

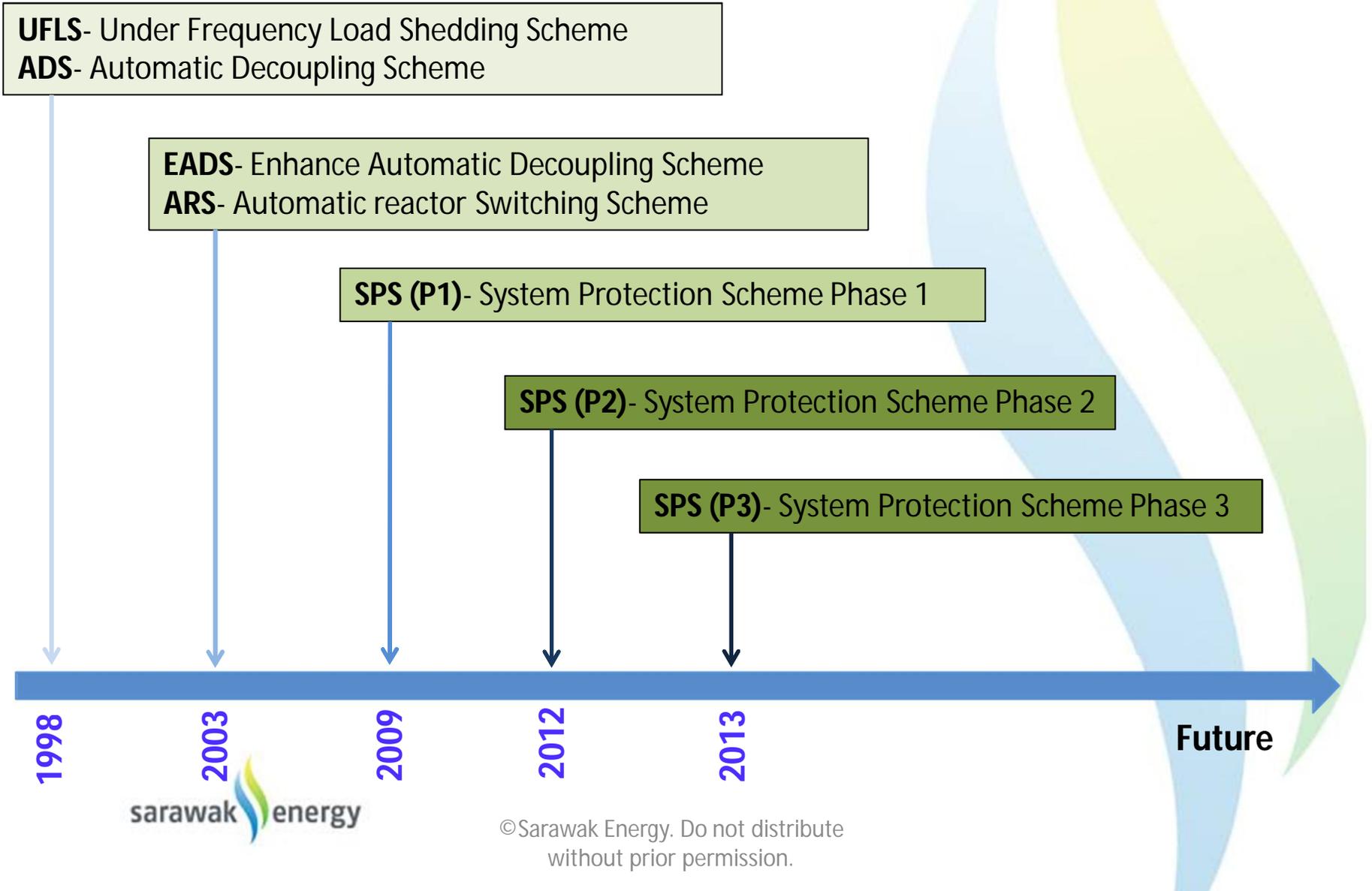


**The Evolution of System Protection Schemes for the
Sarawak Power System**

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Evolution of System Protection Scheme



