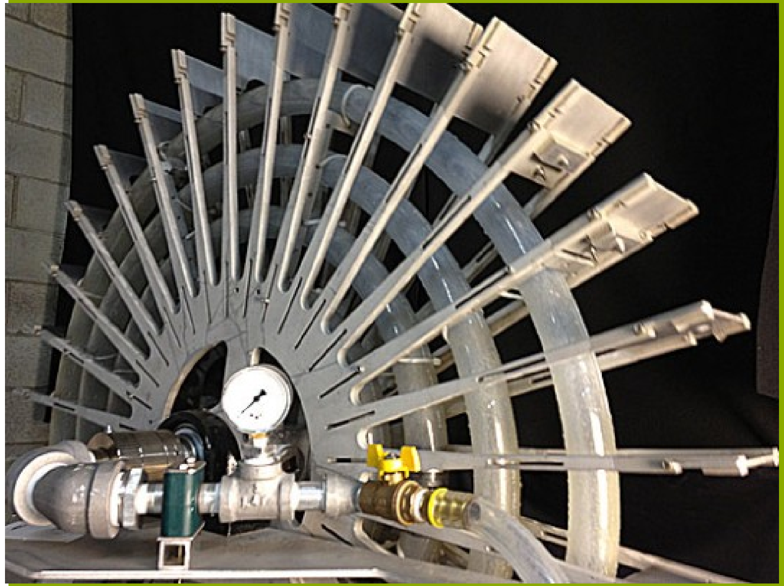
DWS
IRRIGATION

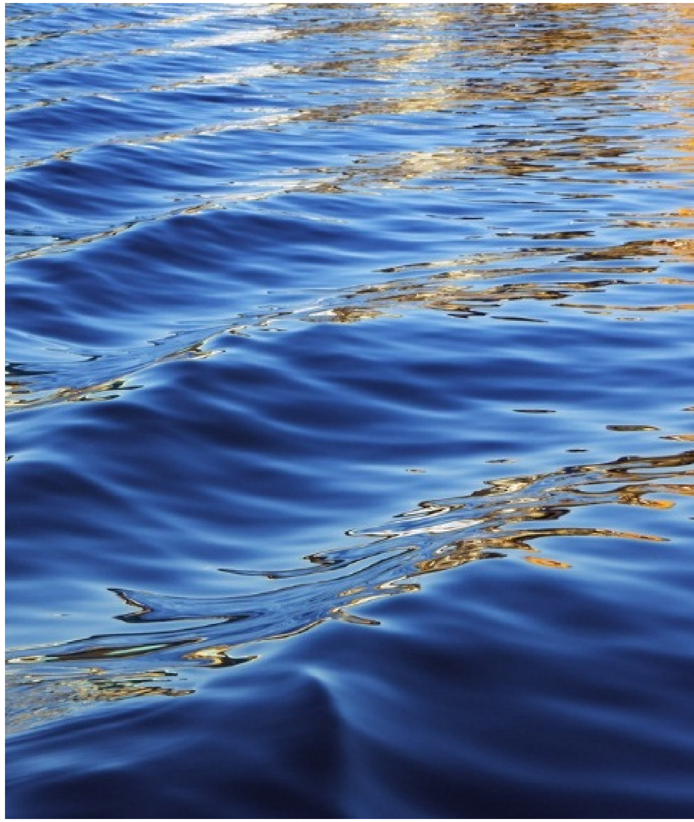
Daley's Water Service Pty Ltd
Specialising in
Water & Energy Efficiency



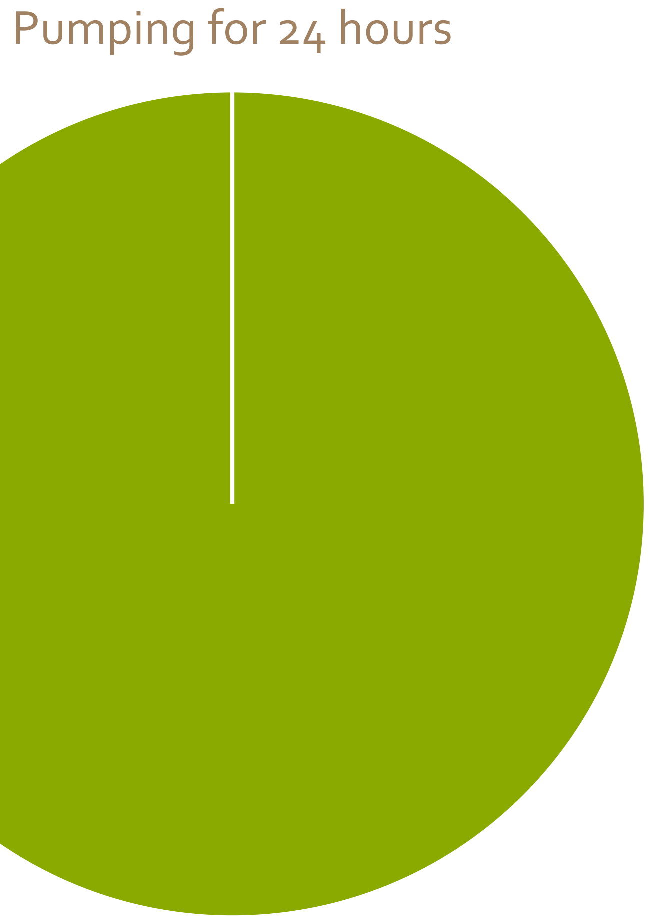
Considering Solar for Irrigation

- Understand your current design and managed system capacity.
- Is your current or proposed pump and distribution system efficient?
- How will system capacity and system efficiency impact on your proposed solar investment.
- What are the solar PV options?
- What are the battery options?
- Current cost and comparisons.

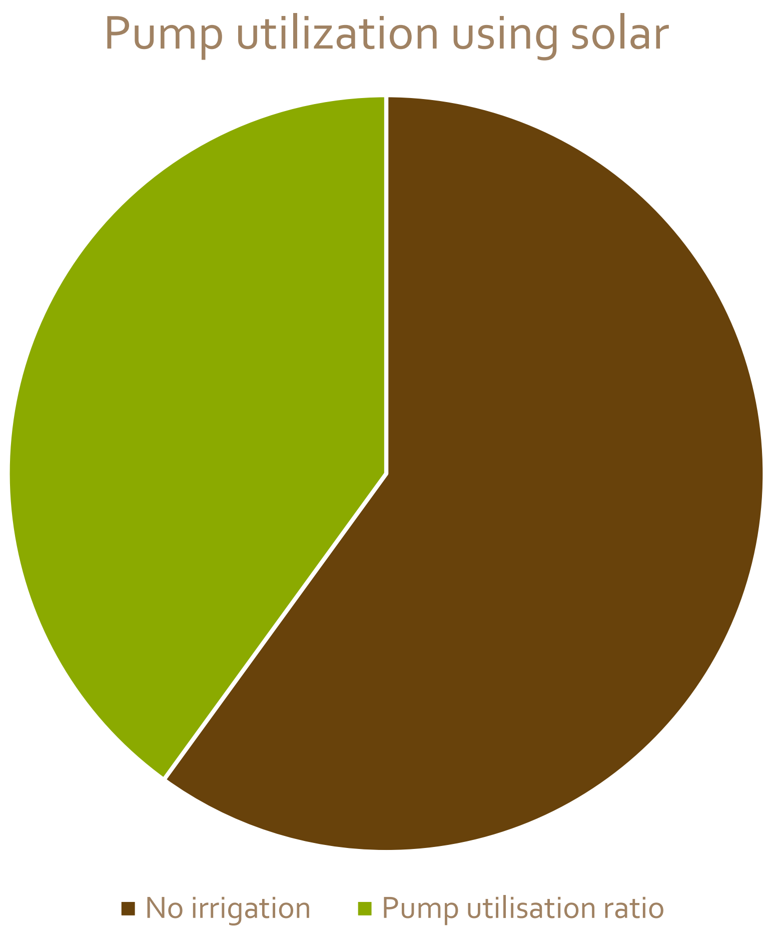
Understand your current design and managed system capacity.



