

Testimony before the Senate Energy and Water  
Development Subcommittee of Appropriations

U.S. Department of Energy Nuclear Energy, Licensing Support  
Program for Small Modular Light Water Nuclear Power Reactors

July 14, 2011

- MADAM CHAIR, MEMBERS OF THE COMMITTEE, THANK YOU FOR THIS OPPORTUNITY TO APPEAR BEFORE YOU TODAY. MY NAME IS PAUL LORENZINI. I AM THE CHIEF EXECUTIVE OFFICER OF NUSCALE POWER, INC., LOCATED IN CORVALLIS, OREGON.
  - ✓ NUSCALE POWER WAS INCORPORATED IN 2007 AND HAS BEEN FUNDED ENTIRELY FROM PRIVATE SECTOR CAPITAL. TO DATE JUST UNDER \$40 MILLION HAS BEEN INVESTED IN OUR COMPANY.
  - ✓ THE GENESIS OF OUR 45 MWE ‘INTEGRATED PRESSURIZED’ SMALL-SCALE POWER MODULE BEGAN OVER 10 YEARS AGO WITH A DEPARTMENT OF ENERGY GRANT THROUGH THE IDAHO NATIONAL LAB AND OREGON STATE UNIVERSITY. THIS GRANT CAME AT A TIME WHEN THIS VERY SAME SUBCOMMITTEE SET AS A GOAL TO ‘SPIN OFF’ MORE PRIVATE SECTOR INVESTMENTS FROM THE NATIONAL LAB COMMUNITY AND LEVERAGE PRIVATE CAPITAL IN NEW COMPANIES.
  - ✓ THIS PROGRAM INCLUDED THE CONSTRUCTION OF A ONE-THIRD SCALE, ELECTRICALLY HEATED TEST FACILITY TO VALIDATE THE SAFETY FEATURES OF THE PLANT. IN OTHER WORDS, OUR PLANT DESIGN RESTS ON A SOLID FOUNDATION WHICH INVOLVES MORE THAN PAPER STUDIES.
  - ✓ SINCE OUR FOUNDING IN 2007, WE HAVE BEEN ENCOURAGED BY THE GROWING RECOGNITION OF THE VALUE OF SMR’S IN DEVELOPING A BALANCED ENERGY POLICY.
  - ✓ FIRST, WE HAVE SEEN THE RESPONSE OF CUSTOMERS. THEY LIKE SEVERAL UNIQUE ASPECTS OF THE NUSCALE SMR – THE LOWERED FINANCIAL BARRIERS, THE ELIMINATION OF SO-CALLED SINGLE SHAFT RISKS – IF A SINGLE 45 MWE UNIT GOES DOWN, THE REST OF THE PLANT CONTINUES TO OPERATE ELIMINATING THE NEED TO FIND REPLACEMENT

POWER FOR THE GRID; AND THEY ESPECIALLY LIKE THE ABILITY TO INCREMENTALLY ADD NEW GENERATION TO MATCH LOAD GROWTH. ALL OF THESE FEATURES PROVIDE SIGNIFICANT BENEFITS TO THEIR CUSTOMERS. WE CURRENTLY HAVE MORE THAN TEN MAJOR UTILITIES PARTICIPATING ON OUR CUSTOMER ADVISORY BOARD.

