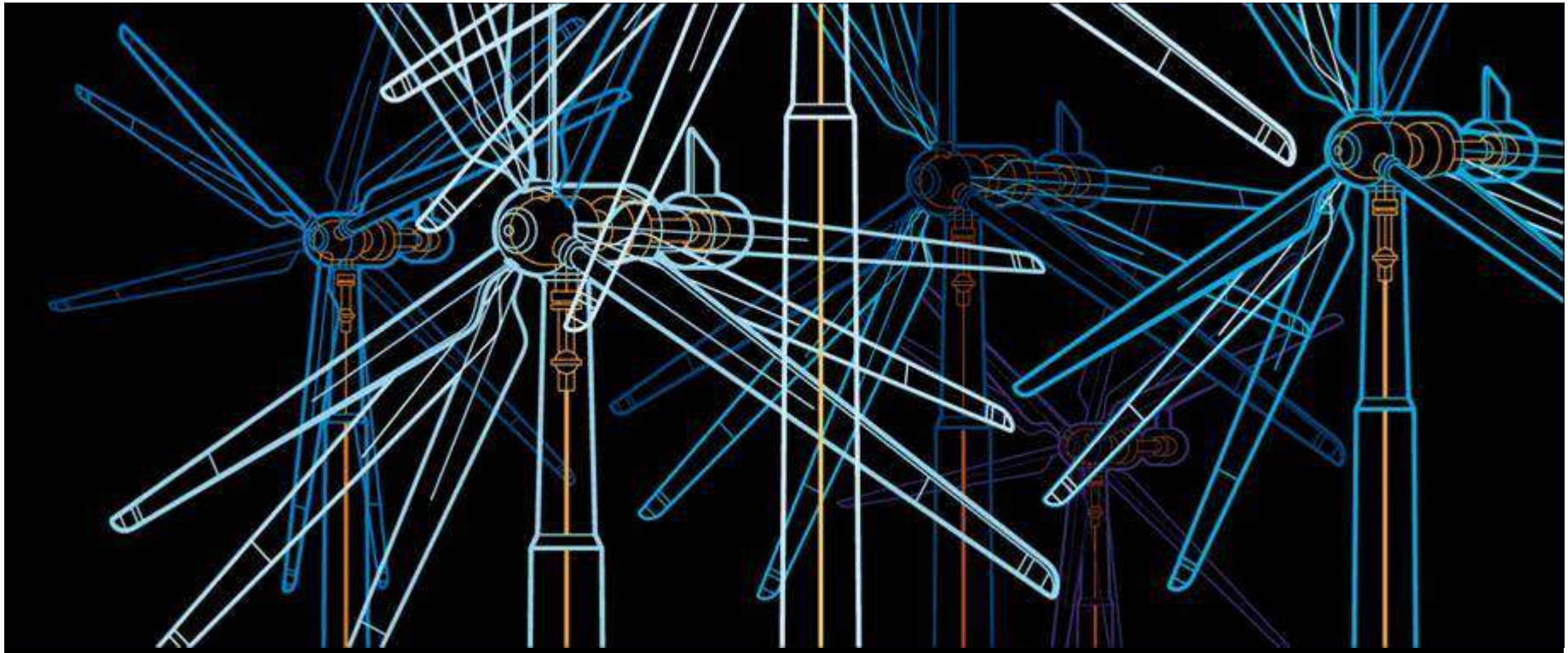


Profibus- Profinet User Conference , 30th June , Steve Moore

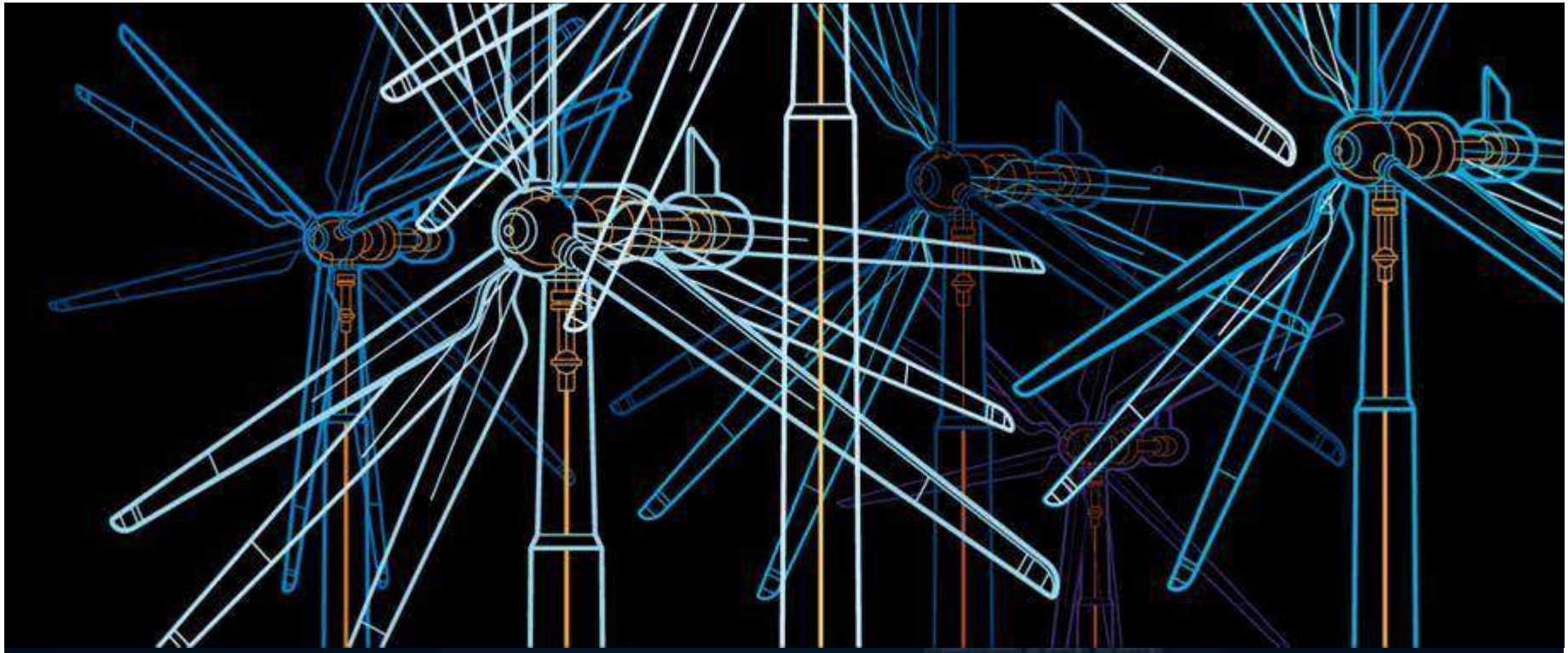
The Use of Profibus in a Renewable Energy Application