Design System Capacity



Managed System Capacity



Design System Capacity

- The maximum application rate (mm/day)

Flow/Area/Time

System Capacity

The system capacity is the maximum possible rate at which the machine can apply water to the irrigated field area

Expressed in mm/day

NOT the depth applied per pass (mm)

$$\text{System Capacity} = \frac{\text{Daily pump flow rate (L/day)}}{\text{Field irrigated area (m}^2\text{)}}$$

System Capacity Example

System type:	Travelling Gun
Pump flow rate:	22.5 Litres/second
Area Irrigated:	30 hectares

$$\text{System Capacity} = \frac{\text{Daily pump flow rate (L/day)}}{\text{Field irrigated area } (\text{m}^2)}$$

Average daily flow rate (L/day) = 22.5(L/s) × 3600(s/hr) × 24(hrs/day)
= 1 944 000 L/day

Area Irrigated (m^2) = 30 (ha) x 10 000 (m^2/ha)
= 300 000 m^2

System Capacity = 1 944 000 / 300 000
= 6.48 L/m^2/day
= **6.48 mm/day** (as 1 L/m^2 = 1 mm)

Potential Managed System Capacity

- ❑ PUR (Pump Utilisation Ratio)
  - Water supply roster
  - Ground water depletion
  - Electricity tariff
  - Wind conditions
  - Life style
- ❑ Application efficiency of the system

Managed System Capacity

- In practice the system capacity of the machine is reduced due to two factors:
  - The pump will have periods of disuse ***Pumping Utilisation Ratio (P.U.R)***
  - A little water is inevitably lost between the nozzle and the crop root zone. ***Application Efficiency (E_a)***

$$\boxed{\text{Managed System Capacity} = \text{System Capacity} \times \text{P.U.R} \times E_a}$$

Example Cont…

For the system discussed previously, during the peak of the growing season, the pump averages 6 days use out of every 7 to allow for hose changes and typical farming practices. The system uses a 1.2" taper nozzle at 70 psi at 300° sector angle in wind, so the application efficiency is estimated at 0.8 (80%).

$$\boxed{\text{Managed System Capacity} = \text{System Capacity} \times \text{P.U.R} \times E_a}$$

System Capacity = 6.48 mm/day (from previous example)

Pumping Utilisation Ratio = 6 days per week × 20 hrs per day = 120 hrs out of 168 hrs per week = 0.71

Gun Application Efficiency = 0.85

Managed System Capacity = 6.48 × 0.71 × 0.8 = **3.7 mm/day**

Design System Capacity

- **The maximum application rate (mm/day)**

Flow/Area/Time

System Capacity

The system capacity is the maximum possible rate at which the machine can apply water to the irrigated field area

Expressed in mm/day

NOT the depth applied per pass (mm)

$$\text{System Capacity} = \frac{\text{Daily pump flow rate (L/day)}}{\text{Field irrigated area (m}^2\text{)}}$$

System Capacity Example

System type:	Travelling Gun
Pump flow rate:	22.5 Litres/second
Area Irrigated:	30 hectares

$$\boxed{\text{System Capacity} = \frac{\text{Daily pump flow rate (L/day)}}{\text{Field irrigated area (m}^2\text{)}}}$$

Average daily flow rate (L/day) = 22.5(L/s) × 3600(s/hr) × 24(hrs/day)
= 1 944 000 L/day

Area Irrigated (m^2) = 30 (ha) x 10 000 (m^2/ha)
= 300 000 m^2

System Capacity = 1 944 000 / 300 000
= 6.48 L/m^2/day
= **6.48 mm/day** (as 1 L/m^2 = 1 mm)

Potential Managed System Capacity

- ❑ PUR (Pump Utilisation Ratio)
  - Water supply roster
  - Ground water depletion
  - Electricity tariff
  - Wind conditions
  - Life style
- ❑ Application efficiency of the system

Managed System Capacity

- In practice the system capacity of the machine is reduced due to two factors:
  - The pump will have periods of disuse ***Pumping Utilisation Ratio (P.U.R)***
  - A little water is inevitably lost between the nozzle and the crop root zone. ***Application Efficiency (E_a)***

$$\boxed{\text{Managed System Capacity} = \text{System Capacity} \times \text{P.U.R} \times E_a}$$

Example Cont…

For the system discussed previously, during the peak of the growing season, the pump averages 6 days use out of every 7 to allow for hose changes and typical farming practices. The system uses a 1.2” taper nozzle at 70 psi at 300° sector angle in wind, so the application efficiency is estimated at 0.8 (80%).

$$\boxed{\text{Managed System Capacity} = \text{System Capacity} \times \text{P.U.R} \times E_a}$$

System Capacity = 6.48 mm/day (from previous example)

Pumping Utilisation Ratio = 6 days per week × 20 hrs per day = 120 hrs out of 168 hrs per week = 0.71

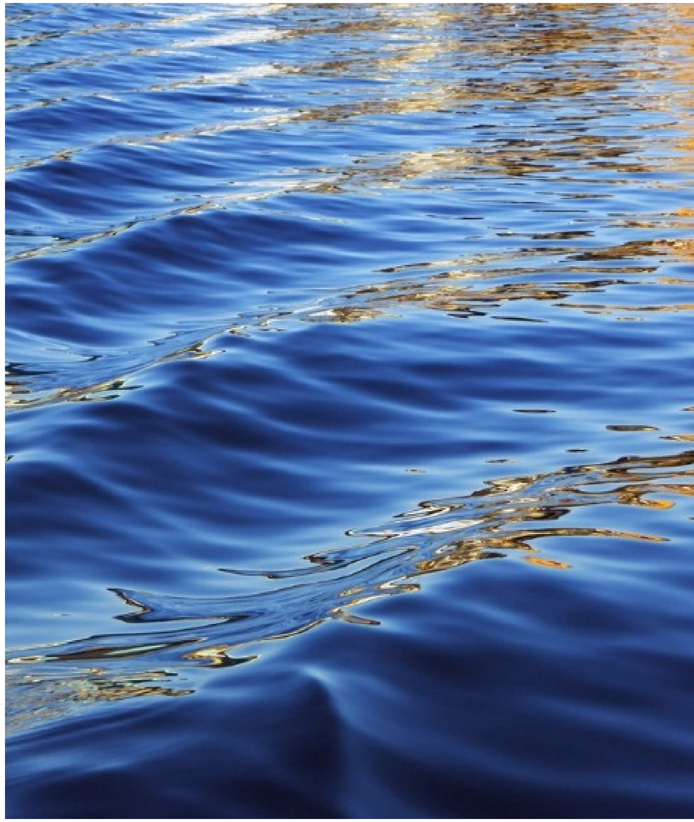
Gun Application Efficiency = 0.85

Managed System Capacity = 6.48 × 0.71 × 0.8
= **3.7 mm/day**

Points to consider

- Managed system capacity should also match the soil water holding capacity. For example if the managed system capacity is calculated at 7 mm per day and you irrigated every 6 days you would be applying 42mm. So if your soil holding capacity was 35mm you would have 7mm of irrigation lost to deep drainage or runoff.

Is your current or proposed pump and distribution system efficient?

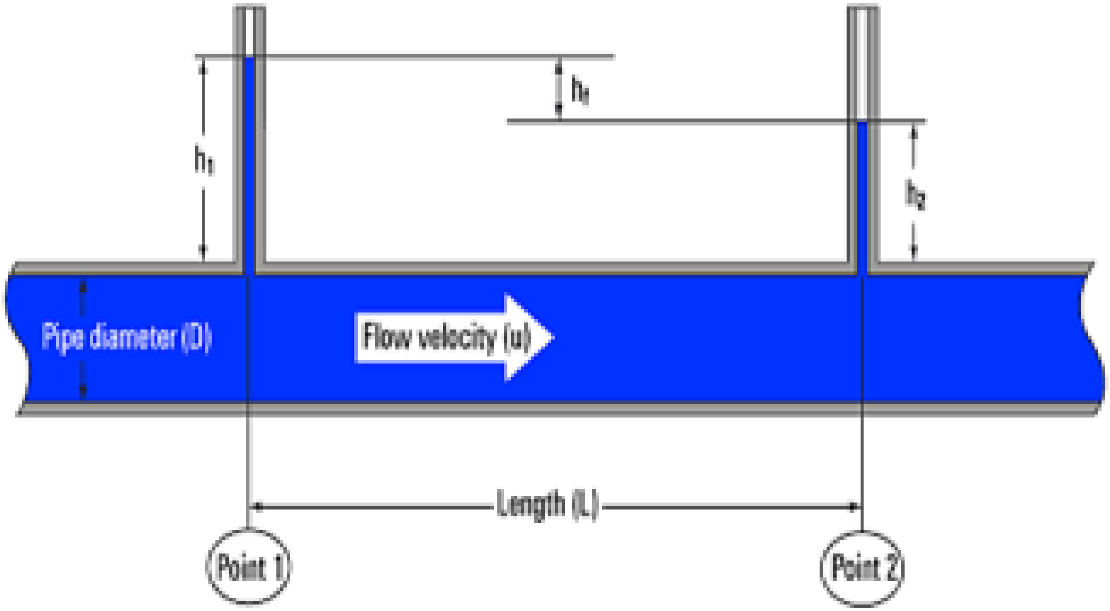


Pump Total Dynamic Head

- Elevation or Static Head
- Pressure Head
- Velocity Head
- Friction Head
- Minor Head

