Accordingly, the fluid energy storage device can be discharged only when a particular condition warrants it. An advantage of this arrangement is that the fluid energy storage device can remain charged until such a condition exists, even if other conditions that may place a strain on the hydraulic system are present. Such other conditions may include normal fluctuations in system pressure, and can be accommodated by a different fluid energy storage device, for example, the first accumulator **130***a* shown in FIG. **2**.

Another feature of at least some embodiments of the systems described above with reference to FIGS. **1-3** is that the nature and type of actuator or actuators receiving power from the selectively discharged fluid energy storage device can be limited. For example, in some embodiments, not all aircraft actuators can receive power from the selectively discharged fluid energy storage device, but instead, a boom actuator or other designated actuator can be coupled to the selectively discharged fluid energy storage device to receive such power. An advantage of this arrangement is that in the event of a significant drop in hydraulic pressure, only the system or systems designated to receive power will receive such power. As a result, other systems that might otherwise take power away from the designated system are prevented from doing so. In a particular aspect of this embodiment, the boom actuator or other refueling system actuator can receive power in such instances, while other actuators which may be less important during a hydraulic system failure do not.

Still another feature of at least some embodiments of the systems and methods described above with reference to FIGS. **1-3** is that they can include self-displacing accumulators. Such accumulators operate to expel fluid from one side of the accumulator while taking in fluid on the other. An advantage of such an accumulator is that it does not require the hydraulic fluid reservoir to be increased in size when the accumulator is installed. Accordingly, the accumulator can be retrofitted into an existing hydraulic system without requiring changes to the reservoir. A follow-on advantage of this feature is that it can simplify a retrofit operation. Another follow-on advantage for both retrofit systems and new systems is that the reservoir can have a relatively small size, which reduces the overall weight of the aircraft on which it is installed.

Yet another feature of at least some embodiments of the systems and methods described above with reference to FIGS. **1-3** is that they can be specifically configured for ease of installation. This can be particularly advantageous when the system capabilities are to be retrofit into an existing system, and/or when the system is to be replaced. For example, in a particular embodiment shown in FIG. **2**, selected components can be provided in a single line replaceable unit **170** (e.g., contained in a single housing) outlined by dashed lines in FIG. **2**. The unit **170** can include the two energy storage devices **130**, the pressurized gas source **117**, the check valve **115** and the bleed valve **116**. Optionally, the unit **170** can include other components as well, e.g., the selector valve **118**. The unit **170** can be readily connected to an existing hydraulic system at connection points **171**. An advantage of this arrangement is that the capabilities provided by the unit **170** (e.g., providing back-up hydraulic power to one or more selected hydraulic devices and smoothing out normal fluctuations in system pressure without requiring an increase in reservoir size) can be added to an existing hydraulic system without requiring significant changes to the existing system.

From the foregoing, it will be appreciated that specific embodiments of the invention have been described herein for purposes of illustration, but that various modifications may be made without deviating from the invention. For example, in some embodiments, the accumulators (or other energy storage devices) need not include self-displacing accumulators. In such cases, the accumulators need not be coupled to the return line. In other embodiments, the accumulator can be replaced with another suitable device for storing hydraulic energy. In still further embodiments, aspects of the invention can be applied to systems other than aerial refueling systems. For example, in some cases, actuators that drive devices in addition to or in lieu of deployable aerial refueling devices can be coupled to a selectively dischargeable accumulator. In still other embodiments, the hydraulic system **110** or aspects thereof can be applied to systems other than aircraft. Aspects of the invention described in the context of particular embodiments may be combined or eliminated in other embodiments. For example, the hydraulic system **110** need not include both the first accumulator **130***a* and the second accumulator **130***b*, but can instead include only the second accumulator **130***b*. Further, while advantages associated with certain embodiments of the invention have been described in the context of those embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the invention. Accordingly, the invention is not limited except as by the appended claims.

We claim:

1. An aircraft system, comprising:

a hydraulic fluid source;

a hydraulic supply line coupled to the hydraulic fluid source;

a hydraulic return line coupled to the hydraulic fluid source;

a hydraulic aircraft actuator coupled between the hydraulic supply line and the hydraulic return line;

a fluid energy storage device coupled to at least one of the hydraulic supply line and the hydraulic return line, the fluid energy storage device including the second of two accumulators;

a first valve coupled between the fluid energy storage device and the at least one of the hydraulic supply line and the hydraulic return line to at least approximately prevent a flow of hydraulic fluid from the fluid energy storage device to the at least one of the hydraulic supply line and the hydraulic return line;

a second, control valve coupled between the fluid energy storage device and the actuator, the control valve being changeable between a first configuration in which the control valve at least restricts fluid flow between the fluid energy storage device and the actuator, and a second configuration in which the control valve allows a flow of fluid to the actuator at least sufficient to operate the actuator;

a first accumulator coupled to at least one of the supply line and the return line in parallel with the second accumulator and the first valve to provide fluid energy to the hydraulic supply line during normal system fluctuations; and

a secondary supply line coupled to the control valve and connected at a point between the first valve and the second accumulator.

2. The system of claim **1**, further comprising a controller coupled to the control valve to move the control valve between a closed position corresponding to the first configuration, and an open position corresponding to the second configuration.

3. The system of claim **2** wherein the controller includes a manual controller.

4. The system of claim **2** wherein the controller includes an at least partially automated controller.