PROFIBUS - PROFINET
user conference

Power and productivity for a better world™

Introduction

- **Application description**
- **System Development**
- **Decision Making**
- **Control & Monitoring Requirements**
- **Process Optimisation**
- **Application Video**



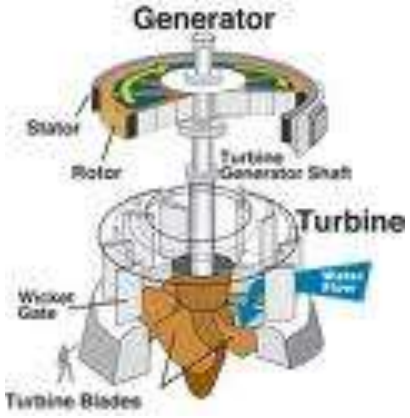
Application Description

Renewable Applications

- **The renewable energy market presents an extremely large opportunity for power electronic equipment suppliers**
- **Examples of current Renewable Energy applications**
  - **Wind**
  - **Tidal**
  - **Hydro**
  - **Solar (Photovoltaic and Thermal)**
  - **Biomass**

Hydro Applications

- Typical hydro turbine application examples



- Kaplan

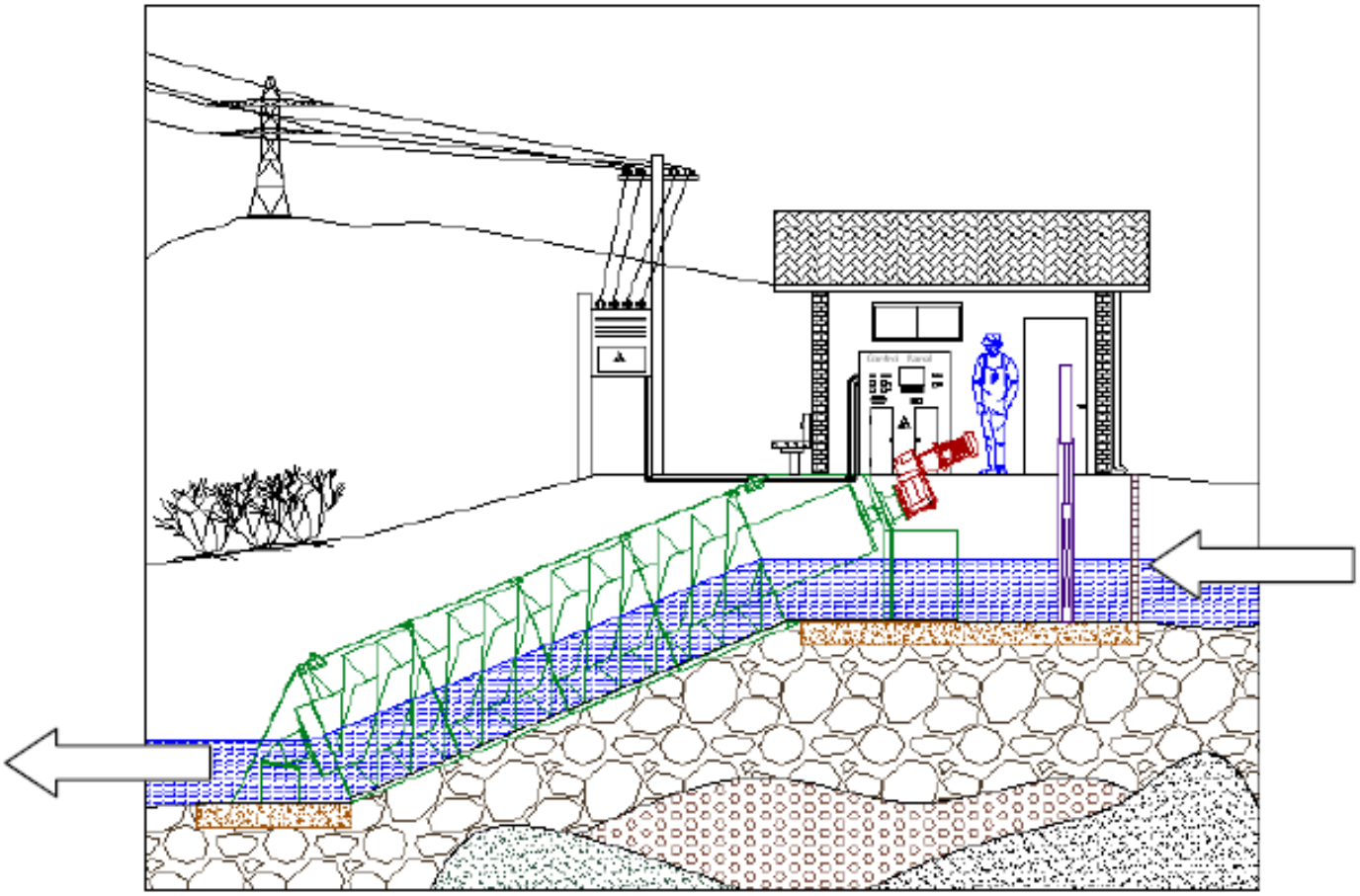
