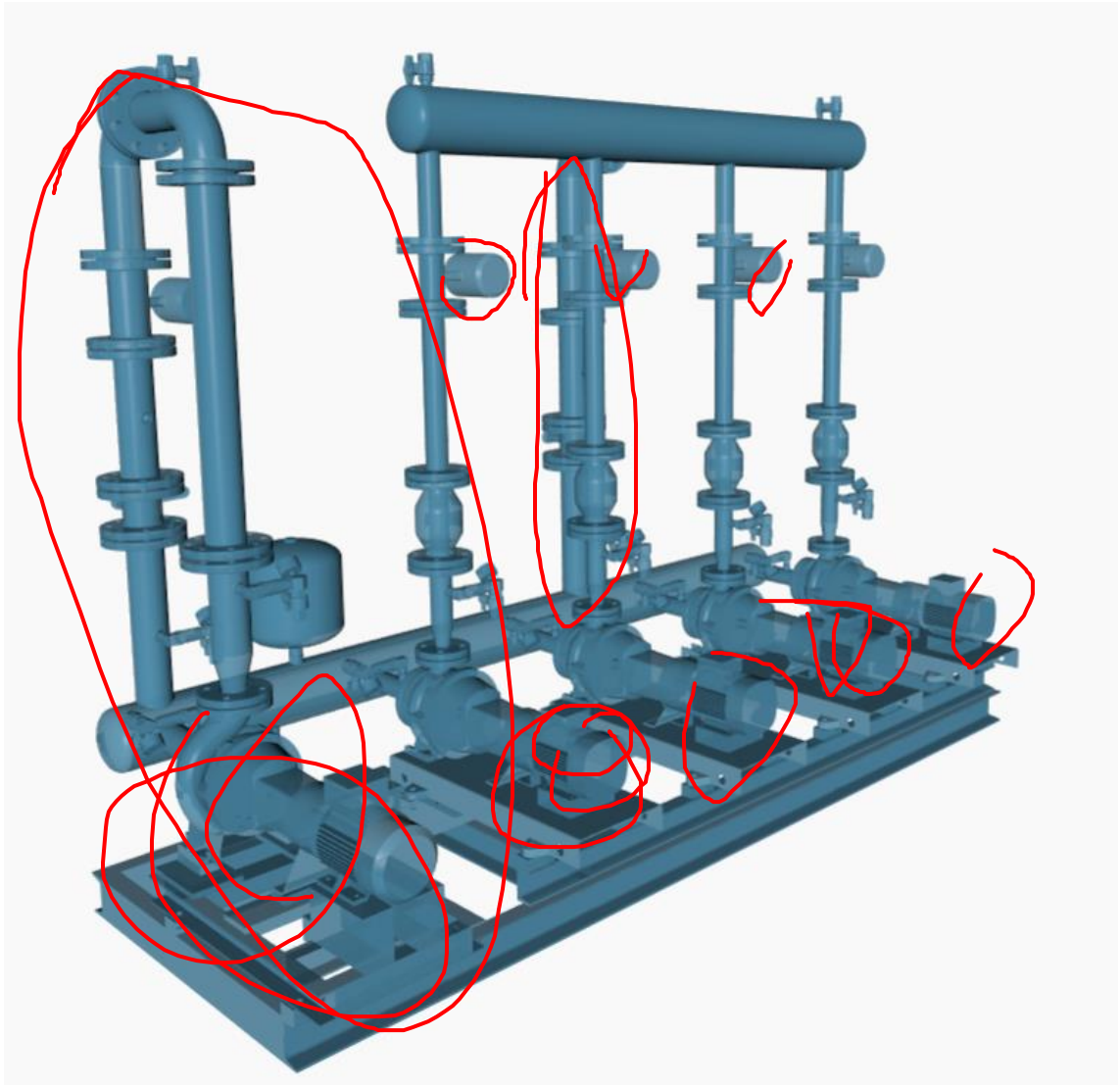
Swiss Pump Demonstrator



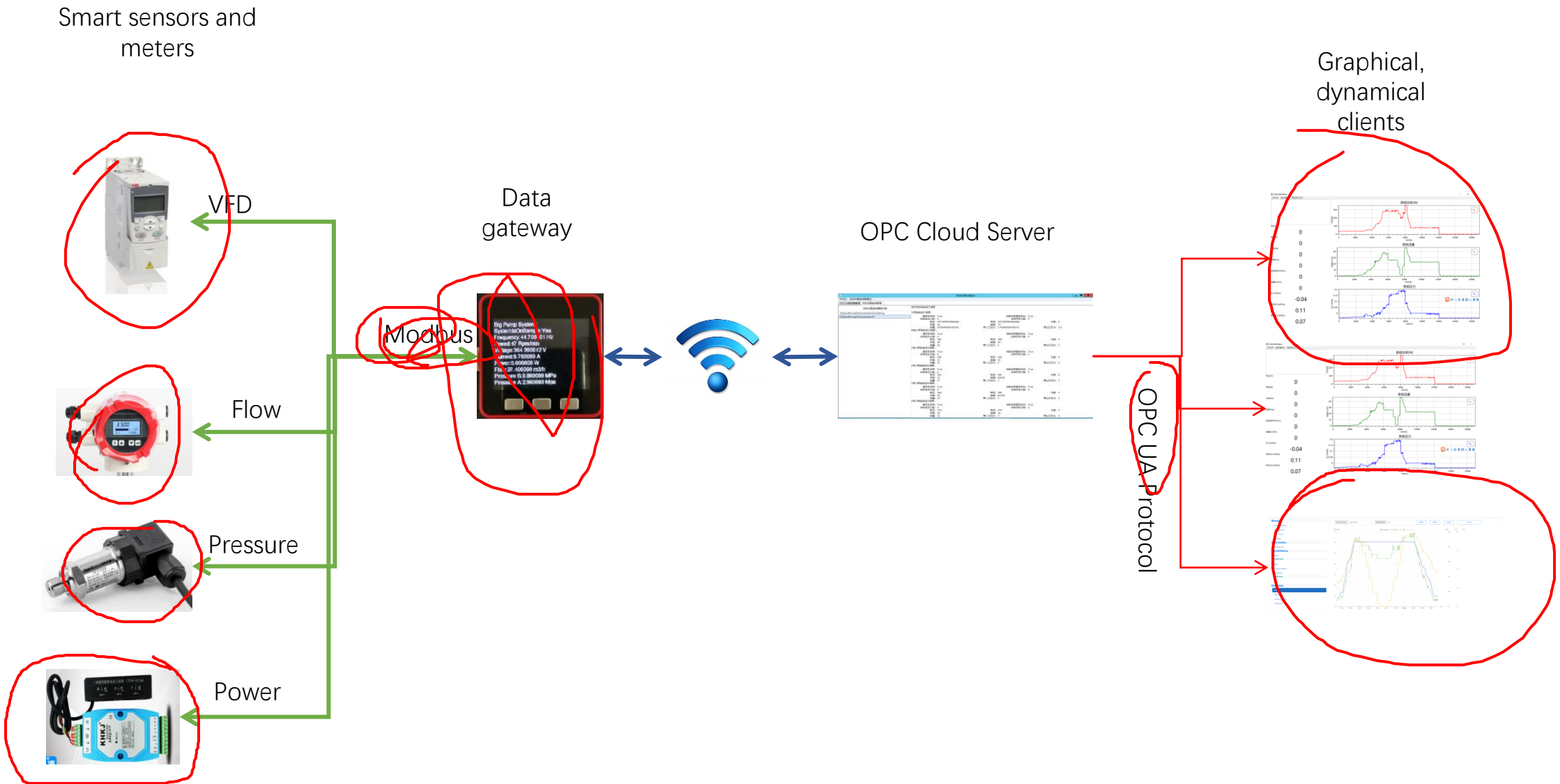
Pump Demonstrator China Version

- I big pump and 4 small pumps to simulate operation load
- Operable and adjustable
- Remotely controlled
- Instant data sampling
- Cloud data receive and publish service
- Web and professional client software
- Apply to other industrial devices and systems