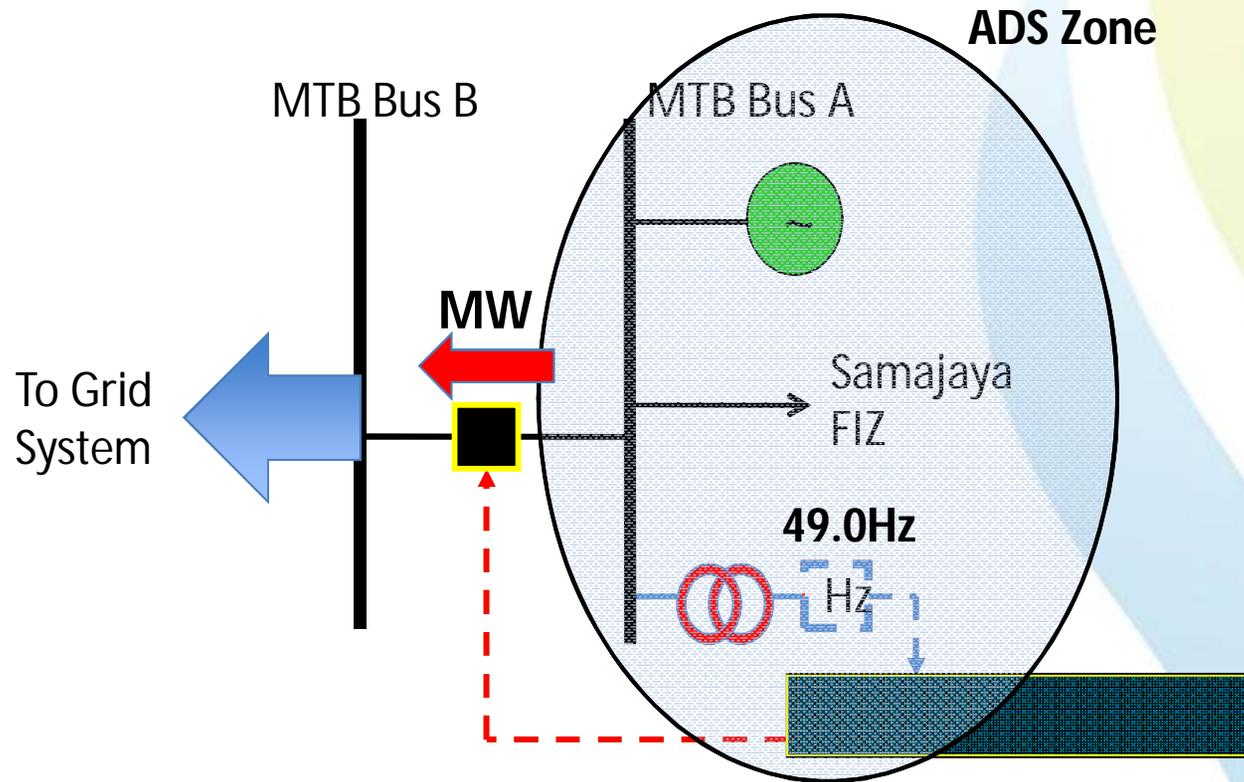
Under Frequency Load Shedding Scheme (UFLS)

- Implemented before 1998
- **Objective :**
 - To ensure system stability under two major scenarios of disturbances:
 - ❖ Loss of Generating units with Grid still intact
 - ❖ Double circuit tripping of the transmission lines, resulting in power deficiency in the region west of Bintulu and in particular, Kuching
- **Operation philosophy :**
 - Detects frequency decline and shed loads accordingly, thus preventing the power system to operate in an unstable operating zone which will inevitably lead to system brownout or blackout

Automatic Decoupling Scheme (ADS)

- Implemented in 1998
- Serve as Backup for the UFLS scheme
- **Objective:**
 - To safeguard the distribution system supplying the sensitive loads in Samajaya Free Industrial Zone
- **Operation Philosophy :**
 - Dedicated Kuching Biawak power station to supply Samajaya FIZ and in the event of major disturbance, the entire Samajaya FIZ distribution network together with the power station will be decoupled from the Grid system

