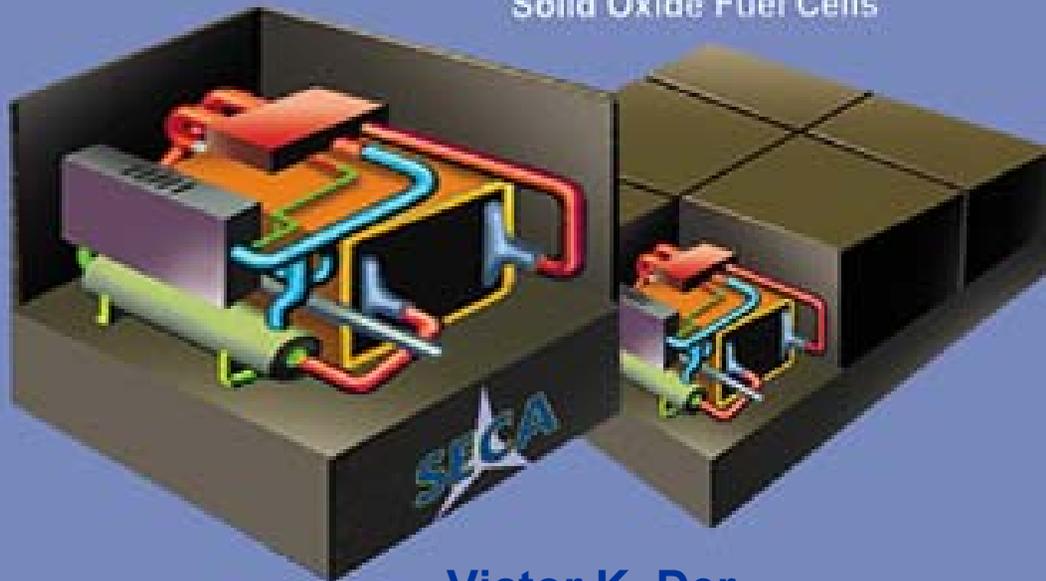


# U.S. D.O.E. PERSPECTIVE ON POTENTIAL FOR FUEL CELL – TURBINE HYBRID POWER SYSTEMS



Solid Oxide Fuel Cells



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# U. S. DOE FOSSIL ENERGY ADVANCED POWER PROGRAM



- Focus on Clean, High-Efficiency, Low-cost Central and Distributed Generation Systems
- Efficiency improvements and clean power with an ultimate goal of achieving 60% electrical efficiency for central and over 70% for gas based distributed power systems with virtual elimination of emissions
- Power Generation technologies include fuel cells, fuel flexible turbines, fuel cell turbine hybrids, advanced integrated gasification combined cycles and advanced combustion cycles
- For advanced central systems, pursuing technologies with features that will be compatible with carbon capture and sequestration.