- ✓ SECOND, THE NRC'S POLICY GUIDANCE ISSUED IN MARCH 2010 FOR POTENTIAL SMR APPLICANTS WAS A VERY POSITIVE STEP FORWARD. THIS KEY GUIDANCE FROM OUR SAFETY REGULATOR HAS GIVEN US THE PRELIMINARY ROADMAP WE NEEDED TO SUBMIT A HIGH QUALITY APPLICATION.
- ✓ FINALLY, THE INCLUSION OF FEDERAL COST SHARING FOR THE DEVELOPMENT OF COMMERCIAL SMR'S IN PRESIDENT OBAMA'S BUDGET LAST FEBRUARY HAS BEEN CRITICAL TO OUR ABILITY TO ATTRACT THE INVESTORS WHO ARE OBVIOUSLY NECESSARY FOR OUR SUCCESS.
- ✓ AS WE NOW CONSIDER THE FUTURE OF THAT PROGRAM, LET ME FOCUS MY REMARKS IN FOUR AREAS:
  - FIRST, THE ECONOMICS OF SMALL MODULAR REACTORS (SMR'S)
  - SECOND, THE WAYS IN WHICH THEY ENHANCE THE SAFETY OF NUCLEAR POWER, A CRITICAL QUESTION IN A POST-FUKUSHIMA WORLD
  - THIRD, A FEW BRIEF COMMENTS ON SPENT FUEL; AND
  - LASTLY, THE KEY QUESTION -- DOES AN SMR COST SHARING PROGRAM SERVE THE NATIONAL INTEREST?
- LET ME SPEAK FIRST TO THE ECONOMIC QUESTION.
  - ✓ SMALL NUCLEAR PLANTS HAVE BEEN AROUND FOR A LONG TIME AND IN RECENT YEARS THEY ATTRACTED INTEREST BECAUSE THEY COULD SERVE REMOTE LOCATIONS AND ELECTRICAL SYSTEMS WITH SMALLER GRIDS.
  - ✓ IT WAS ALWAYS KNOWN THAT THE INVESTMENT REQUIRED TO BUILD A SMALL NUCLEAR PLANT WOULD BE LESS. BUT IT WAS ALSO BELIEVED – INDEED, IT HAS BECOME ALMOST AN ARTICLE OF FAITH – THAT THE

ECONOMIES OF SCALE WOULD MAKE THEM UNECONOMIC COMPARED WITH LARGER PLANTS.

- ✓ WHEN WE FIRST STARTED NUSCALE IN 2007, WE KNEW THIS IS WHAT PEOPLE BELIEVED. YET WE BELIEVED THOSE OLD CHESTNUTS MIGHT BE WRONG.
  - WE SAW THE ECONOMIC ADVANTAGES OF THE SIMPLICITY OF OUR DESIGN;
  - WE SAW THE ECONOMIC VALUE OF TAKING VIRTUALLY THE ENTIRE NUCLEAR SYSTEM, INCLUDING ITS CONTAINMENT, TO A FACTORY WHERE THEY COULD BE MANUFACTURED UNDER MORE CONTROLLED CONDITIONS.
  - BUT WE ALSO KNEW NO ONE – EITHER INSIDE OR OUTSIDE THE INDUSTRY – WOULD BELIEVE OUR ASSESSMENT OF THE ECONOMICS WITHOUT SOME KIND OF PROOF.
  - IN 2008, WORKING WITH OUR ENGINEERING AND MANUFACTURING PARTNERS, WE DEVELOPED A DETAILED, BOTTOMS UP COST ESTIMATE. WHEN WE GOT THE RESULTS, WE SAW WHERE WE COULD MAKE IMPROVEMENTS IN DESIGN AND CONSTRUCTION, SO WE SPENT AN ADDITIONAL 16,000 MAN-HOURS IN 2009 TO TAKE A SECOND RUN AT IT.
  - WE CAME UP WITH UNIT COSTS – MEANING \$/KW – THAT SURPRISED EVEN US – THEY NOT ONLY COMPARED VERY WELL WITH LARGE PLANT NUMBERS – THEY WERE ACTUALLY LOWER. WHEN WE SHOWED THESE NUMBERS TO UTILITY EXECUTIVES, THEY CHALLENGED US TO INDEPENDENTLY VALIDATE THEM. WE USED A FIRM THAT HAS DONE INDEPENDENT COST ESTIMATING ON MANY LARGE NUCLEAR PLANTS, AND THEY CONFIRMED OUR ESTIMATES WITHIN 10%.
  - WE TOO HEAR ALL THE CHALLENGES TO THE ECONOMICS OF SMALL REACTORS BASED ON SCALING AND OLD RHETORIC – BUT WE’VE DONE THE ESTIMATING – ON AN ACTUAL DESIGN, STARTING FROM THE GROUND UP. THAT’S THE ONLY REAL WAY TO ANSWER THE QUESTION. AND THE RESULTS ESTABLISH QUITE CLEARLY THAT WE HAVE A PLANT THAT WILL COMPLETELY CHANGE THE ECONOMIC STORY FOR NUCLEAR POWER, BY NOT ONLY LOWERING THE

FINANCIAL BARRIERS, BUT BY DOING SO WITH A UNIT COST THAT IS ACTUALLY LOWER THAN COMPETITIVE LARGER NUCLEAR PLANTS.