Friction should not be more then 10% of the TDH

Pressure loss in pipe



System TDH, Energy & Pressure gradients

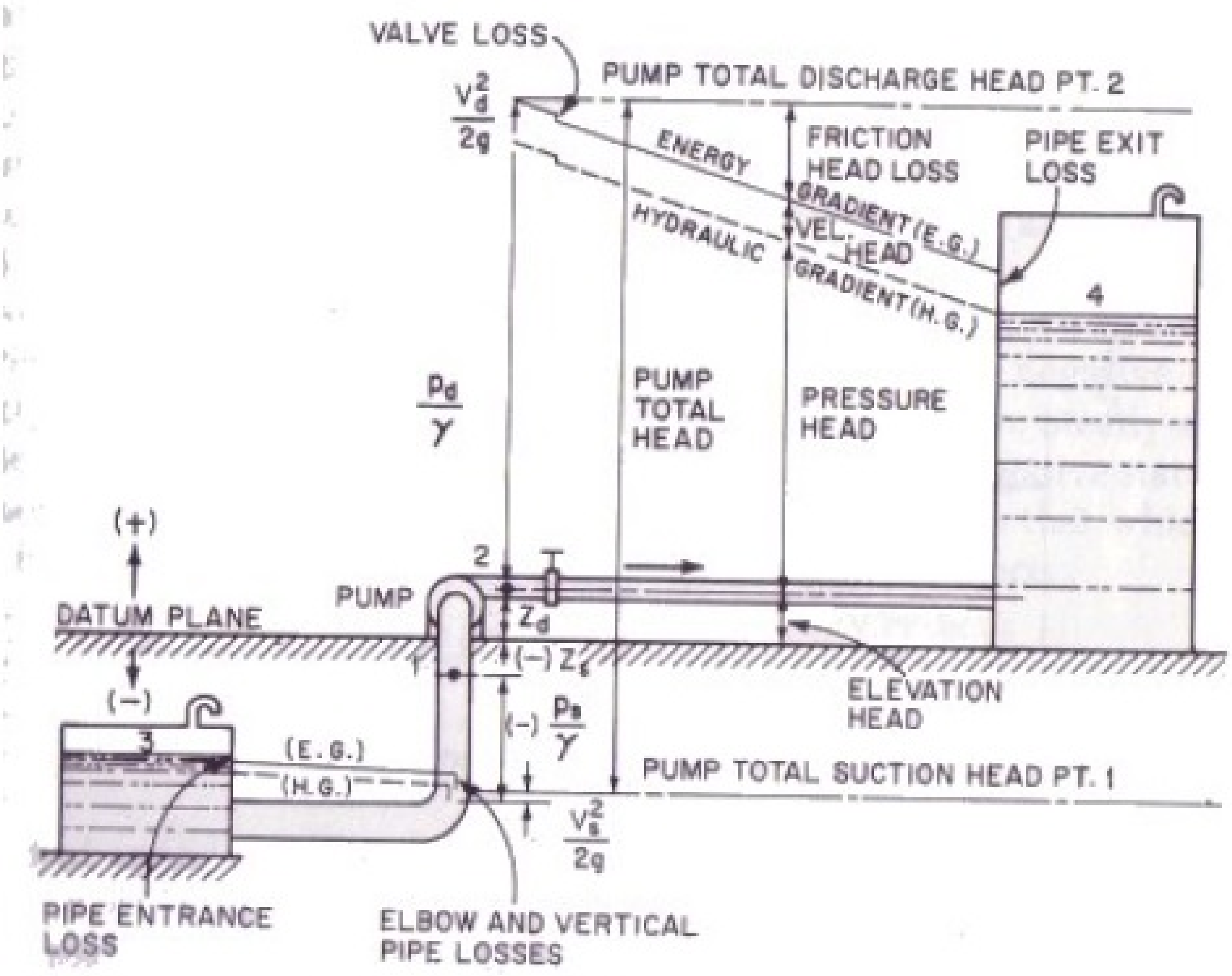
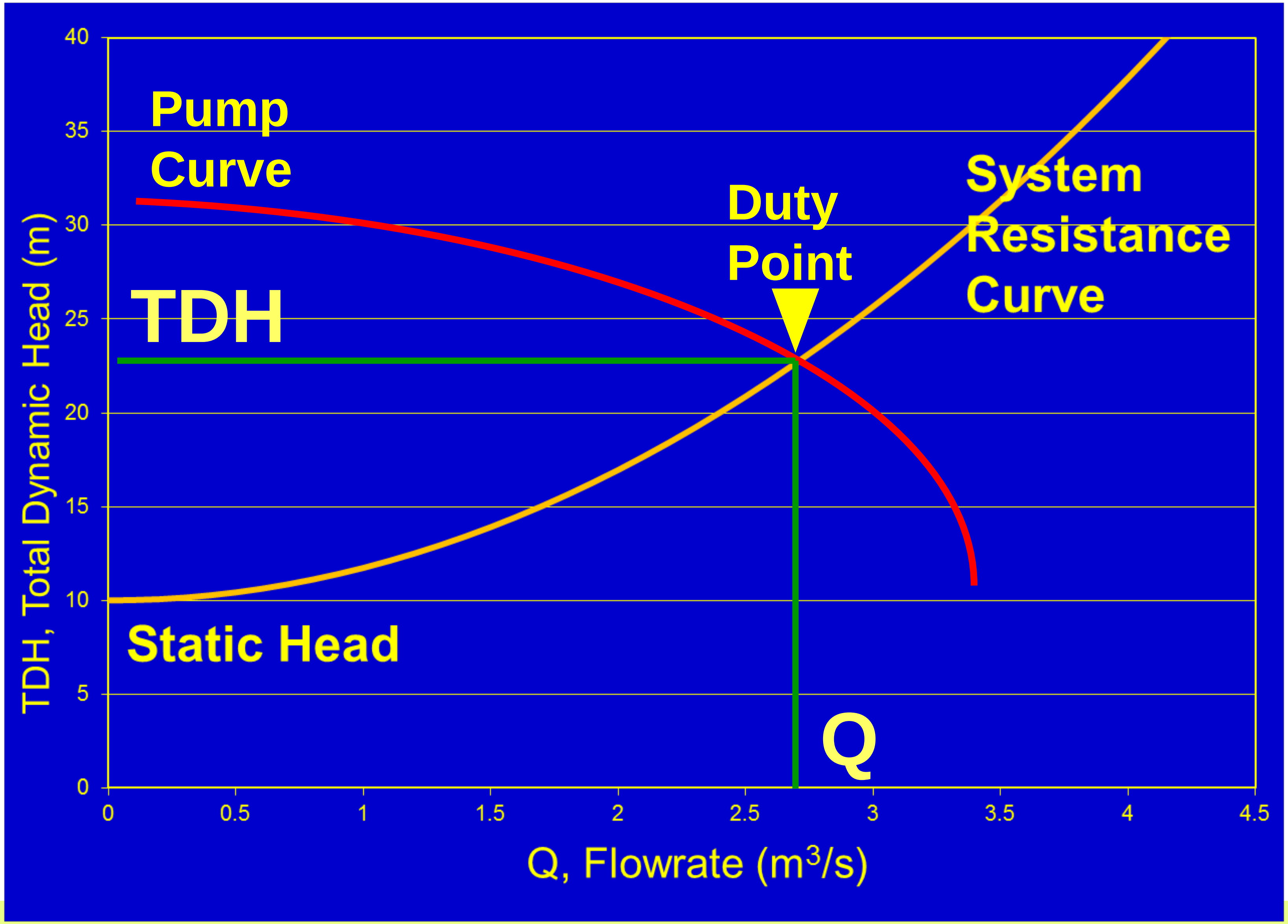


FIG. 9 Energy and hydraulic gradients.