Pump demonstrator 3D



Innovation: Digitalization and standardization

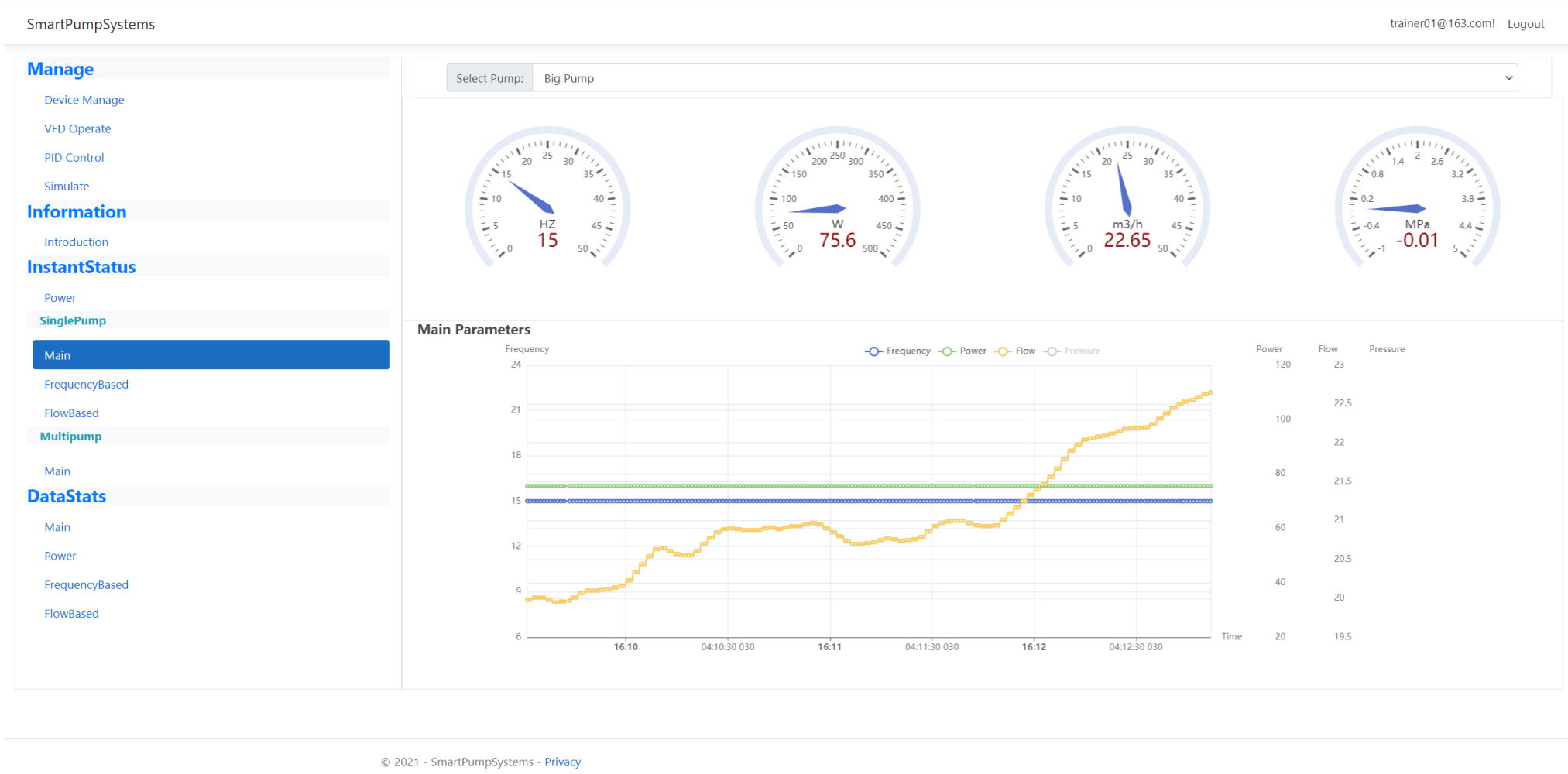


Global accessible web portal

https://pd.scinergyiot.com:7006/

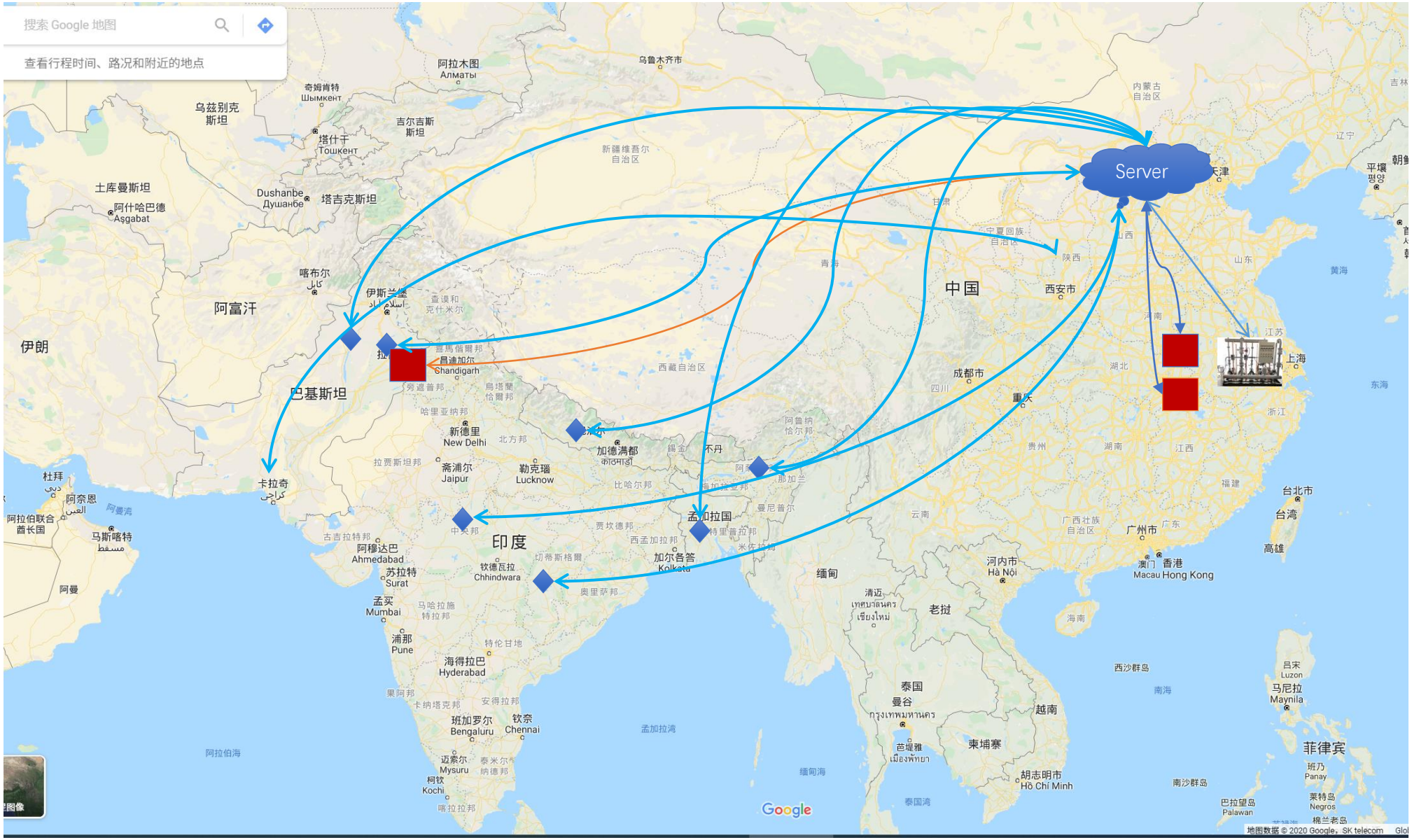
Please register and experience

Web training client – virtual control panel



Everyone has a set of digital and dynamic data display panels!!!

Remote training



Five most important points for efficient pump system

- **Design**: design the system for effective and proper application conditions (water requirement, heat requirement)
- **Losses**: investment on minimum energy losses layout (short lines with large cross section, no unnecessary throttles and bends of the network)
- **Variable operation**: adjust amount of water and pressure under on-demand control
- **Frequency converter**: control the speed of the driving motor (instead of throttle or step switching)
- **Efficient motor**: high efficient motor adapted to pump for needs and speed

Practice 1: how rotating speed affects system flow, pressure and power?

Motor rotating speed:

$$RPM = \frac{60 \times Frequency \times 2}{Poles}$$

Nominal rotating speed under 50 HZ

- 2 poles: 3000 RPM
- 4 poles: 1500 RPM
- 6 poles: 1000 RPM
- 8 poles: 750 RPM

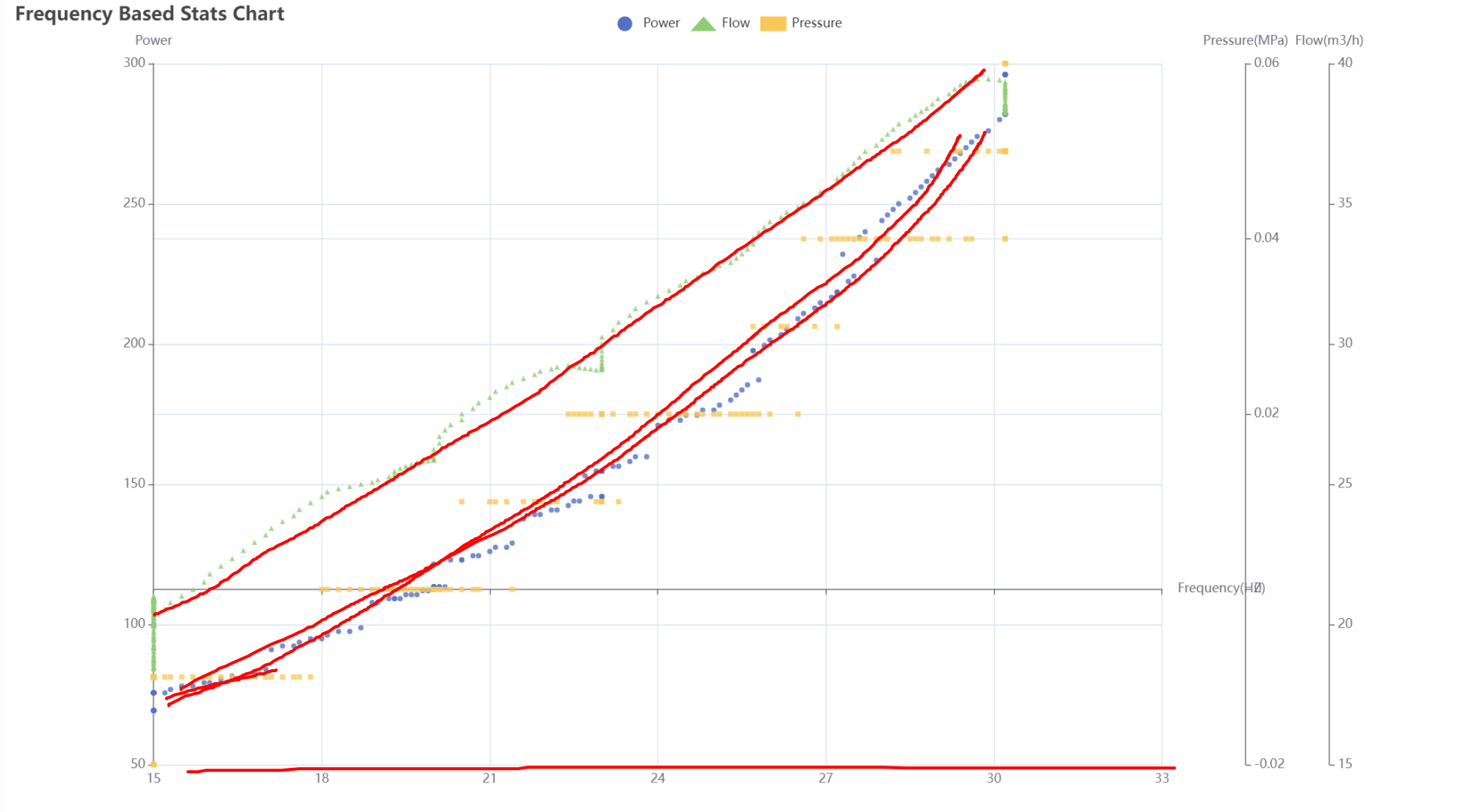
Practice 1: how rotating speed affects system flow, pressure and power?

$$Q_2 = Q_1 * \left(\frac{V_1}{V_2}\right)^1$$

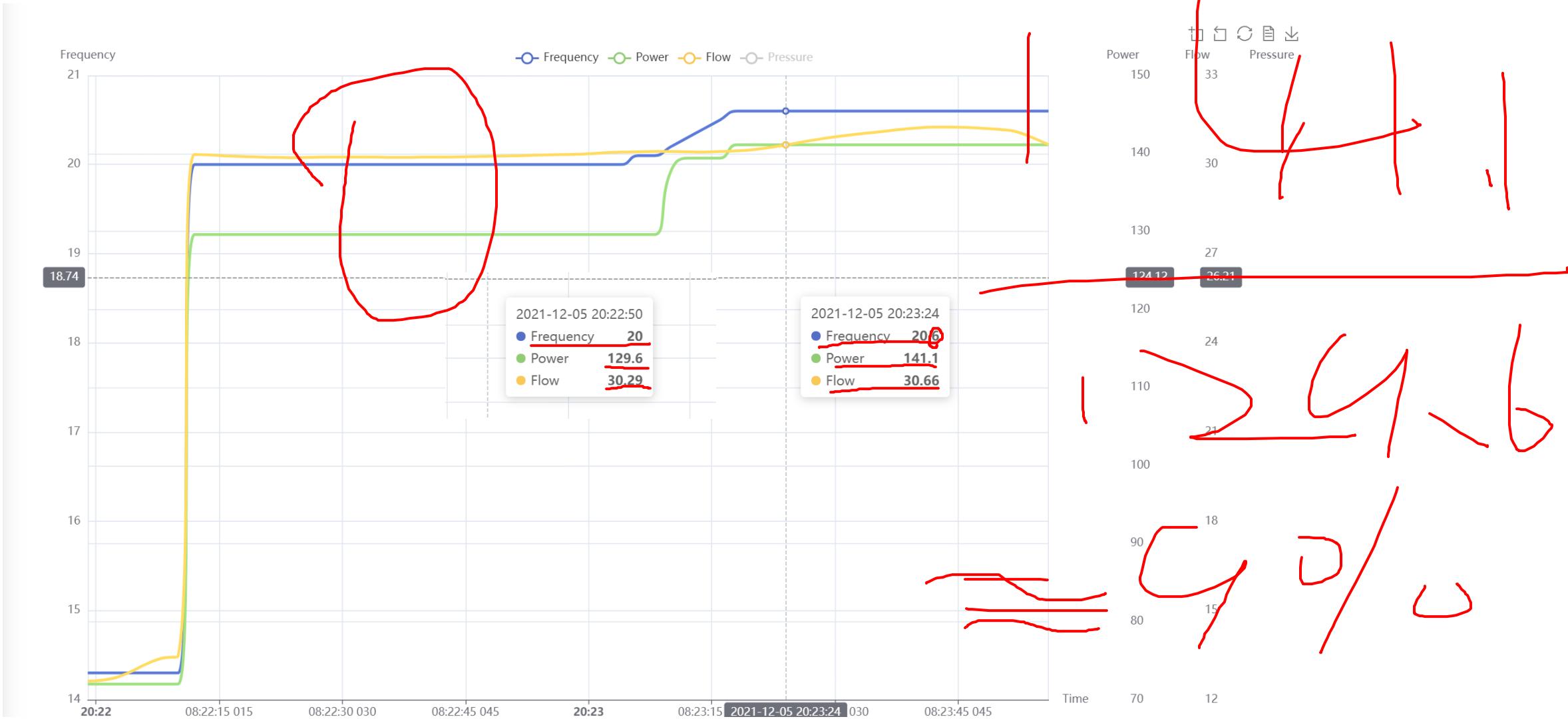
$$H_2 = H_1 * \left(\frac{V_1}{V_2}\right)^2$$

$$P_2 = \mathrm{P}_1 * \left(\frac{V_1}{V_2}\right)^3$$

V: Frequency
Q: Flow
H: Pressure
P: Power



Practice 2: replacing in-efficient motor with efficient motor can save expected energy?