- Pelton

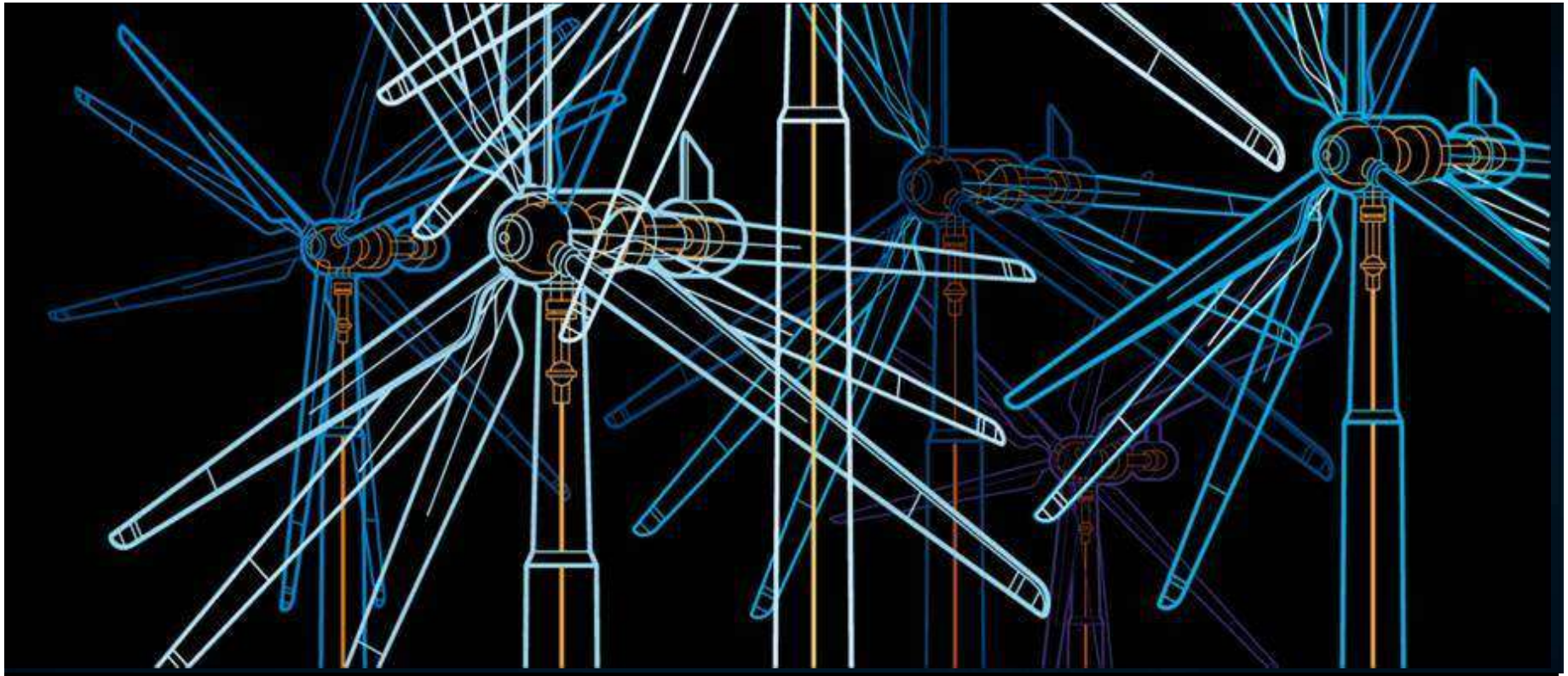
- Francis

Archimedes Screw Generator

- **Solution been used as a method of raising water for centuries**
- **Recent trials have proven that they can also be used for generating electrical power**

Typical Screw Generator Installation





System Development

System Development

- **Screw rotates at low speeds (typically 25-35 rpm)**
- **Typical powers from 1-100's kW**
- **Two generator options available in conjunction with a gearbox**
  - **Induction generator**
    - **Commonly available in 4 to 8 pole designs**
    - **High efficiency**
  - **Permanent magnet synchronous generator**
    - **Lower speed options available**
    - **More complex machine**
    - **High efficiency**