- NEXT LET ME SPEAK TO THE SAFETY QUESTION.
  - ✓ WHEN THE NUSCALE CONCEPT WAS FIRST FUNDED BY THE DEPARTMENT OF ENERGY IN 2001, THE PRINCIPAL DESIGNER, A PROFESSOR AT OREGON STATE UNIVERSITY, DR. JOSE REYES, SET OUT TO DESIGN WHAT HE HOPED WOULD BE THE SAFEST LIGHT WATER REACTOR EVER BUILT. HE HAD SPENT TEN YEARS IN THE NUCLEAR REGULATORY COMMISSION, HE HAD BEEN INVOLVED IN THE ANALYSIS OF THREE MILE ISLAND, AND HE KNEW NOT ONLY OF THE IMPORTANCE OF SAFETY, BUT THE IMPORTANCE OF VALIDATING SAFETY THROUGH BOTH LARGE AND SMALL SCALE TESTS AND EXPERIMENTS.
  - ✓ WITH THE BENEFIT OF HAVING DESIGNED THE TEST FACILITIES THAT DEMONSTRATED THE PASSIVE SAFETY FEATURES OF THE WESTINGHOUSE AP1000 – A VERY IMPORTANT ADVANCE IN THE SAFETY OF NUCLEAR POWER AND ONE THAT, BY ITSELF, WOULD HAVE PREVENTED THE ACCIDENT AT FUKUSHIMA – HE ASKED WHAT MORE COULD BE DONE.
  - ✓ THE RESULT IS THE PLANT WE ARE NOW SEEKING TO COMMERCIALIZE AT NUSCALE POWER.
    - FIRST, HE DEVELOPED A REVOLUTIONARY CONCEPT FOR THE CONTAINMENT – ONE THAT CAN BE FACTORY BUILT, ONE THAT CAN WITHSTAND MUCH HIGHER INTERNAL PRESSURES, AND ONE THAT CAN BE TOTALLY IMMERSSED IN A POOL OF WATER UNDERGROUND.
      - THE SIGNIFICANCE OF THIS LATTER FEATURE IS VERY IMPORTANT. IT MEANS WE HAVE A VERY RESILIENT AND EFFECTIVE PASSIVE SYSTEM FOR REMOVING DECAY HEAT. ABOUT GETTING RID OF THE DECAY HEAT. THIS POOL HOLDS 4 MILLION GALLONS OF WATER AND IS SUFFICIENT TO REMOVE ALL THE DECAY HEAT WITHOUT EVER HAVING TO ADD MORE WATER TO THE SYSTEM.
      - THIS POOL OF WATER IS HOUSED IN A STAINLESS STEEL LINED CONCRETE BUILDING THAT, BECAUSE IT IS MOSTLY UNDERGROUND, IS SEISMICALLY VERY STRONG. THE EFFECT OF THIS POOL AND THE BUILDING IS NOT ONLY TO PROVIDE SECURITY

FOR REMOVING DECAY HEAT, IT ALSO MAKES IT MUCH MORE DIFFICULT FOR ANY RADIOACTIVE RELEASE TO OCCUR BECAUSE THERE ARE NOW ADDITIONAL BARRIERS OUTSIDE THE CONTAINMENT STRUCTURE.