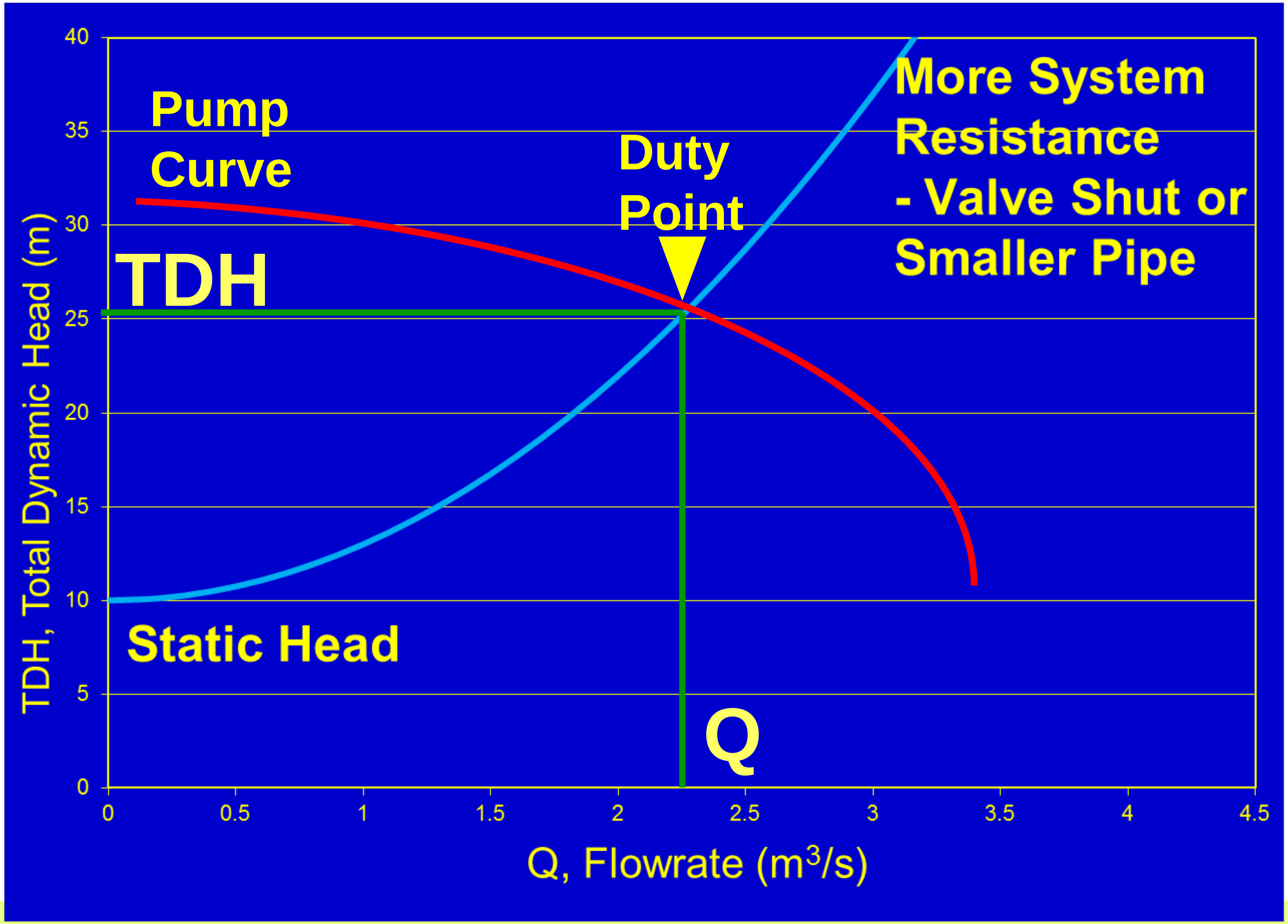
System Resistance Curve = Pipeline Resistance Curve

- Describes the relationship between the head and discharge for a specific pipeline configuration
- accounts for the static, friction & minor head loss over a wide range of discharge
- developed for increments of *flowrate*, calculating *headlosses* for each