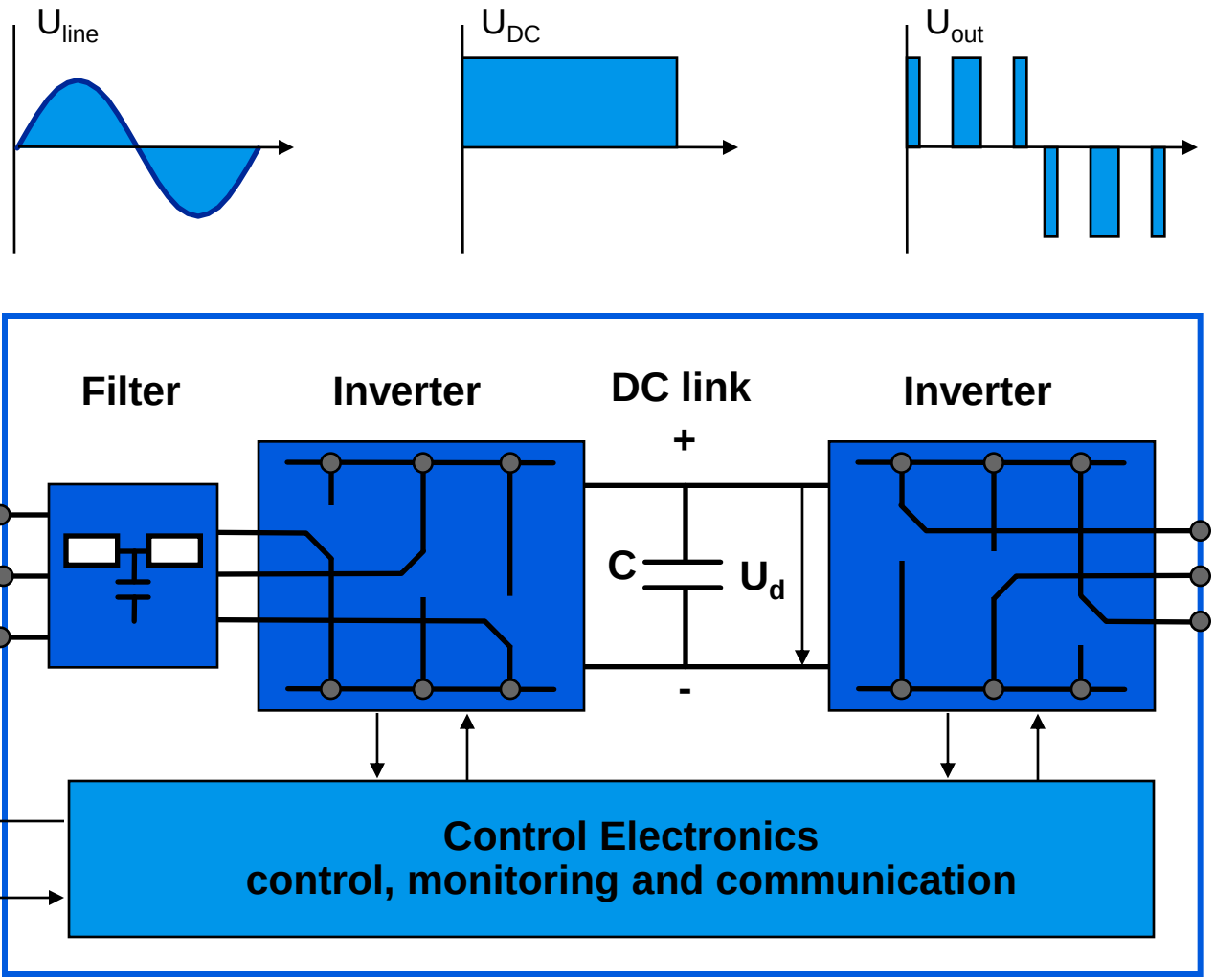
System Development

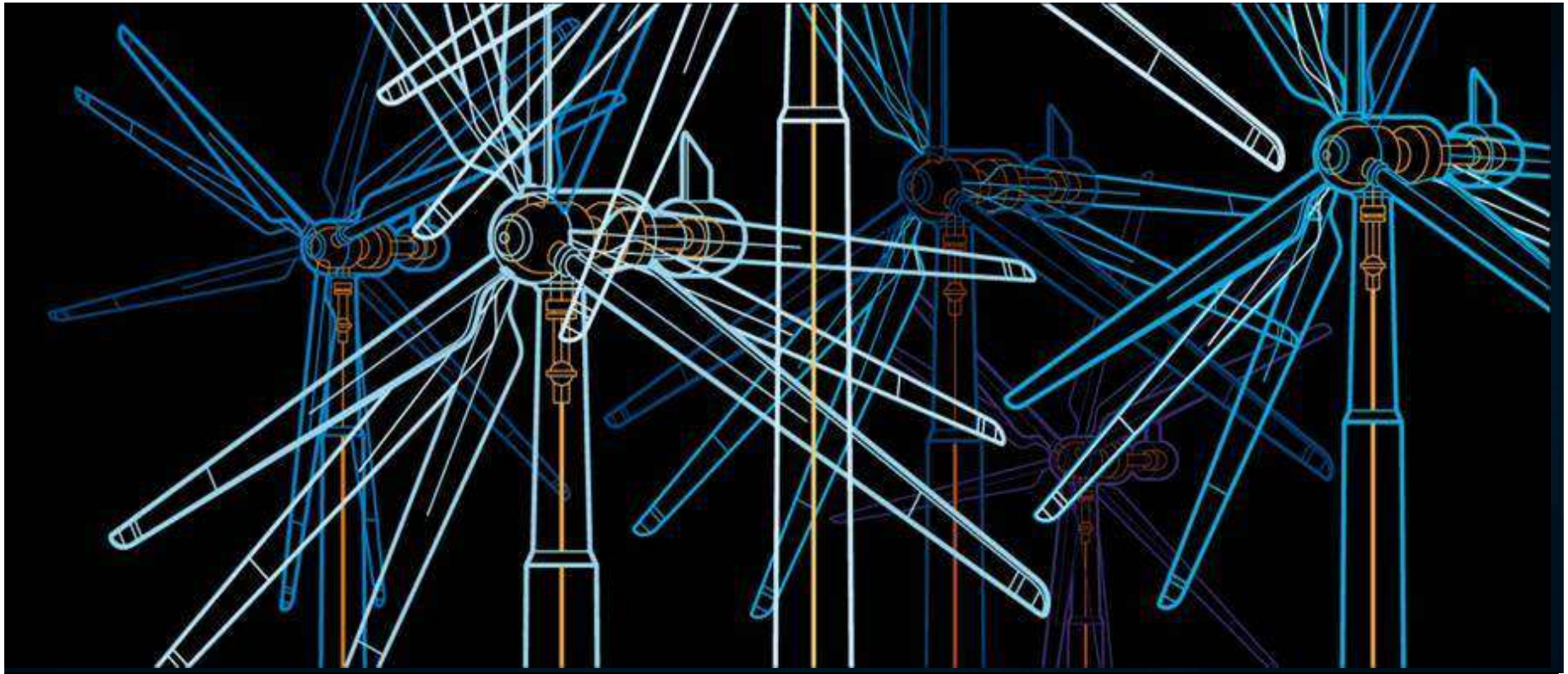
- **Before the first trial system order two options were investigated**
- **Option 1**
  - **4 pole induction generator with three stage gearbox**
- **Option 2**
  - **~300 rpm base speed PM generator with two stage gearbox**
- **Overall system efficiency was calculated at different loads and speeds**
- **Which one do you think was used ?**