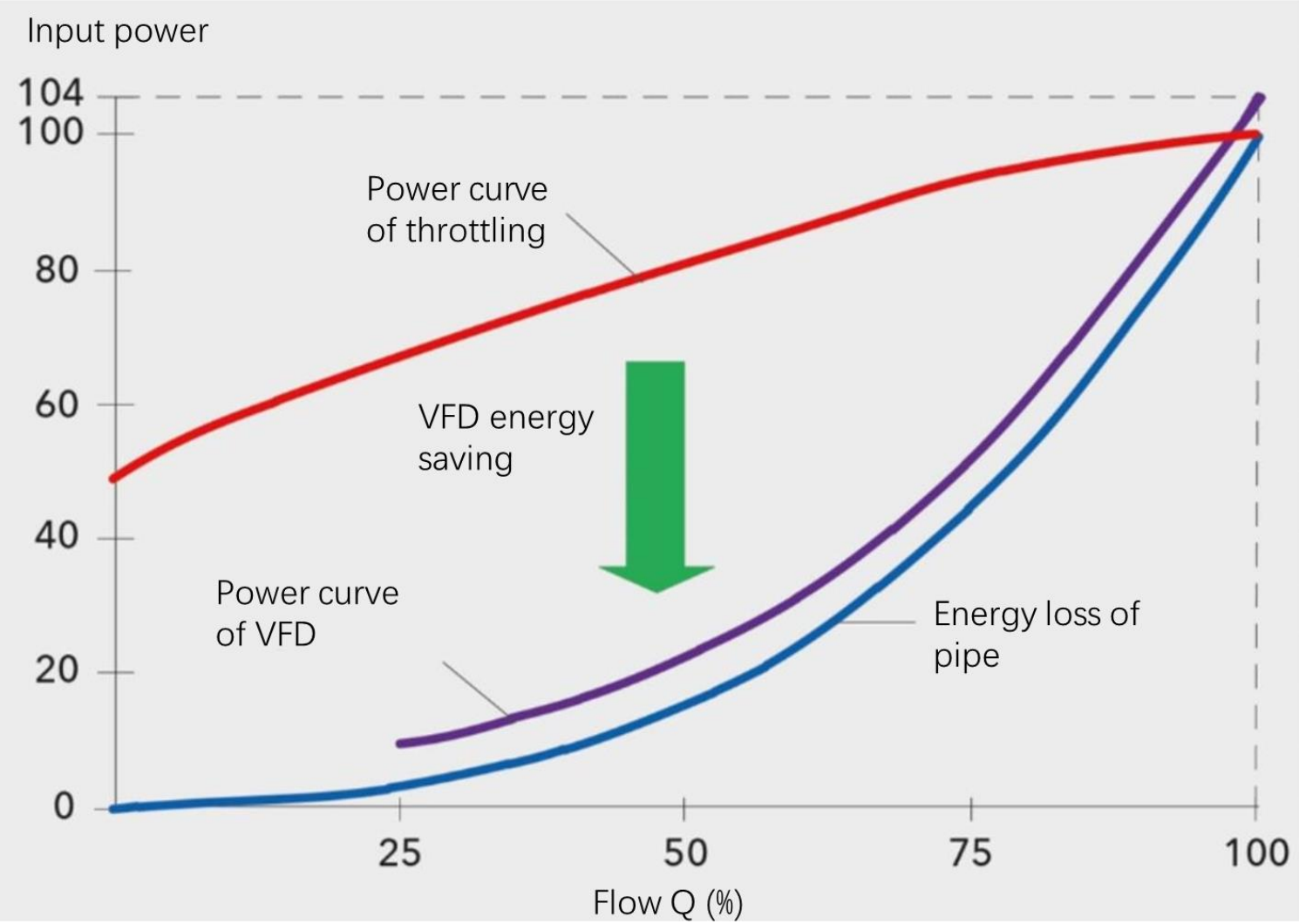


Replacing in-efficient motor with efficient motor can save expected energy? – not for pump system

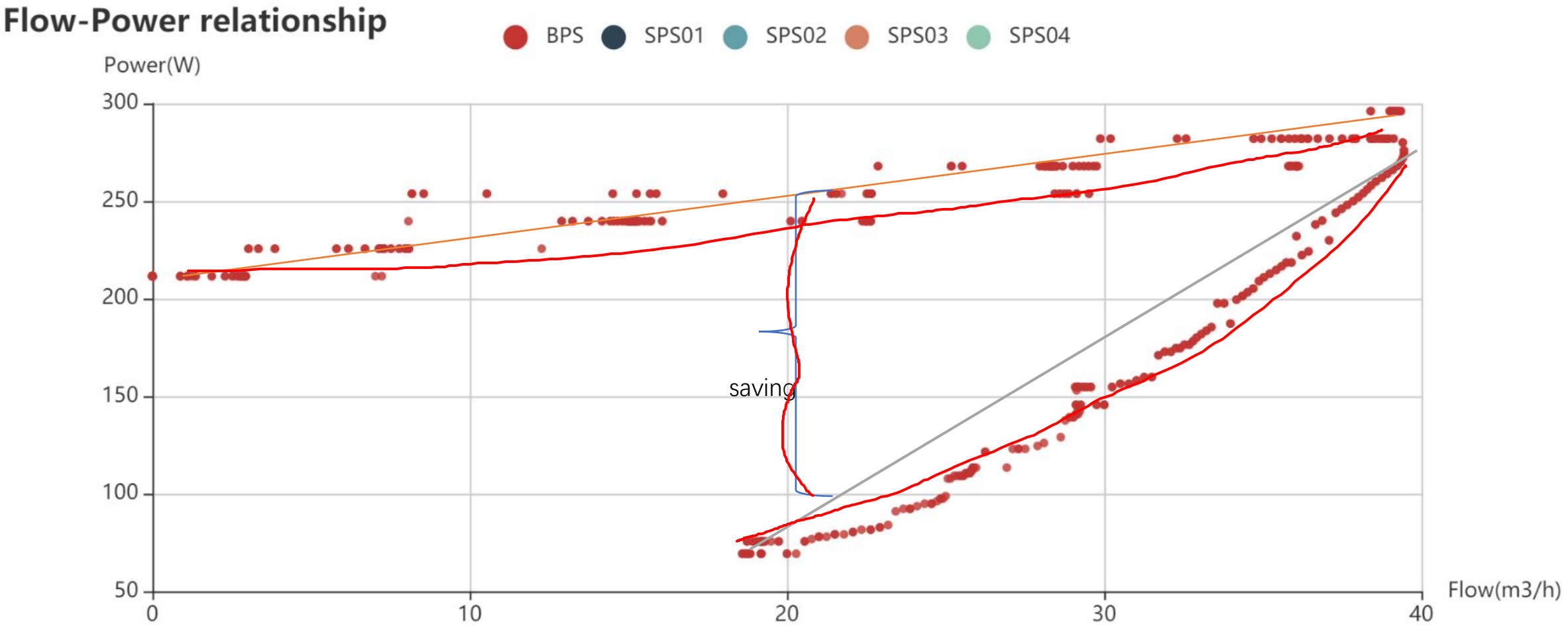
Increase number of revolutions	Increase input and output power of pump
1%	3%
2%	6%
3%	9%
4%	12%
5%	16%