Operation Philosophy for ADS Scheme



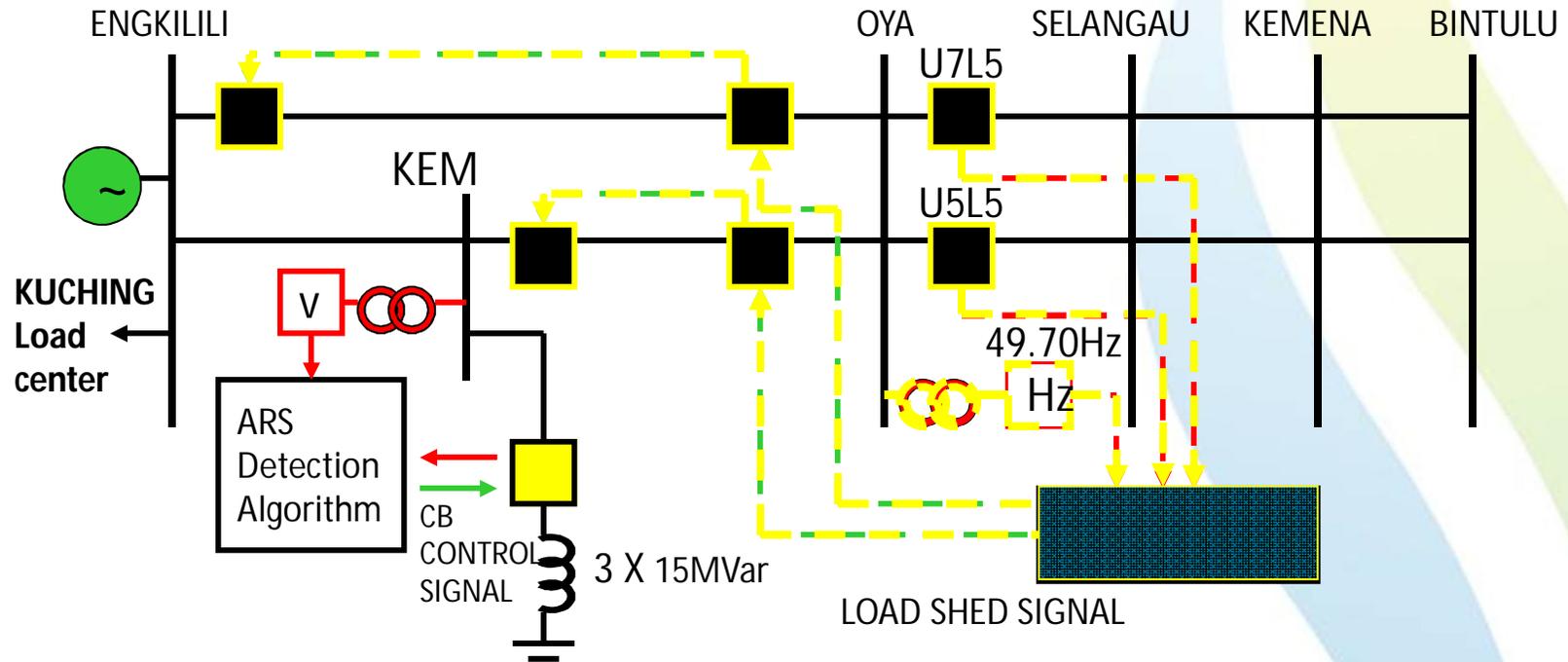
Logic to trigger the operation of ADS

1. Power Flow out of the ADS Zone + UF on MTB Bus < 49.0 Hz

Enhance Automatic Decoupling Scheme (EADS)

- **System Issue :**
 - Automatic Decoupling Scheme (ADS) solution incurred high generation fuel cost
 - UFLS scheme is no more effective in mitigating the power deficient condition at the Kuching load center resulted from the double circuits tripping of Engkilili-Mambong 275kV line and Bintulu-Oya 275kV line
- **Solution :**
 - Implement EADS scheme
- **Objective:**
 - Work with the present UFLS scheme to safeguard Sarawak power system against double circuits tripping of Engkilili-Mambong 275kV line and Bintulu-Oya 275kV line
 - To replace ADS scheme
 - Reduce Generation fuel cost
- **Operation Philosophy :**
 - Detects the opening of the circuit breakers at both circuits to generate a logic controlled signal to trip load at transmission level

Operation Philosophy for EADS Scheme



Logic to trigger the operation of EADS at Oya

1. Oya (U7L5 & U5L5) CBs status open + $UF < 49.70\text{HZ}$

System Protection Scheme Phase 1 (SPS)