System Development

- **With this type of hydro turbine you cannot control the prime mover to give a constant screw speed (same as a wind turbine).**
- **This means the use of an inverter to control the generator and return energy to the grid.**
- **This is done using standard variable speed drive hardware.**

System Development – Regenerative AC drive





Decision Making

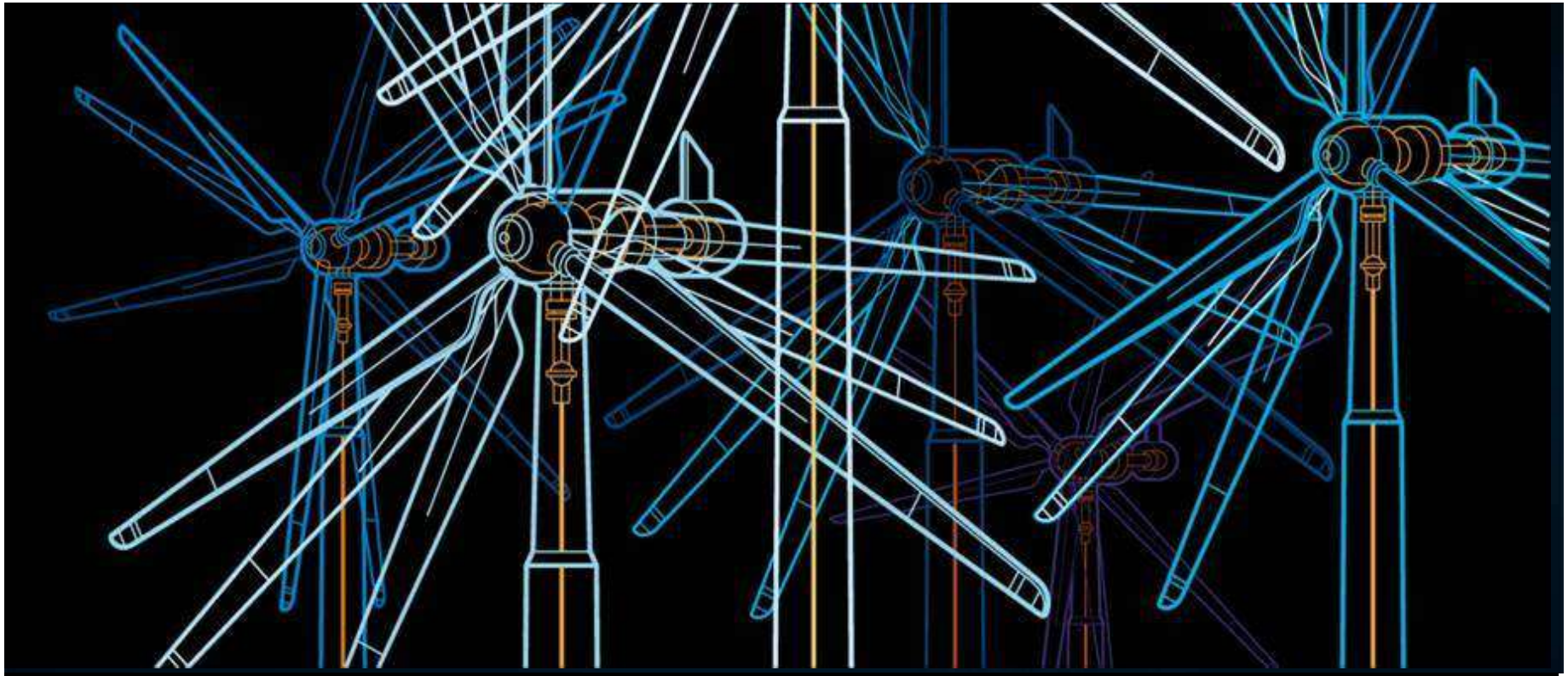
Decision Making

- **The decision was made to use induction generator with higher ratio gearbox**
- **Why ?**
  - **String efficiency was only 1-2% lower than for the PM design but the initial cost was approx 50% higher for the drive and motor**
  - **Motor was readily available (ex stock) , easy to maintain and serviceable by existing site workforce**
  - **VSD spares already available locally**