Practice 3: how valve control affect flow, pressure and power?

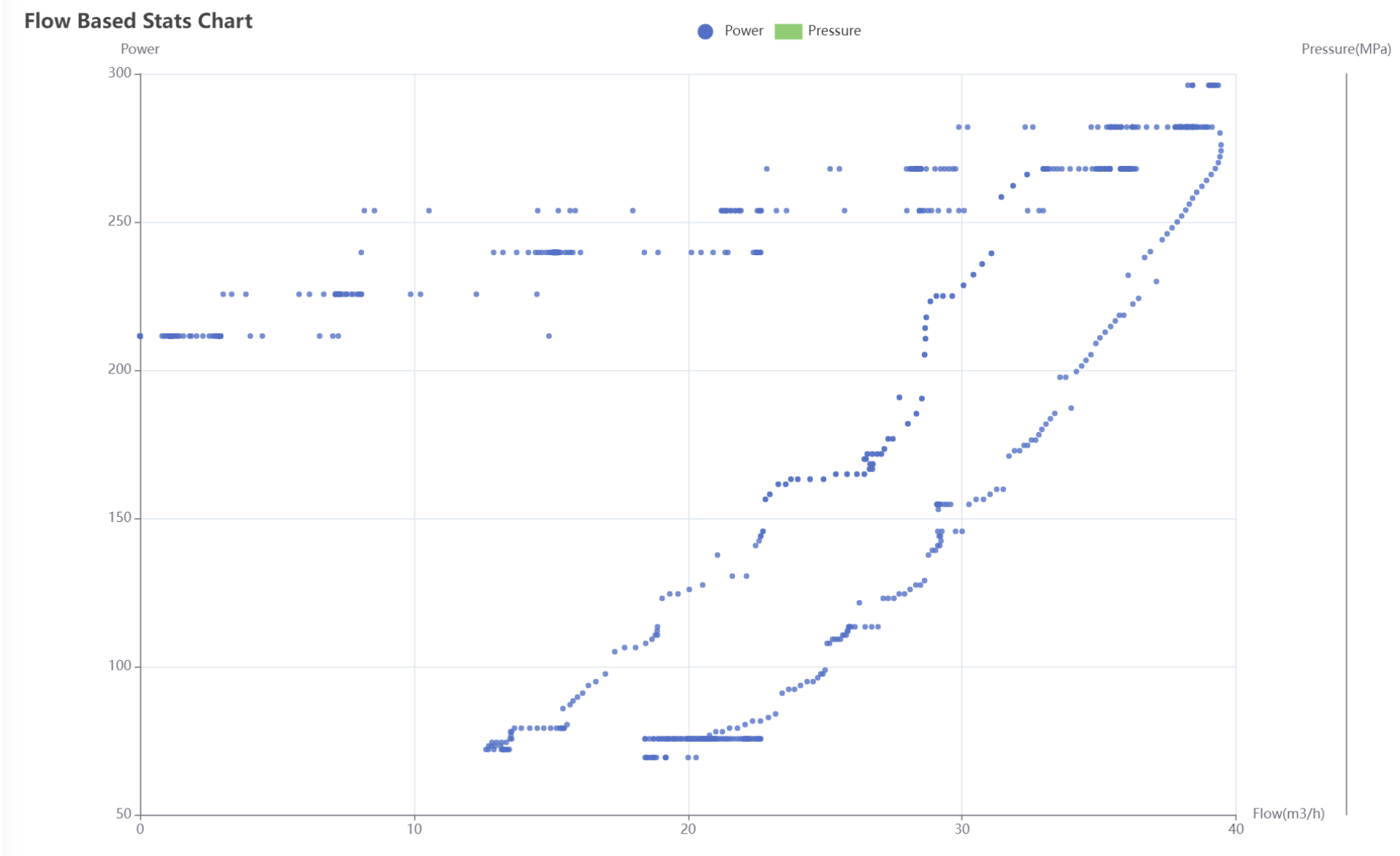
Practice 4: why VFD can save energy? - Theoretic figure