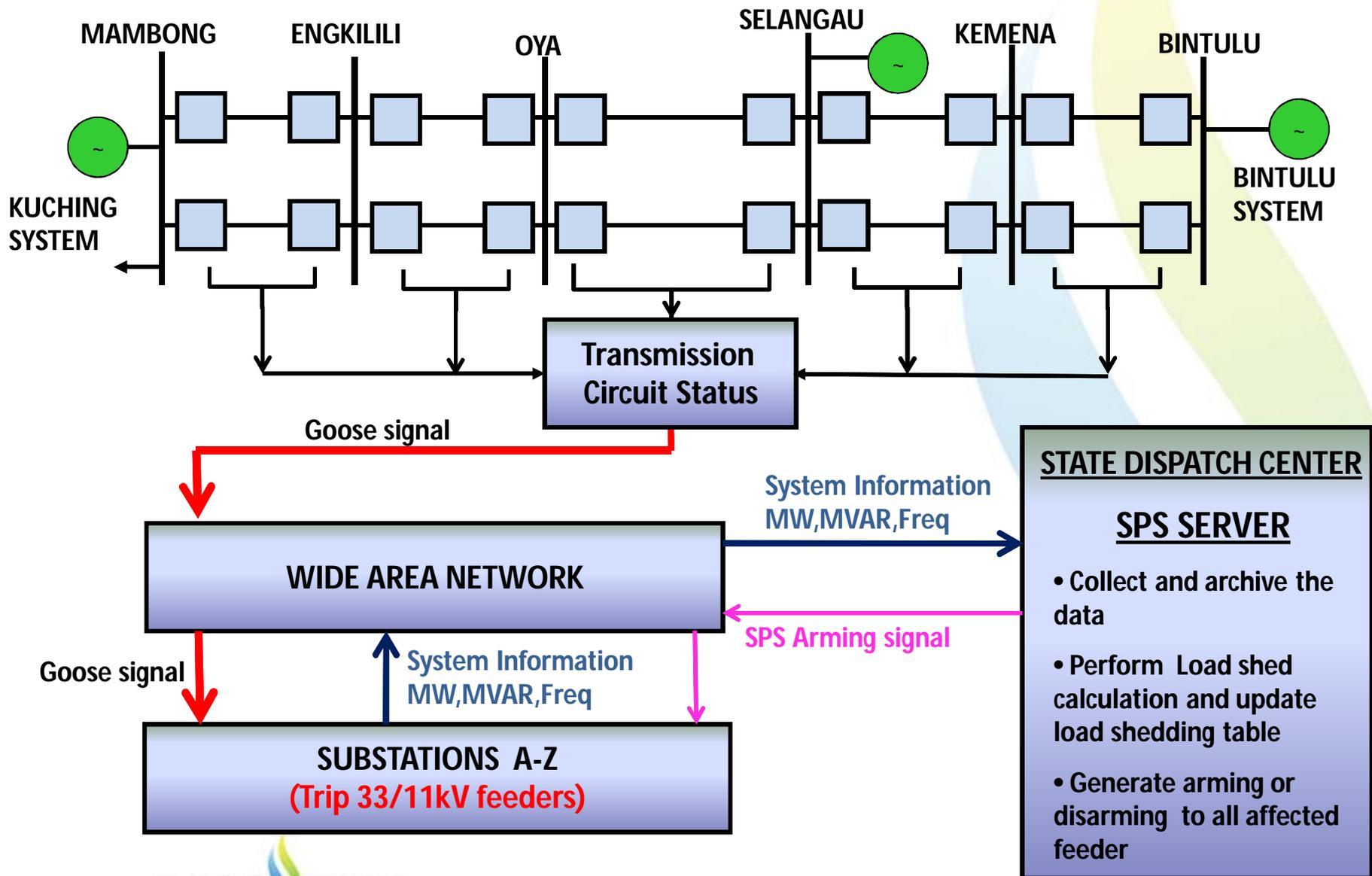
- **System Issue :**
 - EADS and UFLS scheme are no more effective to safeguard Sarawak power system against the loss of any double circuits section in between Mambong-Engkilili-Oya-Selangau-Kemena-Bintulu 275kV transmission lines
 - High generation fuel cost due to dispatching of Biawak diesel generation to safeguard Sarawak power system against the loss of double circuit tripping contingency
- **Solution :**
 - Implement SPS system
- **Objective:**
 - To safeguard Sarawak power system against the loss of double circuit tripping contingency
 - Allow GSO more flexibility in operating the power system and utilize the generation resources more efficiently
 - To replace EADS scheme

System Protection Scheme Phase 1 (SPS)

- **Operation Philosophy :**

- Capture generation and load information, calculate quantum of sheddable loads required for a pre-defined set of contingent events, and the detection of the inception of the contingent event with sensors located strategically in the power system
- Event-based scheme consisting of five N-2 contingency detection zones
 - ❖ Mambong Zone – To safeguard Sarawak Power System against the loss of double circuit Engkilili-Mambong lines.
 - ❖ Engkilili Zone – To safeguard Sarawak Power System against the loss of double circuit Engkilili-Kemantan-Oya lines
 - ❖ Oya Zone – To safeguard Sarawak Power System against the loss of double circuit Oya-Selangau lines
 - ❖ Selangau Zone- To safeguard Sarawak Power System against the loss of double circuit Selangau-Kemena lines
 - ❖ Kemena Zone - To safeguard Sarawak Power System against the loss of double circuit Kemena-Bintulu lines