Decision Making

- End user
  - YW Esholt WWTW
- OEM
  - Spaans Babcock Ltd
- Main Contractor
  - JN Bentleys Ltd
- Panel Builder
  - CEMA Ltd

- 2 x 90kW generators in series
- Approx 2,700 l/sec flow
- 10m drop



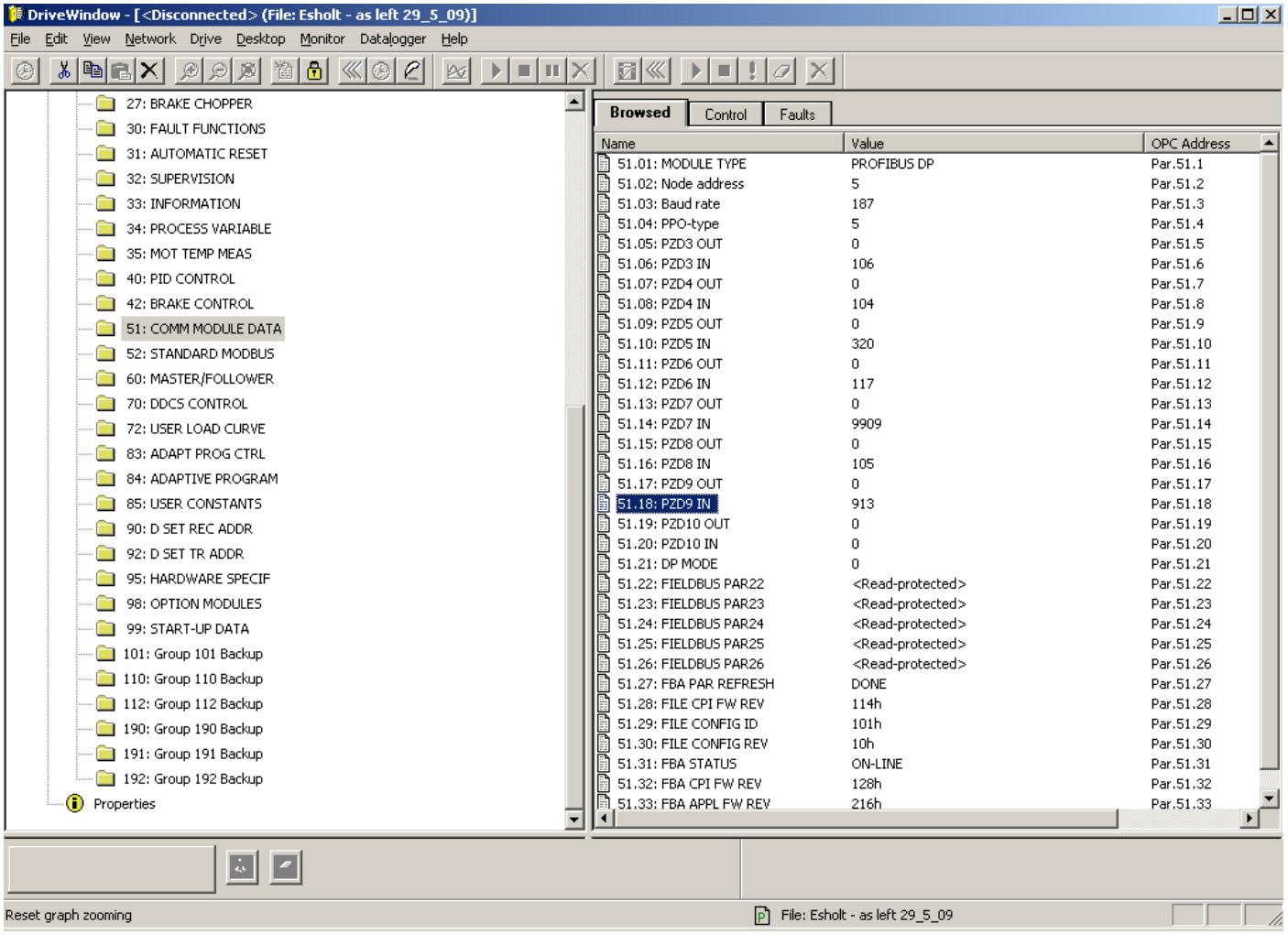
Control & Monitoring Requirements

Control & Monitoring Requirements

- **End User specified Mitsubishi PLC's for the site and required the control and monitoring to be performed from this device**
- **PLC to send**
  - **Command word**
  - **Speed reference**
- **PLC to receive**
  - **Actual motor power , torque and current**
  - **Motor nominal power**
  - **Fault code**
  - **Digital input status**
  - **Regenerative power**