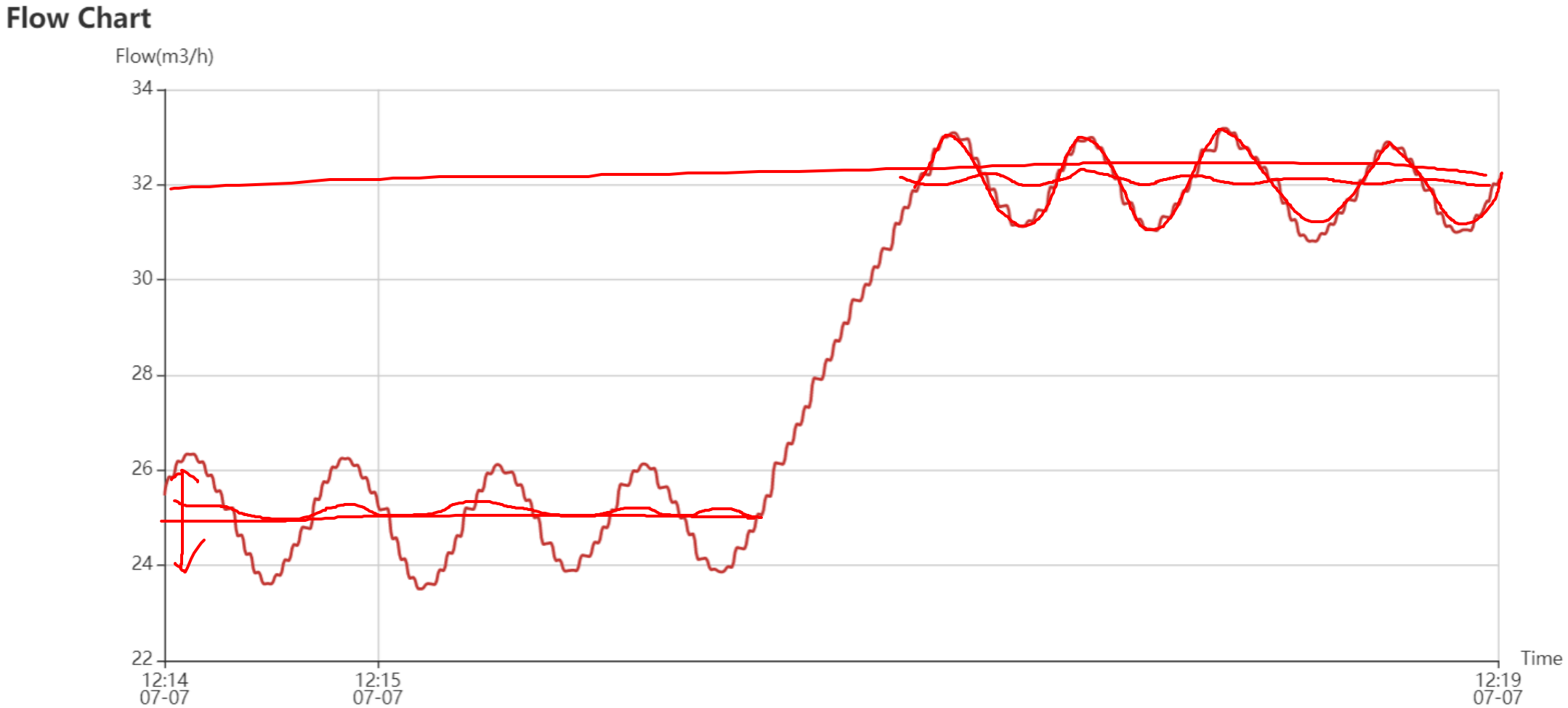
Practice 4: why VFD can save energy? -practical



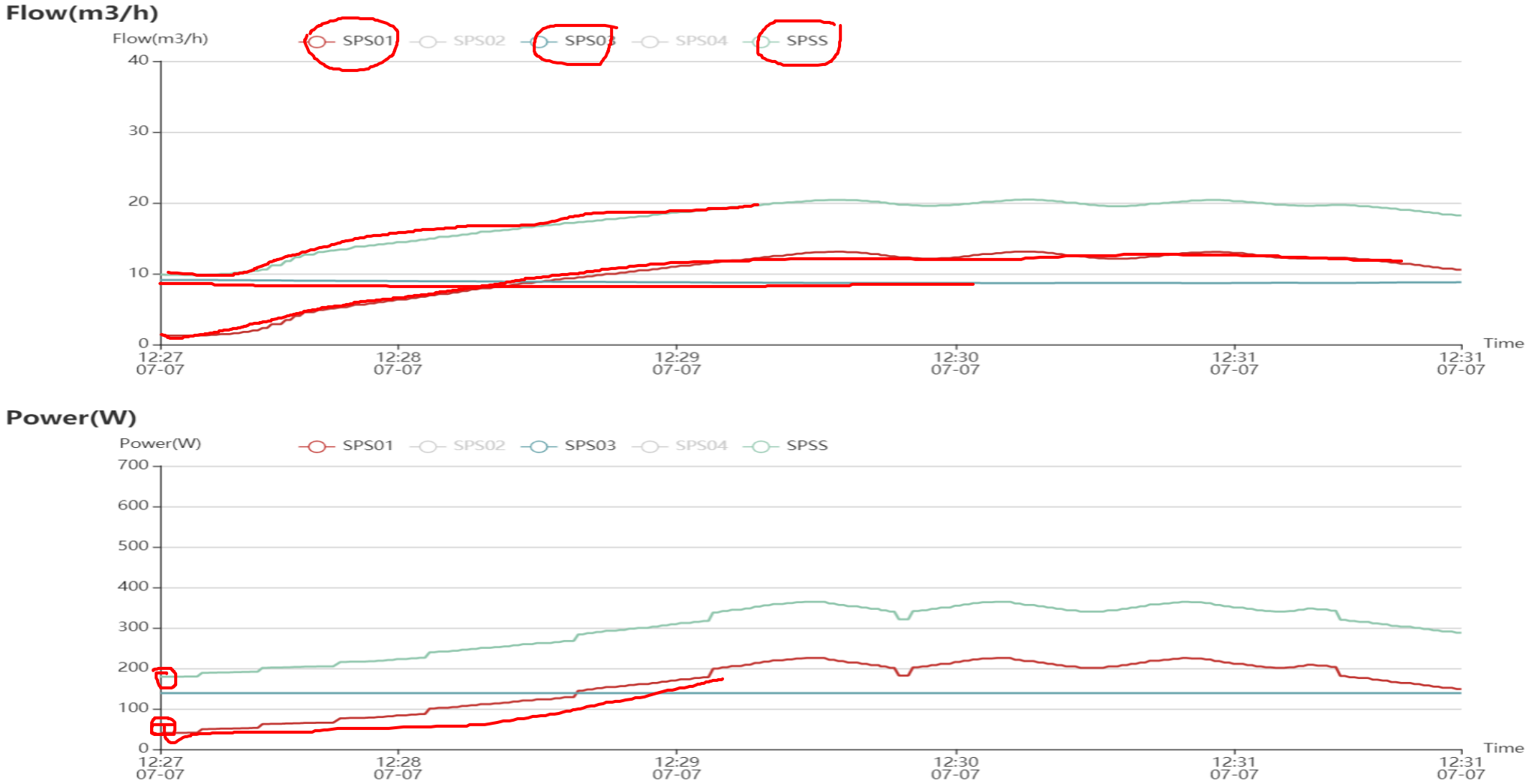
Practice 4: why VFD can save energy? -practical



Practice 5: how VFD can automatic control system? - PID control



Practice 6: how to combine fixed + variable speed pump systems?