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# TECHNOLOGIES IN SUPPORT OF HYBRID SYSTEMS



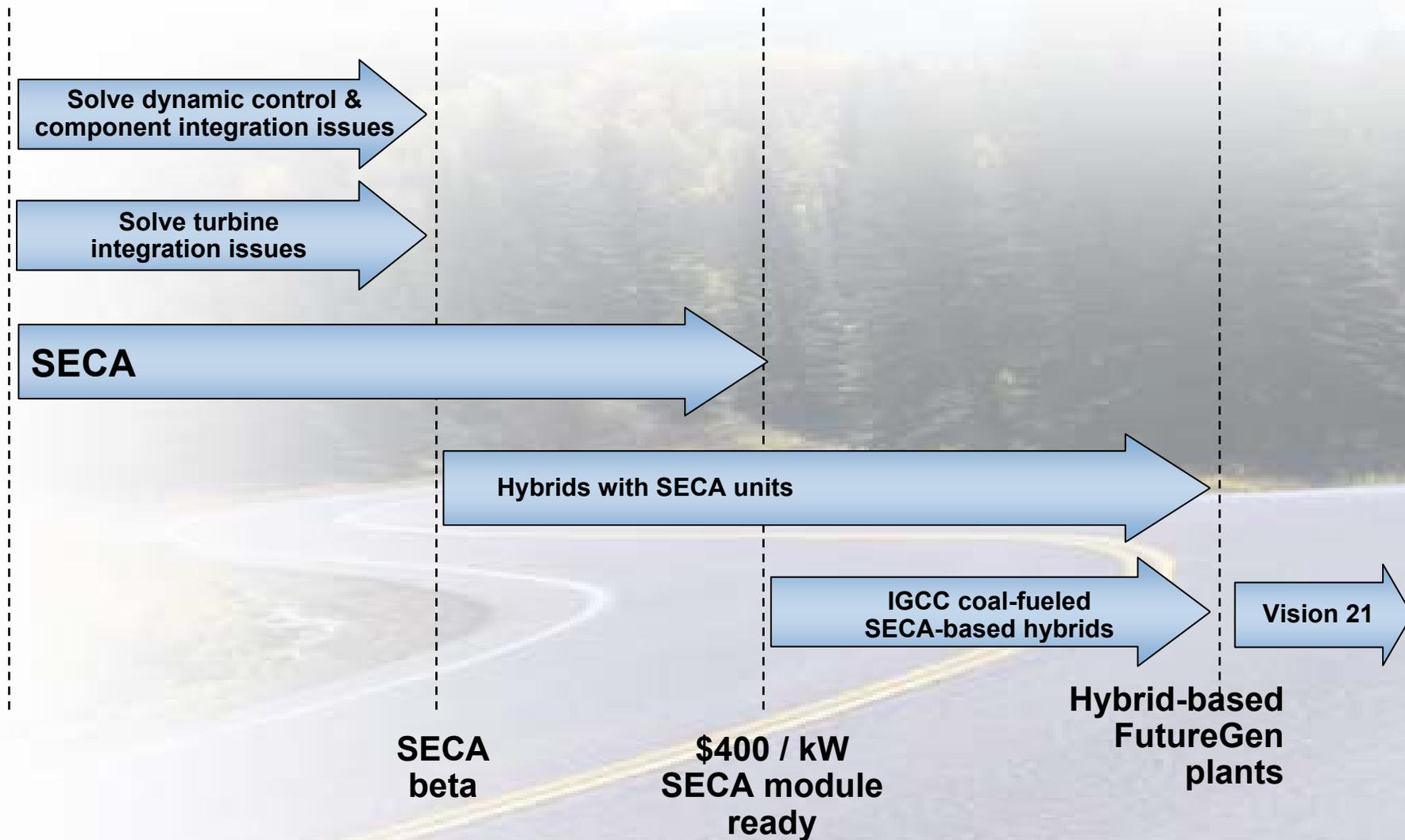
## *FOCUS IS ON A DESIGN-TO-COST APPROACH*

- **Low-Cost Fuel Cells – SECA (Solid State Energy Conversion Alliance) with a goal of achieving \$400/kW by 2010**
- **Fuel Flexible Turbines (including hydrogen fueled) that range from mini to large scale multi-megawatt size for central power**
- **Hybrid integration of Turbines (at \$400/kw) with Fuel Cells**
- **Advanced Materials**
- **Controls, sensors and diagnostics for reliable operations and system protection**



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# TECHNOLOGY ROAD MAP FOR HYBRID POWER SYSTEMS





# IMPORTANCE OF HYBRIDS AS PART OF THE ADVANCED POWER TECHNOLOGY PORTFOLIO

- Hybrids as Fuel Cell-Turbine combined cycles have higher efficiencies than either Fuel Cells or Turbines operating in simple cycles. This feature is important when fuel supply or fuel pricing is at a premium or in regions where environmental regulations dictate tight restrictions on emissions.
- Hybrids by virtue of high efficiency and competitive cost potential could be a way of expanding fuel cells deployment in the market.
- Hybrids are a key power module for large-scale central stations in achieving higher efficiency and in the eventual transition to a hydrogen economy
- Offer operational flexibility as well as having feature components as built-in backup systems



# CHALLENGES FACING HYBRID SYSTEMS



➤ As with many new technologies, a host of issues need to be addressed in order for hybrids to become a reality in the market place:

➤ **Systems:**

- Integration challenges- depending on the degree of integration, may not be as easy as originally perceived
- Systems complexity effects on reliability and servicing
- Hardware modifications to turbines are needed
- Need for controls and systems protections

➤ **Design:**

- Need more operational data and testing for improved design life and performance including cycling modes
- System simplification and trade-offs to meet design-to-cost
- Optimal sizing
- Balance of plant issues



# CHALLENGES FACING HYBRID SYSTEMS (con't)



## ➤ Initial Cost:

- Fuel Cell costs still an major component (manufacturing and materials)
- Costs of ancillary hardware and balance of plant

## ➤ Market Acceptance of a new technology

- Customer Confidence (“low Serial number” syndrome) and the value of the warranty
- Supply Chain – willingness of manufacturer to invest in new product line (e.g., flexible turbine at off-sizes from main product line) and need for product service support after purchase