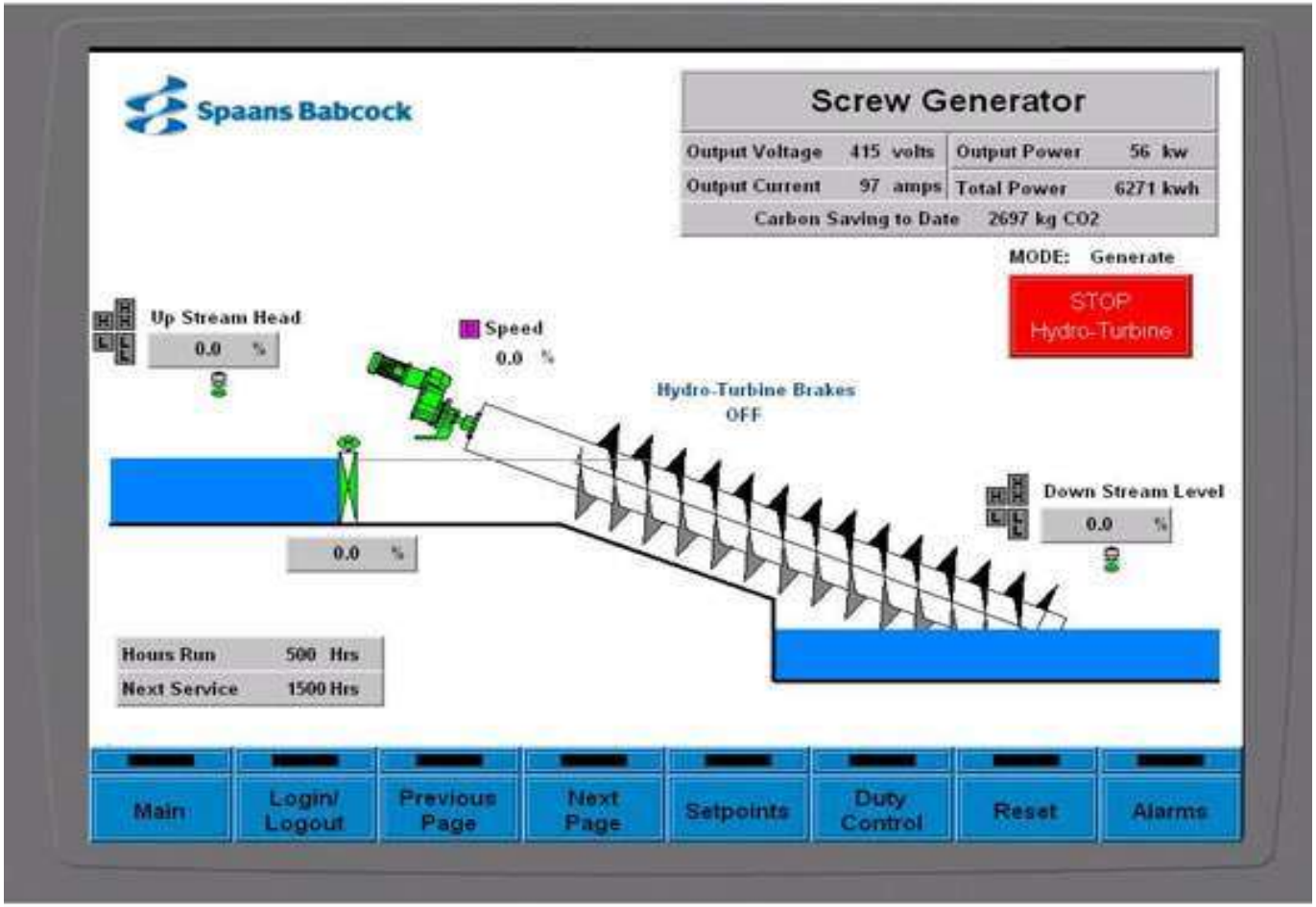
Control & Monitoring Requirements

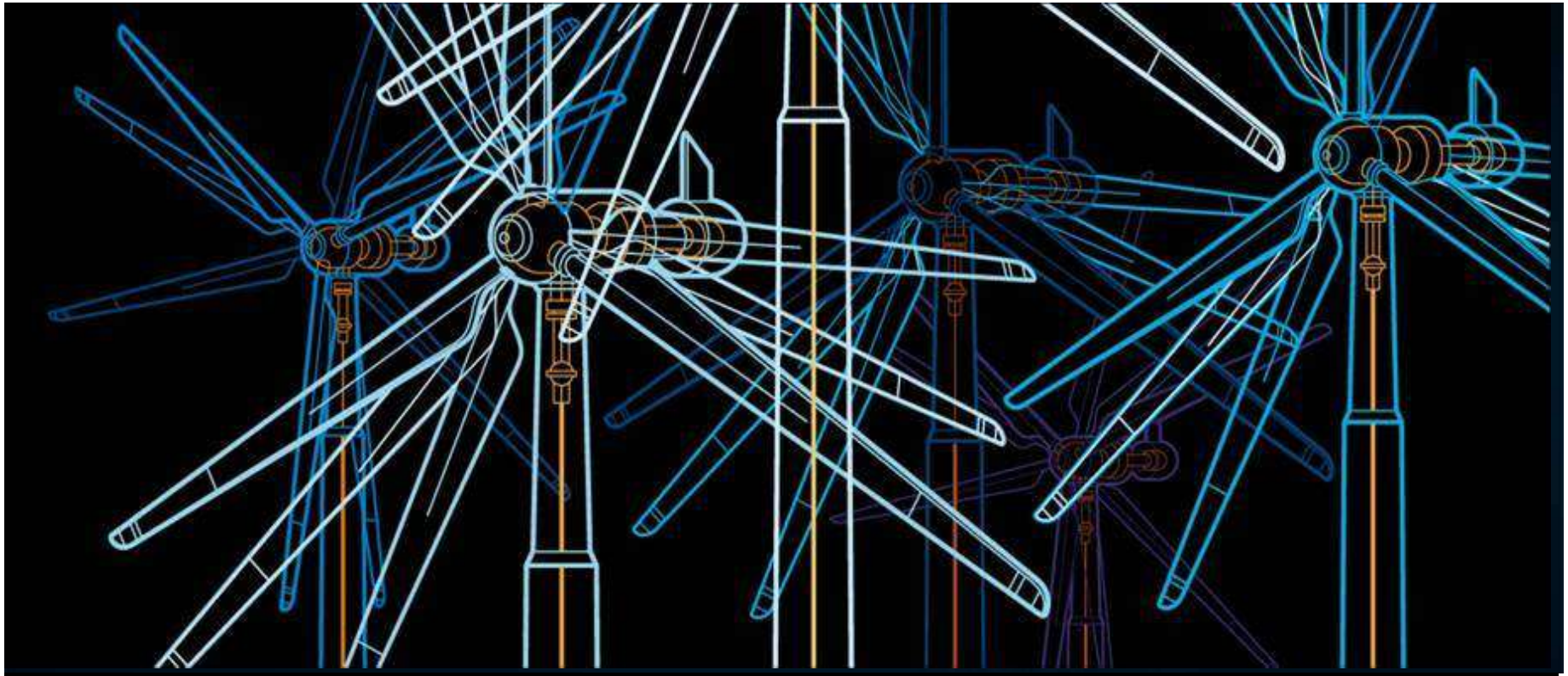
- **Decision made to use Profibus for this functionality and implemented in the drive as follows**