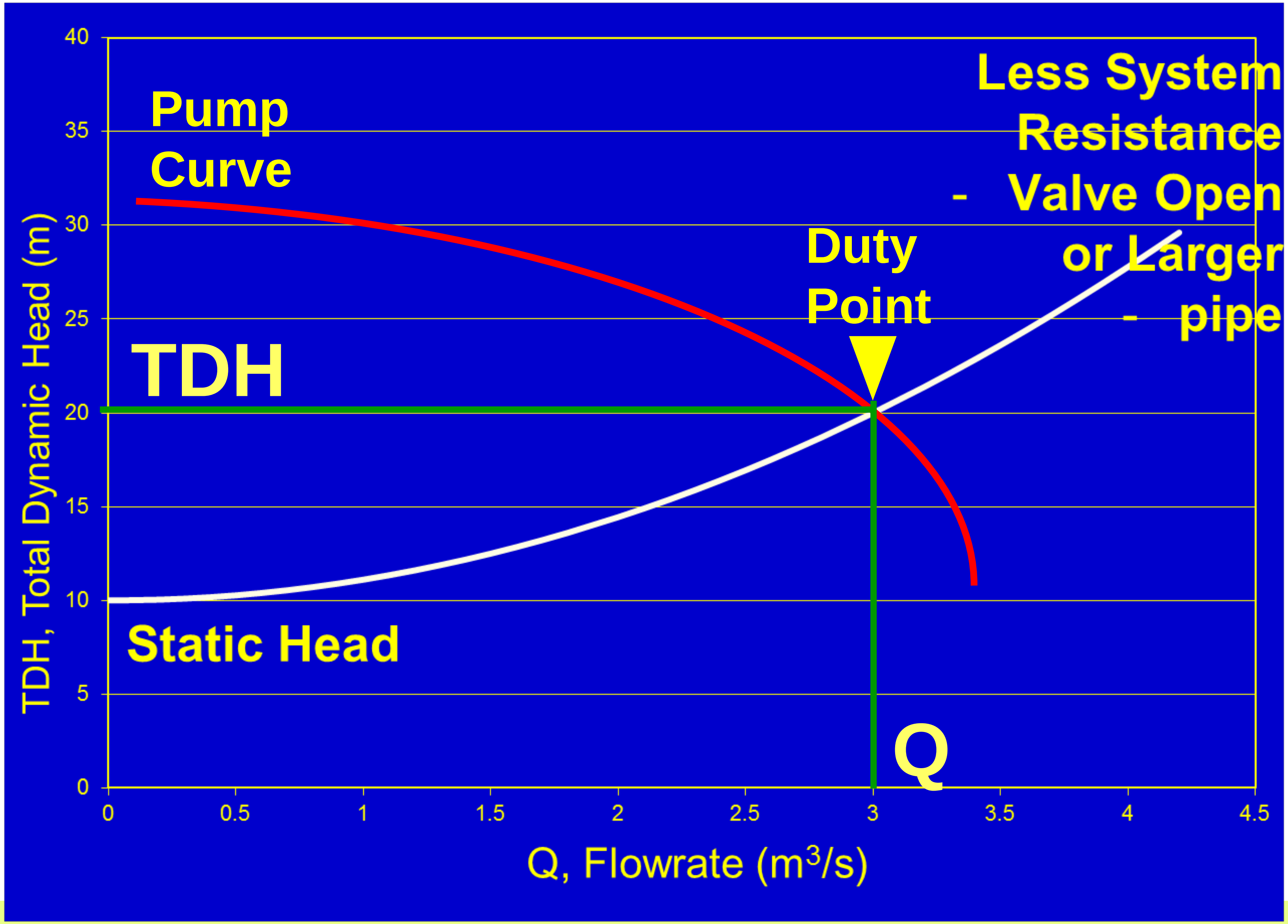
System Resistance and Pump Curve



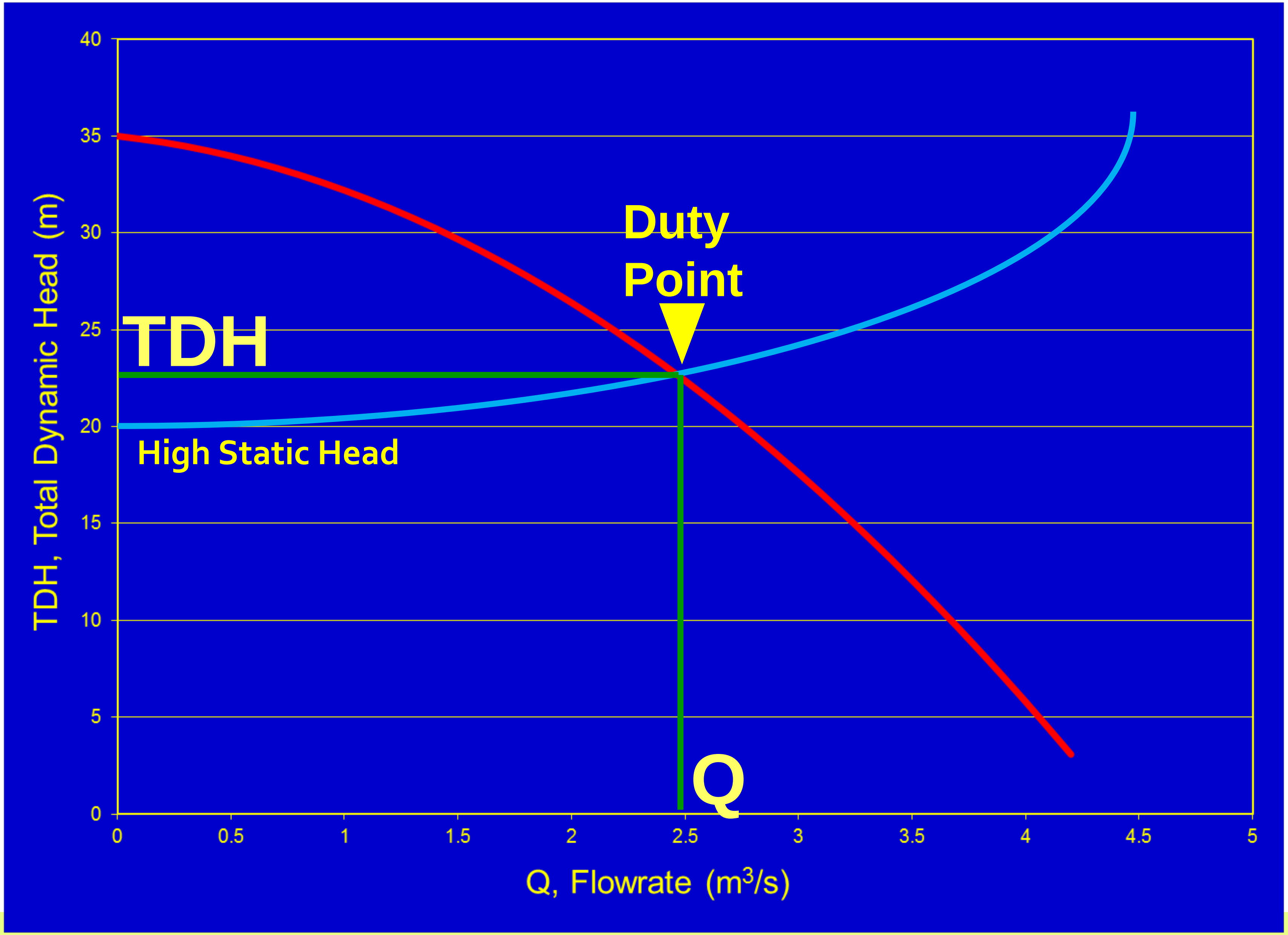
Altering System Curve



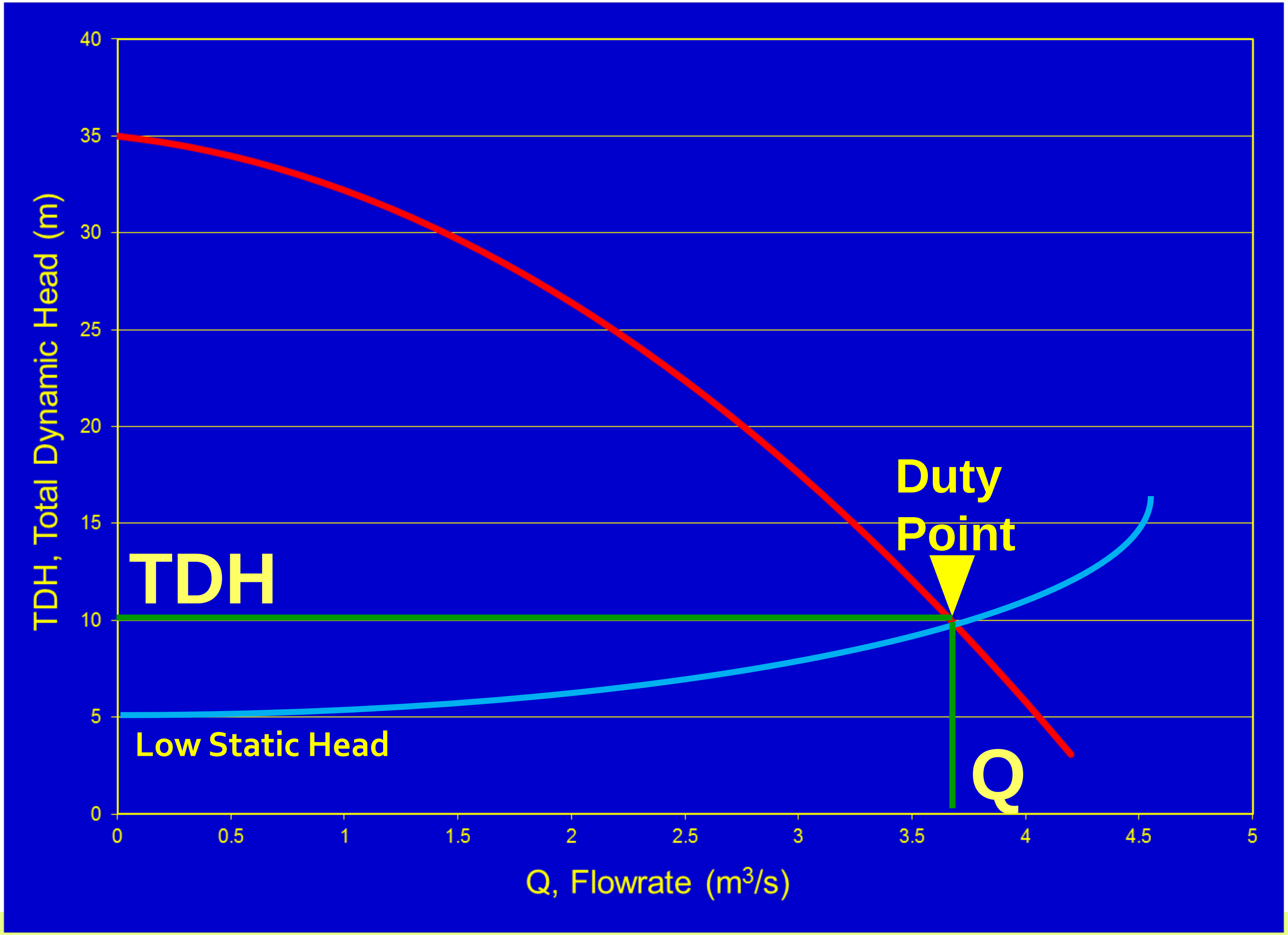
Altering System Curve



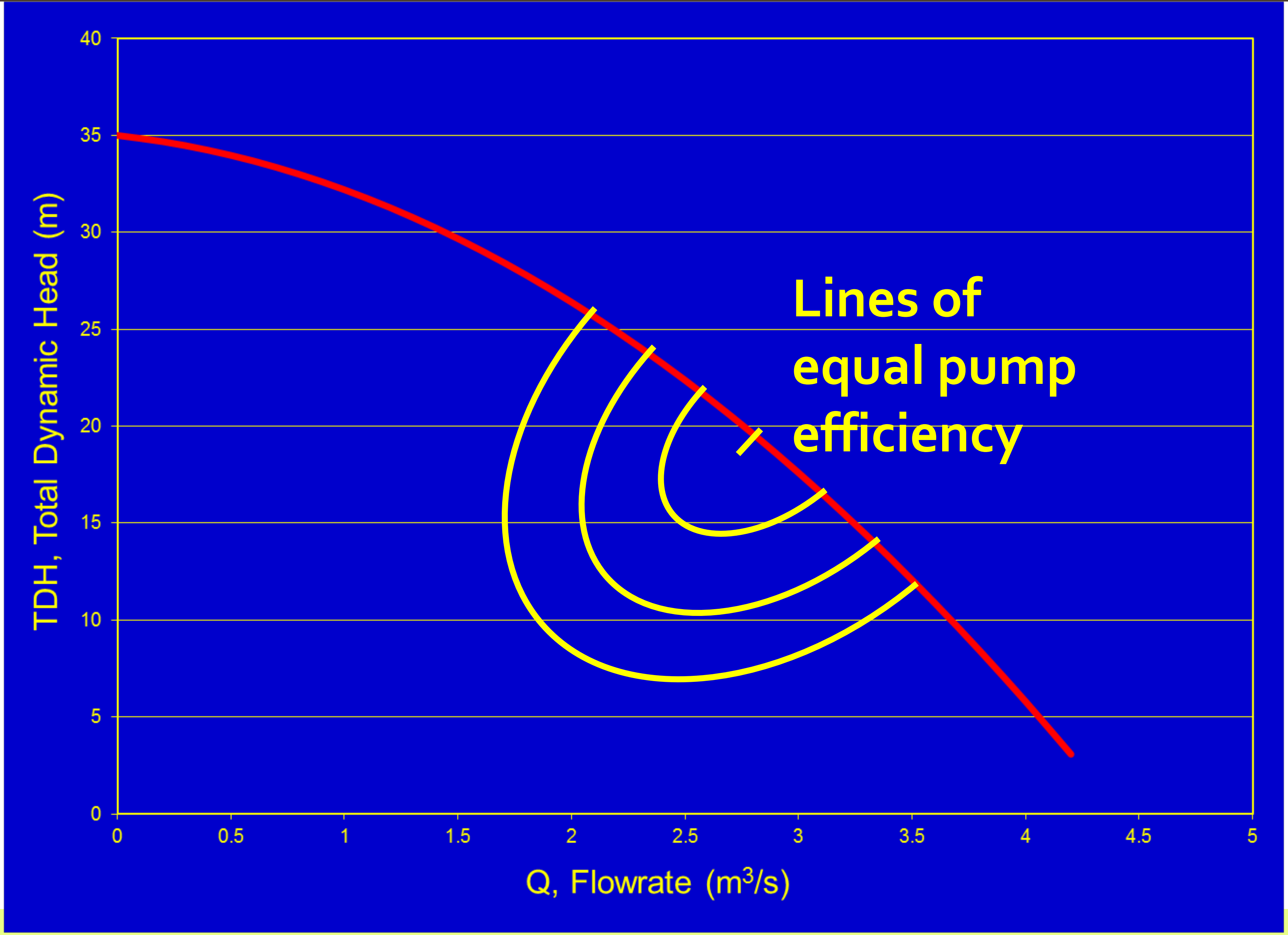