Operation Philosophy for SPS system



System Protection Scheme Phase 2(SPS)

- **System Issue :**
 - Frequency Instability during system islanding
 - ❖ Loss of Bintulu-Similajau double circuits
 - Loss of Similajau-Bakun double circuits
 - ❖ Over frequency during loss of any double circuit in between 275kV Engkilili-Oya-Selangau-Kemena-Bintulu-Similajau lines
 - Loss of N-1 275kV transmission lines reliability
 - ❖ Loss of Engkilili-Kem-Oya single circuit
 - ❖ Loss of Oya-Selangau single circuit
 - ❖ Loss of Selangau-Kemena single circuit
 - ❖ Loss of Kemena-Bintulu single circuit
 - ❖ Loss of Bintulu-Similajau single circuit
 - Power import at Engkilili or Oya or Selangau or Kemena exceed SPS capability limits
 - ❖ Required to dispatch Biawak diesel generation to reduce import level
- **Solution :**
 - Expand and reconfigure the existing SPS system

System Protection Scheme Phase 2(SPS)

- **Objective:**
 - To Safeguard Sarawak Power system from collapse against either Bintulu-Similajau or Similajau-Bakun 275kV double circuit tripping contingency
 - Prevent generating units at Mukah, Bintulu, Pujut and Bakun trip on over frequency protection during loss of any double circuits section in between Oya-Selangau-kemena-Bintulu-Similajau 275kV transmission lines
 - Protect the 275kV transmission line conductor exceeds its stated capability limit during loss of any single circuit in between Engkilili-Oya-Selangau-Kemena-Bintulu-Similajau275kV transmission lines
 - Manage grid system overvoltage within statutory limits during the system islanding condition
 - Allow the GSO more flexibility to operate the power system and utilize the generation resources more efficiently

System Protection Scheme Phase 2(SPS)

- **The development of SPS Phase 2 :**
 - Adaptive Over frequency Generator Shedding Scheme (AOFG)
 - Adaptive (N-1) 275kV Line Overload Load Shedding Scheme (ALOLS)
 - Adaptive Reactor Switching Scheme (ARSS)
 - New Bintulu and Similajau Zone in SPS system for N-2 Bintulu-Similajau 275kV line and Similajau-Bakun 275kV line contingency respectively
 - New Bulk Load tripping scheme for the existing SPS Oya, Engkililli, Selangau and Kemena zone

System Protection Scheme Phase 3(SPS)

- **System Issue :**
 - Similajau-Samalaju 275kV transmission line conductor exceeds its stated capability limit due to loss of Similajau-Samalaju 275kV double circuits
 - Power import at Mambong, Engkilili, Oya, Selangau, kemena, Bintulu and Similajau exceed existing SPS capability and load shed limits.
 - Kuching extended power system overvoltage during system islanding condition
 - SPS system malfunctions due to hardware and software failure
- **Solution :**
 - Expand and reconfigure the existing SPS system
 - Still under development, expected to be completed in middle of year 2013

System Protection Scheme Phase 3(SPS)

- **Objective:**
 - Protect the 275kV transmission line conductor exceeds its stated capability limit during loss of Similajau-Samalaju double circuits
 - Manage grid system overvoltage within statutory limits during the system islanding condition
 - Allow the GSO more flexibility to operate the power system and utilize the generation resources more efficiently
 - To increase SPS system reliability and availability
 - To eliminate any single point of failure within the communication network equipments that connects SDC to all participating substations in SESCO's SPS System

System Protection Scheme Phase 3(SPS)

- **The development of SPS Phase 3 :**
 - Adaptive (N-2) 275kV Line Overload Load Shedding Scheme
 - Adaptive Capacitor bank Inter-tripping Scheme (ACTS)
 - SPS System redundancy upgrade

Future development for SPS System

- New scheme to mitigate the following system issues ;
 - Frequency Instability
 - ❖ N-2 Murum-Murum Junction 275kV line (Loss of whole Murum hydro power station)
 - ❖ Loss of whole Bakun hydro power station
 - Voltage instability
 - ❖ N-2 Similajau-Bakun 275kV line
 - ❖ N-2 Similajau-Murum Junction 275kV line
 - ❖ Outage of one Similajau-Bakun 275kV line and one Similajau-Murum Junction line
 - 275kV Transmission Line conductor exceeds its rated capability limits
 - ❖ N-2 Similajau-Bakun 275kV line
 - ❖ N-2 Similajau-Murum Junction 275kV line
 - ❖ Outage of one Similajau-Bakun 275kV line and one Similajau-Murum Junction line

Thank You



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