Control & Monitoring Requirements

- **System HMI display as follows**

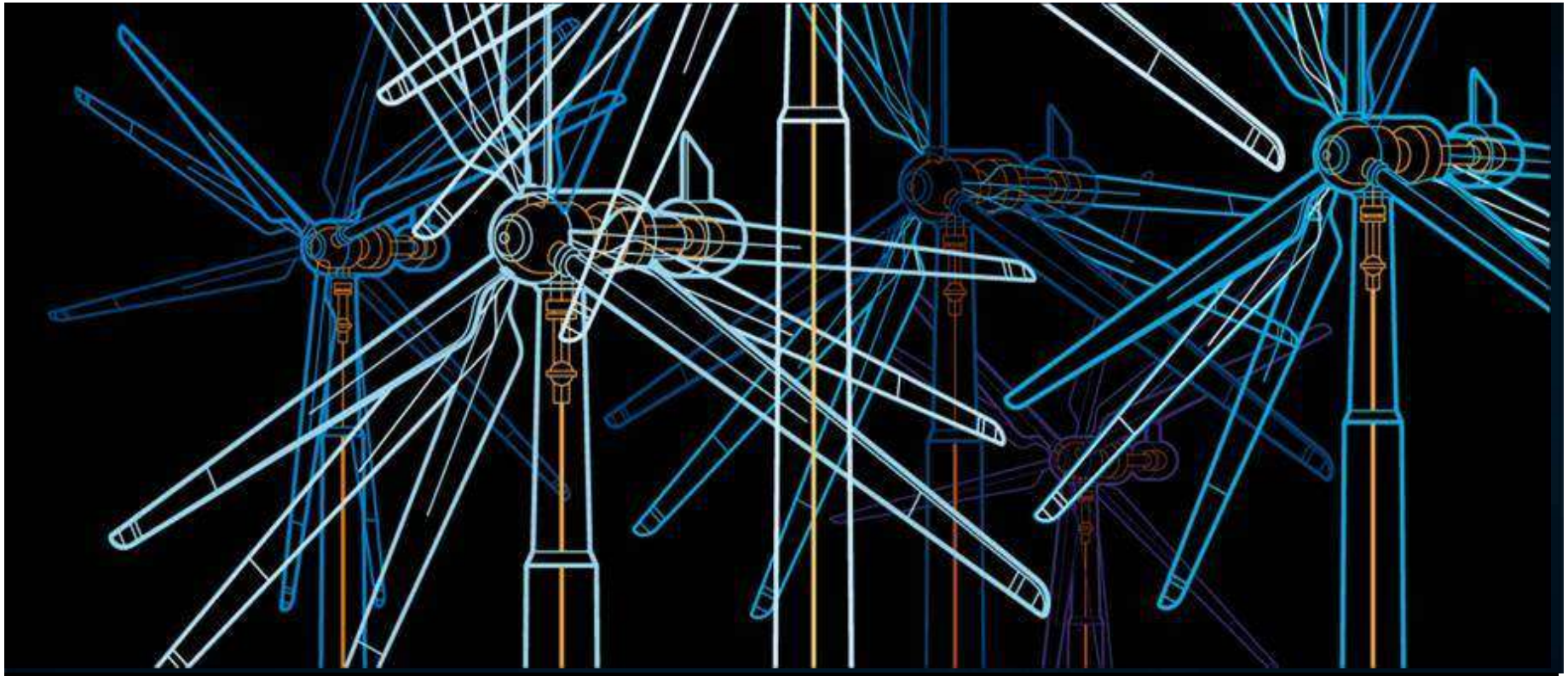




Process Optimisation

Process Optimisation

- **How can we be sure that we are extracting the maximum energy from the system ?**
- **ABB and Spaans Babcock have worked together to model the power output from the system at different loads and speeds**
- **Screw speed should follow the flow rate of the river but this is often difficult and expensive to obtain**
- **It has been found by calculation that the maximum power can be extracted by controlling the height of the water in the penstock preceding the turbine itself**
- **An ongoing project is to collect the site data to back up the calculations**
- **This data is already available over the Profibus link**



Application Video

Application Video

- Application Video

Power and productivity
for a better world™