System Curve



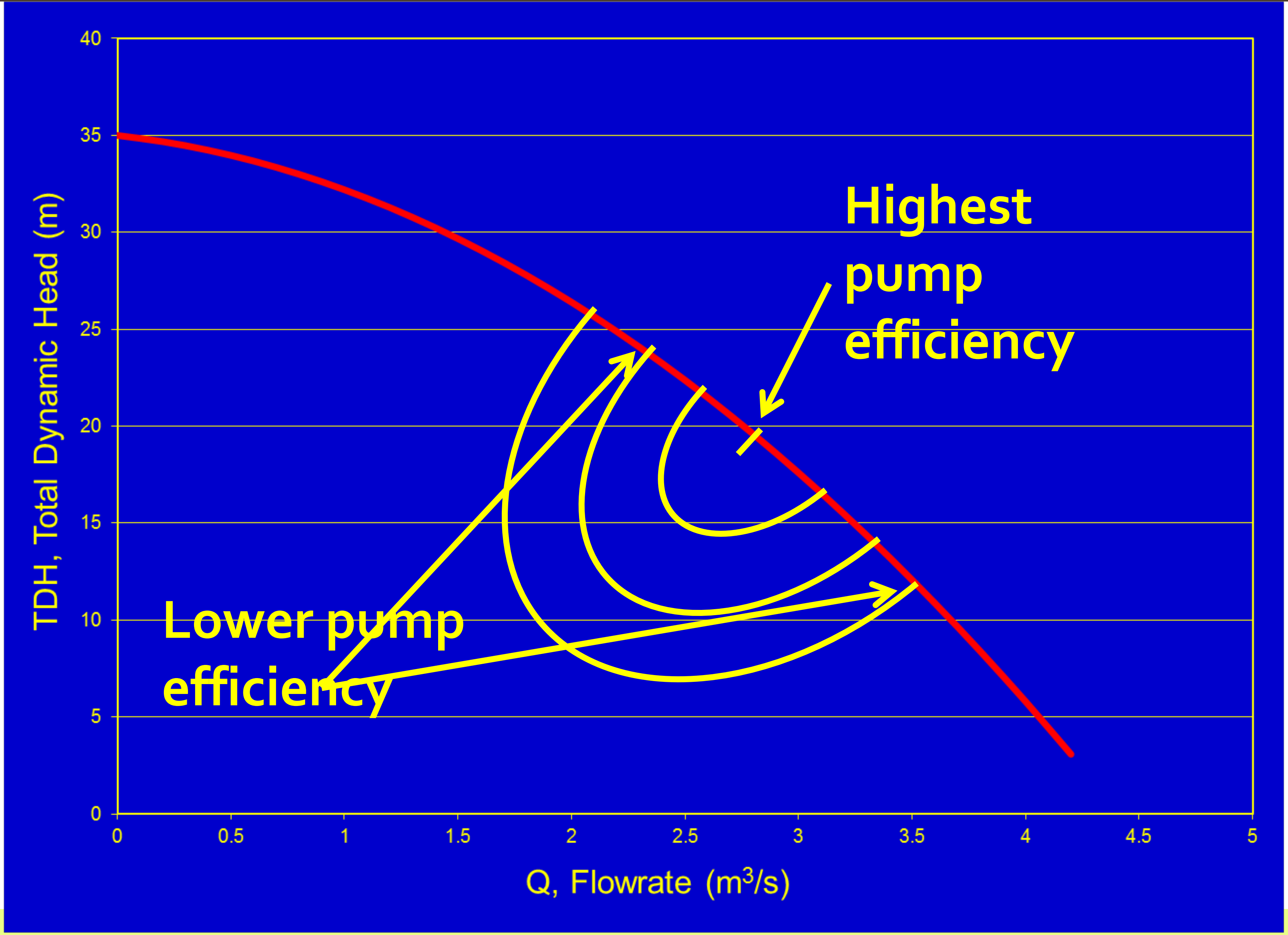
System Curve



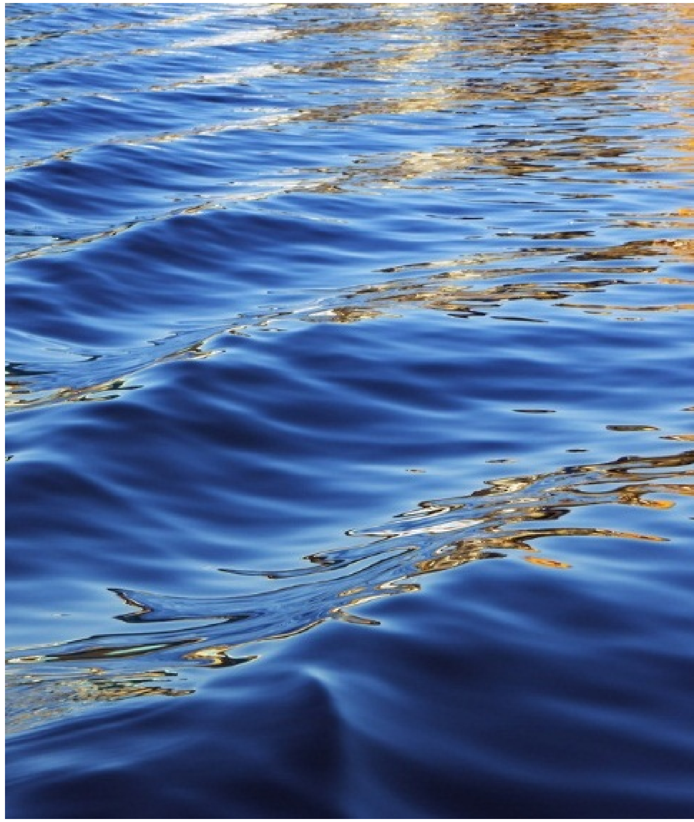
Pump Efficiency Curves



Pump Curve + Efficiency



capacity and system efficiency impact on your proposed solar investment.