Practice 7: will partial load reduce efficiency?

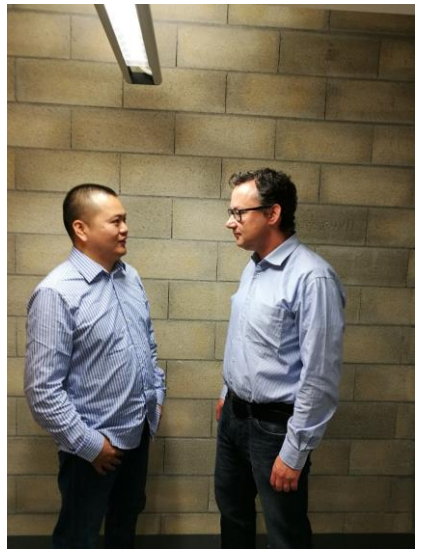
- System base power: 290W

System power (W)	VFD Frequency (HZ)	VFD Input Power (W)	VFD Load (%)	VFD Output Power(W)	VFD Power Loss(W)	VFD Efficiency (%)
475	15	185	2.7	75	105	40
640	20	350	6.4	140	210	40
885	25	595	12.5	215	380	36
1230	30	940	21.6	350	590	37

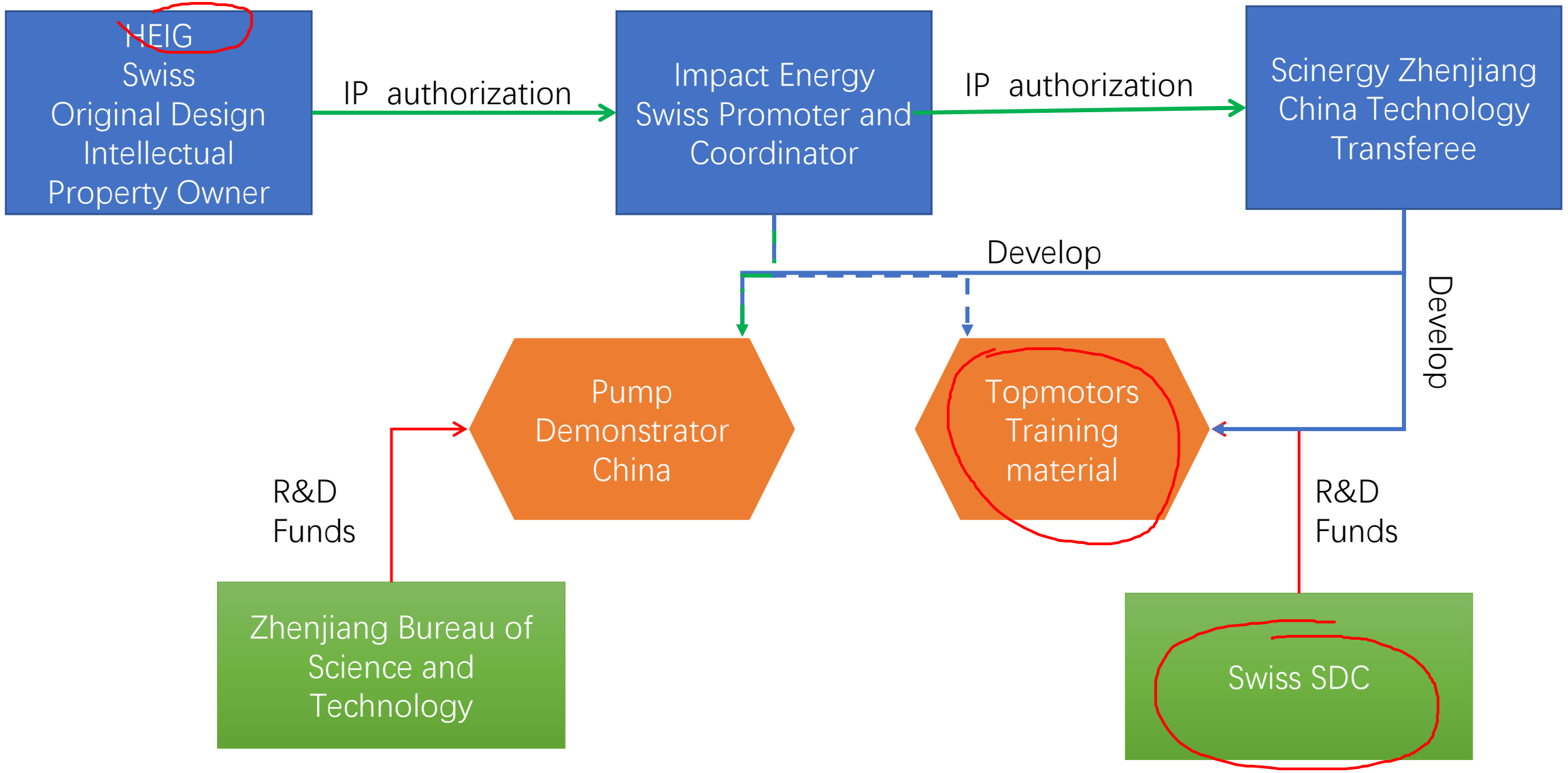
Practice 8: how IoT technology can support efficiency improvement?

- Device communication protocol: analog, Modbus, I2C, etc
- Cloud communication protocol: OPC UA
- System status monitoring
- System remote control
- System data persistent and storage
- System data analysis and optimization plan
- Energy efficiency AI or expert system

Swiss Pump Demonstrator



International cooperation pattern



Thank You!

Hu Bo

Director of Top10

hu.bo@top10.cn