- SECOND, HE TOOK ADVANTAGE OF SIMPLICITY. DRAWING ON THE NATURAL CIRCULATION LEARNING FROM THE AP1000 TESTS, HE DESIGNED THE REACTOR TO BE ENTIRELY COOLED BY NATURAL CIRCULATION – WHICH ELIMINATES PUMPS, PIPES AND VALVES AND ALL THE POTENTIAL FAILURE MODES (AND COSTS) ASSOCIATED WITH THAT EQUIPMENT. IN SO DOING, HE ELIMINATED THE SO-CALLED LARGE BREAK LOSS OF COOLANT ACCIDENT THAT LARGELY DOMINATES THE SAFETY ANALYSIS OF LARGE PLANTS.
  - FINALLY, HE SOUGHT OUTSIDE EXPERT ADVICE. VERY EARLY IN OUR PROGRAM, HE CONVENED TWO EXPERT REVIEW PANELS, ONE CHAIRED BY DR. GRAHAM WALLACE, A FORMER CHAIR OF THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS), AND A SECOND CHAIRED BY DR. MICHAEL CORRADINI, A MEMBER OF THE NATIONAL ACADEMY OF ENGINEERING AND A MEMBER OF THE ACRS. THESE INDEPENDENT REVIEWS NOT ONLY VALIDATED OUR BELIEF IN THE SAFETY OF THIS PLANT, THEY ALSO MADE HELPFUL RECOMMENDATIONS TO ENHANCE THE SAFETY EVEN FURTHER.
  - WE HAVE SINCE COMPLETED AN INITIAL PROBABILISTIC SAFETY ANALYSIS WHICH SHOWS THAT THE PROBABILITY OF ANY EVENT LEADING TO FUEL DAMAGE IN THIS PLANT IS ONCE EVERY FIFTY MILLION YEARS (50,000,000 YEARS). THIS EXCEEDS THE REQUIREMENTS OF THE NUCLEAR REGULATORY COMMISSION BY A FACTOR OF 5,000
- ✓ BECAUSE I KNOW IT IS IMPORTANT TO MEMBERS OF THIS COMMITTEE, LET ME SPEAK ALSO BRIEFLY TO THE QUESTION OF SPENT FUEL.
- I WILL MAKE THREE QUICK POINTS:
    - FIRST, SPENT FUEL IN THE NUSCALE PLANT IS HOUSED IN AN UNDERGROUND PROTECTED STRUCTURE.

- SECOND, IT HAS APPROXIMATELY FOUR TIMES THE WATER VOLUME OF CONVENTIONAL SPENT FUEL POOLS PER MW OF THERMAL POWER.
- FINALLY, IT USES WHAT ARE CALLED LOW DENSITY FUEL RACKS THAT MAKE IT MUCH EASIER TO REMOVE HEAT FROM THESE SPENT FUEL ASSEMBLIES.
- MADAM CHAIR AND MEMBERS OF THE COMMITTEE AN SMR PROGRAM SERVES THE NATIONAL INTEREST IN SEVERAL WAYS:
  - ✓ IT SERVES THE NATIONAL GOAL OF BRINGING TO MARKET A NON-CARBON SOURCE OF BASELOAD ENERGY – THAT IS, ENERGY AVAILABLE ALL DAY, EVERY DAY. NUCLEAR POWER ACHIEVES THAT GOAL AND SMR’S FURTHER IT BY OVERCOMING FINANCIAL BARRIERS, AND BY REACHING MARKETS NOT ACCESSIBLE TO LARGER REACTOR DESIGNS.
  - ✓ SECOND, IT BUILDS THE DOMESTIC MANUFACTURING BASE, AND THUS CREATES JOBS AND THE POTENTIAL FOR EXPORTS.
  - ✓ THIRD, AND PERHAPS MOST IMPORTANT, IT TAKES THE SAFETY OF NUCLEAR POWER TO A NEW LEVEL, SOMETHING THAT WILL BE DEMANDED IN A POST-FUKUSHIMA WORLD.
  - ✓ FINALLY, AND MOST IMPORTANTLY THIS PROGRAM ASSURES THAT OUR OWN US NUCLEAR REGULATORY COMMISSION WILL BE ENGAGED IN THE SAFETY ANALYSIS AND LICENSING OF THIS NEXT GENERATION OF REACTORS AND WILL PRESERVE WHAT IS KNOWN AROUND THE WORLD AS THE ‘GOLD STANDARD’ OF SAFETY REVIEWS.
- MADAM CHAIR AND MEMBERS OF THIS COMMITTEE, IT TAKES A SUBSTANTIAL INVESTMENT TO BRING THESE TECHNOLOGIES TO MARKET. IT MAY NOT HAPPEN WITHOUT SOME KIND OF ASSISTANCE. WE HAVE AN OPPORTUNITY TO MOVE THIS PROGRAM FORWARD AND CAPTURE THE UNIQUE ADVANTAGES OF THIS NEXT ADVANCE IN THE USE OF NUCLEAR ENERGY – BOTH ON AN ECONOMIC AND A SAFETY FRONT. I URGE YOUR SUPPORT FOR THIS PROGRAM.
- THANK YOU FOR GIVING ME THIS OPPORTUNITY AND I WOULD BE HAPPY TO ANSWER QUESTIONS.