Compare two China Pumps pumping 500ML per year

Required pump duty point:- 8 ML/day @ 10 M TDH

12HBG 40 belt driven by a 30 kW electric motor.
The combined efficiency is 88%.
Electricity cost @ $0.20 kWh = $7.49 per ML
Diesel cost @ $1.00 Litre = $10.70 per ML
Solar over 20 years = $4.75 per ML

Solar alone investment $47,456.00
Solar & batteries $84,438.00 would increase the capacity to 19 ML /day ($8.44 ML)

Approximately 256m2 of panels required.

10HB30 belt driven by a 30 kW electric motor.
The combined efficiency is 75%.
Electricity cost @ $0.20 kWh = $8.98 per ML
Diesel cost @ $1.00 Litre = $12.83 per ML
Solar over 20 years = $5.69 per ML

Solar alone investment $56,913.00
Solar & batteries $ 101,278.00 would increase the capacity to 19 ML /day ($10.12 ML)

Approximately 328 M2 of solar panels required.

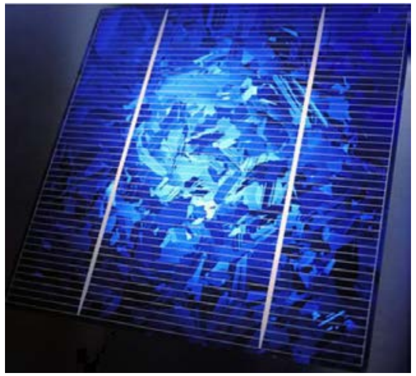
Solar PhotoVoltaics = PV:

COMPONENTS

1. PANELS
2. INVERTERS
3. CONTROLLERS
4. BATTERIES

- Current technology
- New technology on horizon

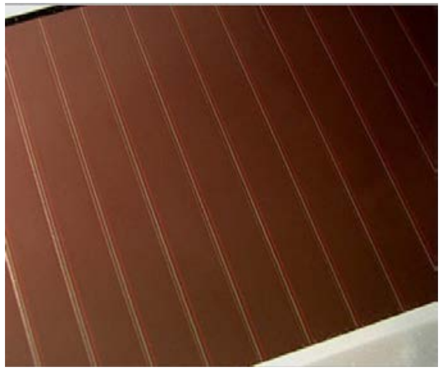
PANELS/CELLS: currently



<u>Silicon cells</u>
Mono or Poly crystalline

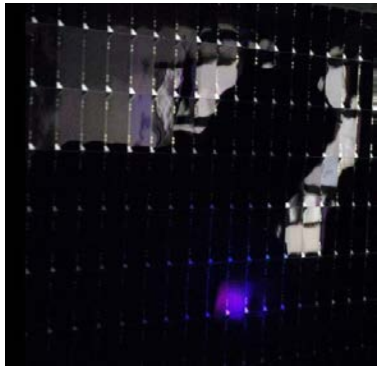
15-17%
Individual 21.5%

91% of world market



<u>Thin film</u>
Amorphous silicon
CIGS
3-13%

Tolerant of heat and shade
Limited availability/ practicality

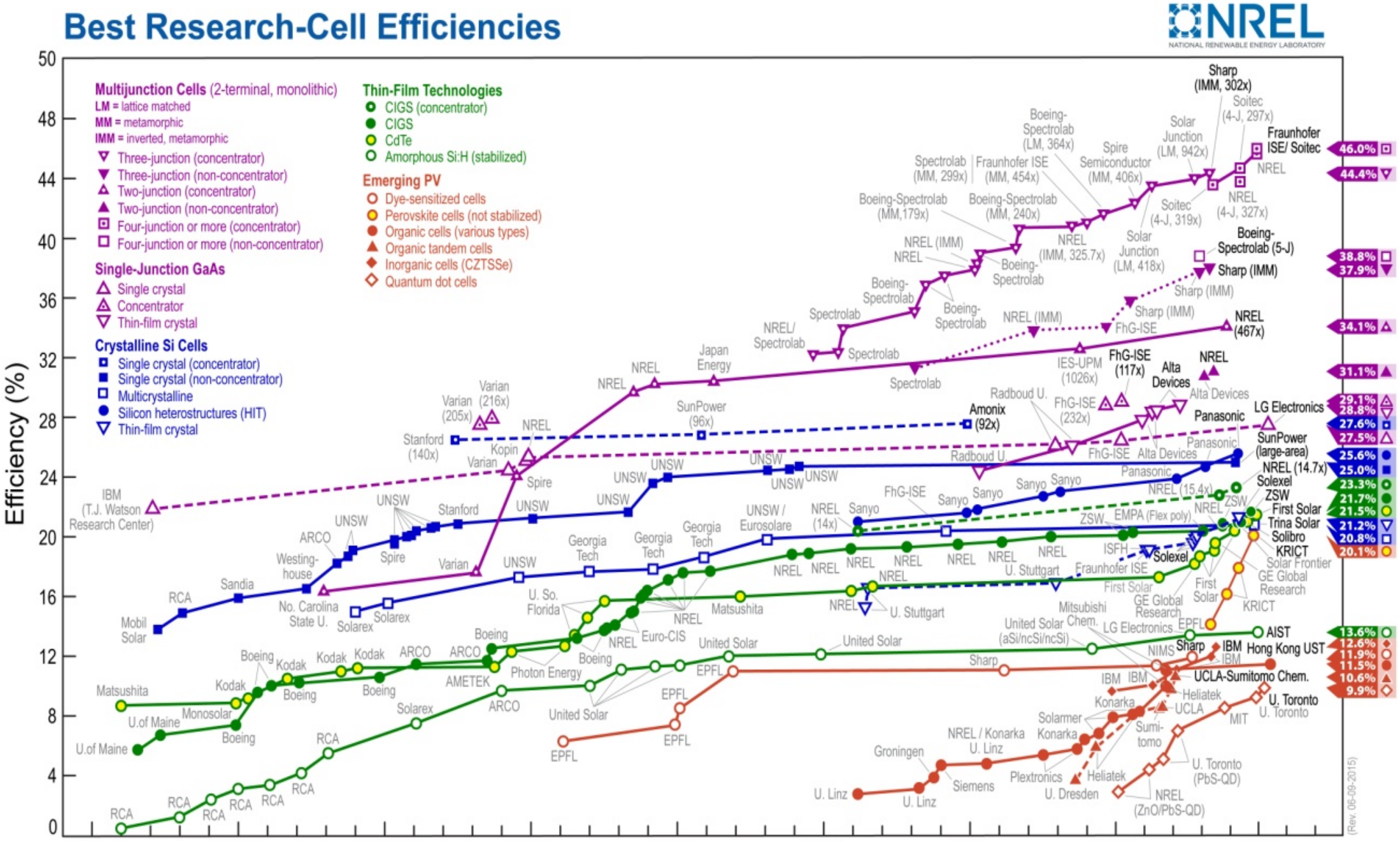


<u>Multi-junction cells</u>
Silicon, gallium arsnide

36-44%
High Cost

Aerospace / light weight applications

PANELS: New technologies



Solar PV: Inverters

Top Tier European

ABB

SMA

Schneider

As with most things in life purchase the best quality you can afford.

Solar PV: Controllers

Batteries: currently

Lead Acid
Vented (wet)
Valve regulated (VRLA)

High discharge rate (wet)
Up to 10-15 years life
Comparative Low Cost

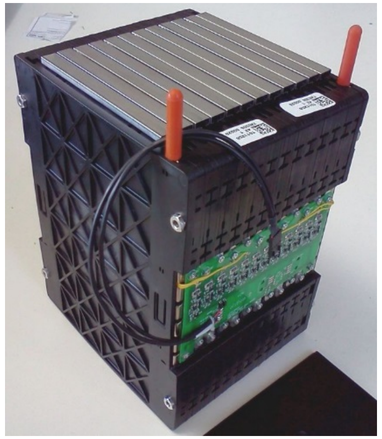
High maintenance (WET)
Minimal maintenance (VRLA)

Nickel- Cadmium (NiCd)