# What's Next?

## *How to Meet the Challenges?*



- Continuation of effort on dramatic cost reduction of the fuel cell technology like that being pursued under SECA
- Government and private sector partnership to share in cost and risks of development of hybrids for both DG and large scale power modules for central stations
- Pursue opportunities in various test platforms including FutureGen
- Industry should take the lead role in identifying customers willing to host demonstrations
- Customer surveys and product information outreach to pave market for hybrids
- Strategy for supply chain, service, parts and warranties



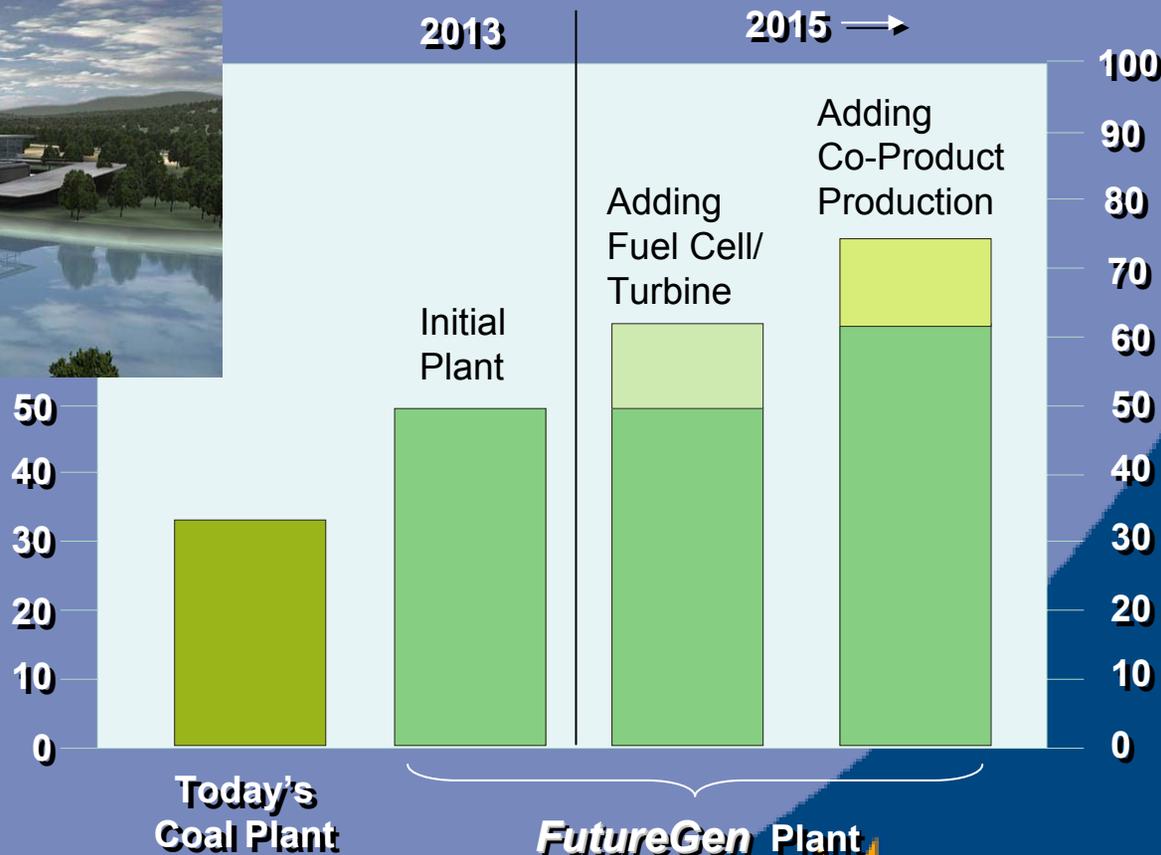
# FutureGen



## The World's Most Energy-Efficient Power Plant



Boosting power plant efficiencies is first step toward reducing greenhouse gases



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## Concluding Remarks

- **Potential Benefits of Hybrids in variety of applications including combined heat and power warrant continued government and private sector cost-shared development.**
- **Hybrids represent a key element of DOE's fossil energy power portfolio to achieve our ultimate high efficiency and zero emission plants of the future. Efficiency is valued in zero emissions plants to off-set power needs for carbon sequestration.**
- **The introduction of hybrid systems may be a viable approach for expanding and accelerating the deployment of fuel cells in the market**