Extreme temperatures
Unpredictable demands
Frequent daily cycling

Up to 10-15 years life
Rarely used in Stand-alone situations
High Cost

Low maintenance



Lithium- ion
Eg Tesla/Kokam

Highest energy density W/kg

Electric Vehicles
High upfront cost

Exceptional Life

Maintenance Free

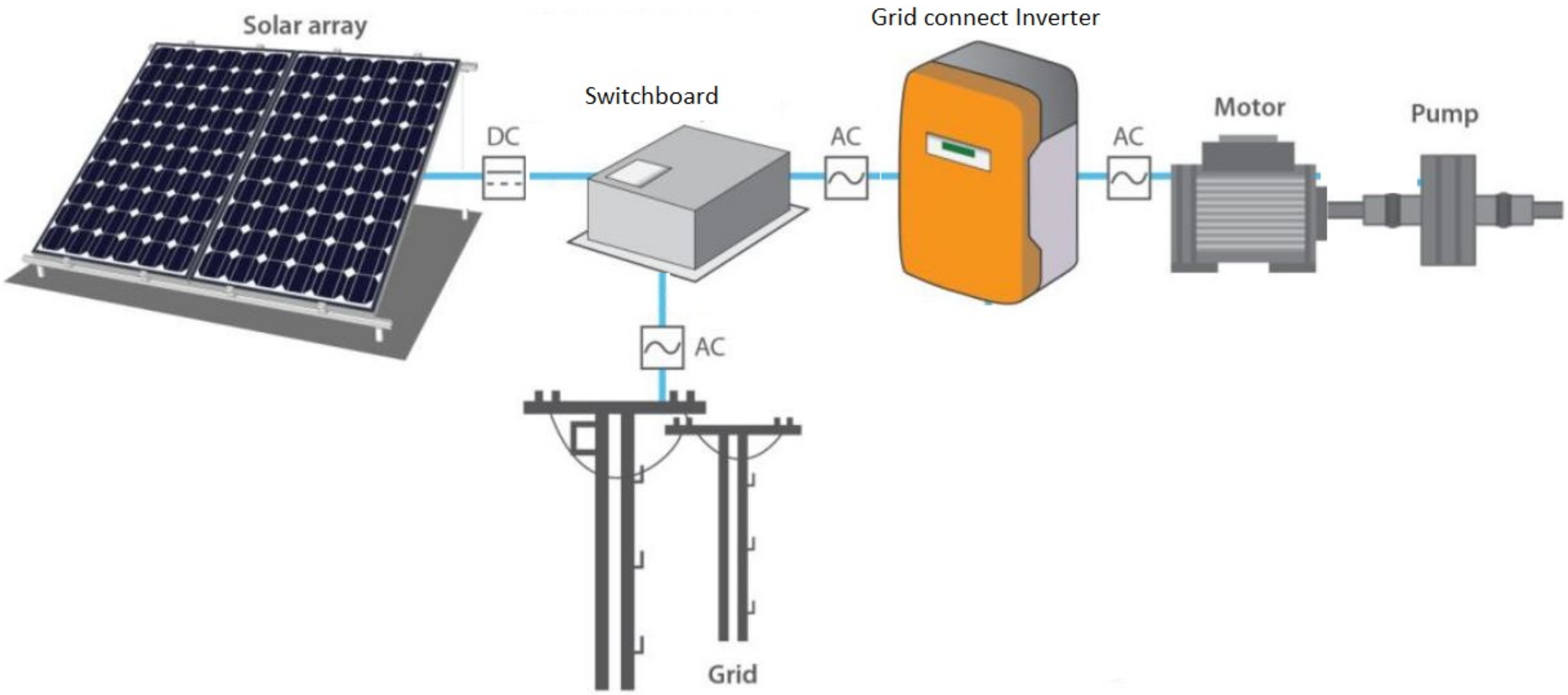
New technologies: Batteries

Tesla Power wall

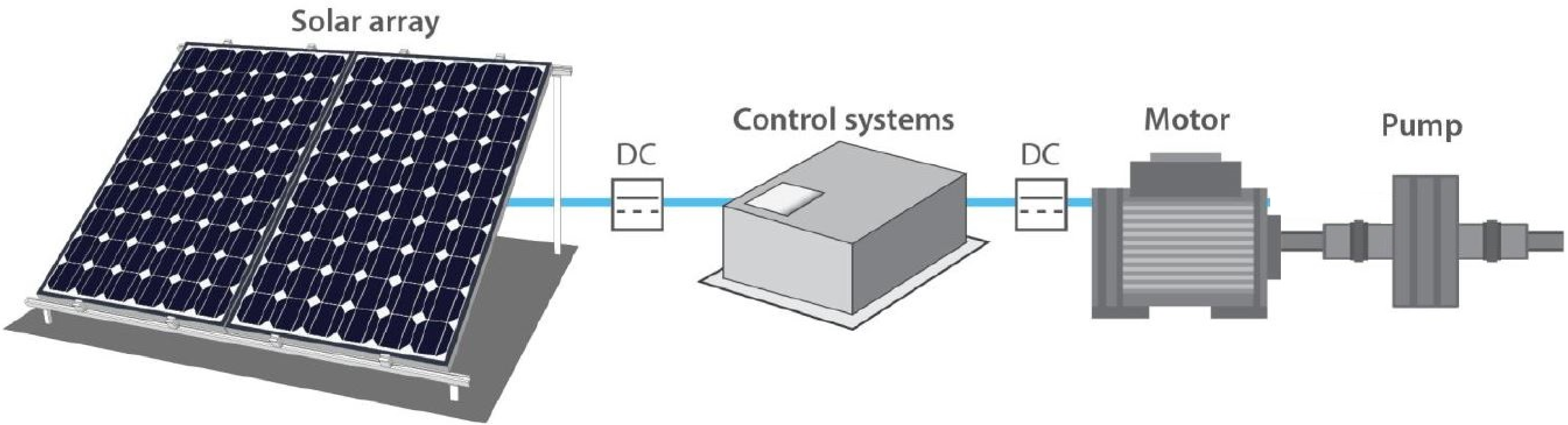
Enphase AC Battery

- Both devices utilise Lithium Technology in slightly different ways.
- Both targeted at residential market
- Limited Commercial (large scale) applications due to cost at this stage.
- Both are potential game changers to the energy sector!

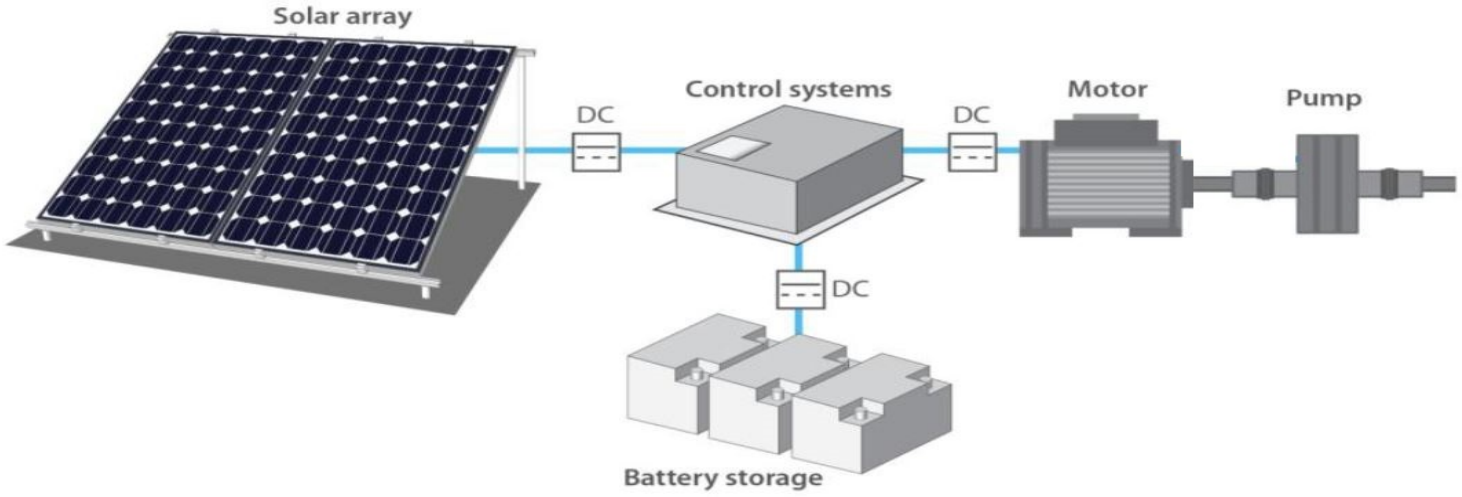
Solar PV with grid



Solar PV alone



Solar PV with batteries
No grid



Solar PV system LARGER than kW drawn by pumps → Extra solar PV generated stored in batteries → Stored power used when solar PV panels do not meet demand

$1.44 Watt
Solar PV system

Lead Acid (VRLA)
$600 kWhr

Common questions

- Will solar suit water harvest pumping?
- Solar and pressurised systems like lateral move or Centre Pivot.
- Could the power generated be used elsewhere on farm?
- Could the panels be portable?
- What is the life expectancy?
- How temperature affects the panel efficiency.